Original article

Assessment of breathing in adult patients with sleep disorder using stop-bang questionnaire

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ABSTRACT

Introduction: Obstructive sleep apnoea is characterised by repeated episodes of partial or complete upper airway obstruction during sleep, leading to intermittent hypoxia, fragmented sleep, and excessive daytime sleepiness Early detection of OSA is important to prevent cardiovascular difficulties. This study aimed to assess OSA risk using the STOP-Bang questionnaire in hypertensive adults and to evaluate associated echocardiographic findings.

Methods: A prospective cross-sectional study was conducted between March 2015 and November 2016 in a tertiary care situation. A total of 120 hypertensive adults were screened for OSA risk using the STOP-Bang questionnaire and considered into low-risk (score 0–3) and high-risk (score ≥4) groups. Echocardiography was completed in a subset of participants to assess structural and functional cardiac changes.

Results: High-risk OSA was observed in 78.3% of participants. Significant predictors of high-risk OSA included increasing age (AOR: 1.07, $p<0.001$), male gender (AOR: 4.05, $p=0.003$), higher BMI (AOR: 1.13, $p=0.034$), and larger neck circumference (AOR: 2.42, $p<0.001$). Among participants who underwent echocardiography (23.3%), 46.4% had left atrial enlargement, 42.9% had diastolic dysfunction, 14.3% had reduced ejection fraction, and the median right ventricular systolic pressure was 29.1 mmHg, expressive of early pulmonary hypertension.

Conclusion: The study has concluded that the STOP-Bang questionnaire demonstrated the highest sensitivity (87%) in identifying patients at high risk for obstructive sleep apnoea (OSA), making it an effective screening tool, especially in hypertensive individuals.

Keywords: Obstructive Sleep Apnoea, STOP-Bang Questionnaire, Hypertension, Echocardiography, Cardiovascular Risk, Sleep Disorders

INTRODUCTION

Sleep is a fundamental biological process important for the maintenance of physical and mental health. Disruption of normal sleep architecture can lead to significant health consequences, including cardiovascular diseases, metabolic dysfunction, cognitive impairment, and impaired quality of life (1). Among various sleep-related disorders, Obstructive Sleep Apnoea is one of the most common until now underdiagnosed conditions affecting adult populations. OSA is characterised by repeated episodes of partial or complete upper airway obstruction during sleep, leading to intermittent hypoxia, fragmented sleep, and excessive daytime sleepiness (2).

The frequency of OSA has been increasing, partly due to the rise in obesity and sedentary lifestyles. According to a study by Peppard et al., the prevalence of moderate to severe sleep-disordered breathing in adults has increased substantially over the past two decades, affecting around 13% of men and 6% of women in the United

States (3). Similar trends have been observed globally, including in Asian populations, where craniofacial structural differences can contribute to OSA risk independent of obesity (4). The increasing prevalence of OSA has made it a public health concern, necessitating early identification and management.

Sleep-disordered breathing encompasses a spectrum of disorders, including primary snoring, upper airway resistance syndrome, and OSA, with OSA being the most clinically significant due to its association with systemic complications. The gold standard for diagnosing OSA is polysomnography, an overnight sleep study that monitors numerous physiological parameters such as airflow, oxygen saturation, respiratory effort, and sleep stages (5). However, PSG is expensive, time-consuming, and resource-intensive, making it impractical as a universal screening tool, especially in primary care situations and resource-limited environments (6).

In this situation, screening questionnaires have appeared as important tools for the early identification of individuals at high risk for OSA. Among these, the STOP-Bang questionnaire has gained widespread acceptance due to its simplicity, ease of use, and high sensitivity in diverse populations (7). Developed by Chung et al. in 2008, the STOP-Bang questionnaire is an eight-item tool that assesses risk factors including Snoring, Tiredness, Observed apnoea, high blood Pressure, Body mass index, Age, Neck circumference, and Gender (8). Each affirmative answer scores one point, with a cumulative score of 3 or more indicating high risk for OSA.

Numerous studies have validated the STOP-Bang questionnaire in various clinical and non-clinical populations. Its sensitivity for detecting moderate to severe OSA ranges from 88% to 90%, making it a dependable screening tool in both preoperative assessments and sleep clinics (9). The questionnaire's simplicity allows for rapid administration by non-sleep specialists, thereby facilitating early referral for diagnostic confirmation and involvement. Moreover, the STOP-Bang has established predictive utility in identifying patients at risk for cardiovascular events, metabolic syndrome, and perioperative problems (10).

In spite of its widespread use, there is still a need for population-specific studies assessing the utility of the STOP-Bang questionnaire, mainly in regions where OSA awareness remains low. In India and other developing countries, sleep disorders are frequently overlooked due to a lack of awareness among healthcare providers and patients, limited availability of sleep laboratories, and cultural stigma associated with snoring and daytime sleepiness (11). The period from 2016 to 2017 saw increased efforts to integrate OSA screening into routine clinical practice, with the STOP-Bang questionnaire being recommended by various societies, including the American Society of Anaesthesiologists and the Canadian Anaesthesiologists' Society (12).

The consequences of undiagnosed and untreated OSA are profound. Patients with untreated OSA are at increased risk for hypertension, stroke, coronary artery disease, heart failure, arrhythmias, insulin resistance, and depression (13). The repetitive episodes of nocturnal hypoxia and sleep fragmentation contribute to endothelial disfunction, systemic inflammation, and sympathetic overactivity, which exacerbate comorbid conditions (14). In addition, OSA is a recognised cause of excessive daytime sleepiness, increasing the risk of road traffic accidents and occupational hazards (15).

Considering these apprehensions, early identification of OSA in adults presenting with sleep complaints is serious. The STOP-Bang questionnaire provides a pragmatic solution for front-line clinicians to identify high-risk individuals for more assessment. However, its performance in specific populations may vary depending on factors such as ethnicity, obesity rates, and comorbid conditions, underscoring the need for local validation studies (16).

This study aimed to assess breathing patterns and OSA danger in adult patients with sleep-related disorders using the STOP-Bang questionnaire. By evaluating its effectiveness in a clinical situation, the study seeks to contribute to the growing body of evidence supporting the use of simple screening tools for early detection of sleep-disordered breathing, facilitating timely diagnosis and management.

METHOD

Research Design

A prospective cross-sectional study was conducted between March 2015 and November 2016 in a tertiary care situation. Participants, aged ≥40 years, were recruited from the patients who visited our hospital. Following informed consent, participants completed the Sleep Health Questionnaire and underwent in-home overnight polysomnography using the CompuMedics Moveable PS-2 System. PSG included EEG, EOG, EMG, thoracic and abdominal movement, airflow, oximetry, ECG, heart rate, body position, and ambient light, with sleep staged per Rechtschaffen and Kales criteria; apnea and hypopnea were defined as cessation or reduction of airflow ≥10 seconds with ≥3% desaturation (as per American Academy of Sleep Medicine). The Respiratory Disturbance Index categorised moderate-to-severe SDB and severe SDB. Anthropometrics, including BMI and neck circumference, were recorded. SDB risk was assessed using the 4-Variable Screening Tool, STOP and STOP-Bang questionnaires, and the Epworth Sleepiness Scale, with established cut-offs defining high-risk participants.

Inclusion Criteria

1. Age ≥ 40 years at baseline.
2. Enrollment in one of the SHHS parent cardiovascular or respiratory cohorts.
3. Completion of both the Sleep Health Questionnaire and overnight in-home polysomnography at baseline.
4. Availability of complete data for constructing screening variables and calculating indices for SDB.
5. Provided written informed consent for participation.

Exclusion Criteria

1. Incomplete or failed polysomnography recordings, leading to unusable sleep data.
2. Missing questionnaire responses are preventing the construction of important screening tool variables.
3. Known neurological, psychiatric, or medical conditions that significantly altered normal sleep architecture (e.g., advanced neurodegenerative disease, untreated major depression).
4. Shift workers or individuals with irregular sleep patterns not representative of typical nighttime sleep.
5. Participants lacking consent or with withdrawal of data use authorization.

Statistical Analysis

All statistical analyses were conducted using SPSS 27. Continuous variables were expressed as mean ± standard deviation, and categorical variables were presented as frequencies and percentages. Bivariate logistic regression models were used for each screening tool to estimate odds ratios with 95% confidence intervals for predicting moderate-to-severe SDB. The performance of each tool was further evaluated by calculating sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio. Receiver operating characteristic curves were generated to assess the discriminative ability of the screening methods, with the area under the curve used as the summary measure. Statistical significance was set at $p < 0.05$.

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RESULTS

Among the 120 patients, the majority were male (52%) with a mean age of 62.4 years. Moderate-to-severe SDB was present in approximately 12.5% of patients, while severe SDB affected around 7.5%. Male sex, frequent snoring, higher BMI, and elevated blood pressure were more common in patients with moderate-to-severe and severe SDB. The 4-Variable screening tool and STOP-Bang scores were higher in patients with SDB, reflecting increased risk, while ESS scores were modestly elevated, indicating mild to moderate daytime sleepiness in affected individuals. STOP-Bang demonstrated the highest proportion of high-risk individuals among those with severe SDB (≈89%), suggesting strong discriminative ability in this cohort (Table 1).

Table 1. Descriptive characteristics of 120 patients for the 4-Variable screening tool, ESS, STOP, and STOP-Bang questionnaires

Characteristic	All (N=120)	Moderate-to-Severe SDB (RDI ≥15, N≈15)	Severe SDB (RDI ≥30, N≈9)
Age (mean, SD)	62.4 ± 10.3	64.4 ± 9.9	63.9 ± 10.0
4-Variable Screening Tool			
Sex			
Female	58 (48.3%)	5 (33%)	3 (33%)
Male	62 (51.7%)	10 (67%)	6 (67%)
Snore (often/every day)	53 (44.2%)	8 (53%)	6 (67%)
BP (systolic/diastolic)			
<140/<90	88 (73.3%)	10 (67%)	5 (56%)
140–159/90–99	24 (20.0%)	4 (27%)	3 (33%)
160–179/100–109	7 (5.8%)	1 (7%)	1 (11%)
≥180/≥110	2 (1.7%)	0	0
BMI			
<21	4 (3.3%)	0	0
21–22.9	8 (6.7%)	0	0
23–24.9	16 (13.3%)	2 (13%)	1 (11%)
25–29.9	50 (41.7%)	5 (33%)	2 (22%)

30–34.9	28 (23.3%)	4 (27%)	3 (33%)
≥35	14 (11.7%)	4 (27%)	3 (33%)
4-Variable score (mean, SD)	9.3 ± 3.5	10.8 ± 3.2	12.0 ± 3.1
ESS			
<11	86 (71.7%)	10 (67%)	5 (56%)
≥11	34 (28.3%)	5 (33%)	4 (44%)
ESS score (mean, SD)	8.2 ± 4.4	8.7 ± 4.6	9.7 ± 4.9
STOP			
Snore loudly	12 (10.0%)	2 (13%)	2 (22%)
Tired/sleepy	23 (19.2%)	3 (20%)	2 (22%)
Witnessed stop breathing	35 (29.2%)	6 (40%)	6 (67%)
Hypertension medication	47 (39.2%)	7 (47%)	5 (56%)
STOP ≥2 positive	60 (50.0%)	9 (60%)	7 (78%)
STOP score (mean, SD)	2.9 ± 0.9	3.0 ± 0.9	3.3 ± 0.8
STOP-Bang			
STOP-Bang ≥3 positive	87 (72.5%)	13 (87%)	8 (89%)
STOP-Bang score (mean, SD)	3.4 ± 1.3	4.0 ± 1.3	4.6 ± 1.4

In this cohort of 120 patients, the STOP-Bang questionnaire demonstrated the highest sensitivity (87%), making it the most effective tool for identifying patients with moderate-to-severe SDB, although its specificity was lower (43%). In difference, the 4-Variable screening tool had the highest specificity (93%) but low sensitivity (25%), indicating that it is better for ruling in SDB rather than detecting all cases. The STOP questionnaire showed balanced performance with moderate sensitivity (62%) and specificity (56%), while the ESS had modest sensitivity (39%) and relatively higher specificity (71%), reflecting its limited utility in isolation for SDB detection. The odds ratios were highest for STOP-Bang (OR 5.1) and the 4-Variable tool (OR 4.5), suggesting strong predictive associations with moderate-to-severe SDB. The area under the ROC curve (AUC) was largest for STOP-Bang (0.64), indicating superior overall discriminative ability compared to the other tools (Table 2).

Table 2: Predictive parameters of 4-Variable screening tool, STOP, STOP-Bang, and ESS for moderate-to-severe SDB

Screening Tool	Sensitivity (%)	Specificity (%)	Correctly Classified (%)	LR +	LR −	Odds Ratio (95% CI)	AUC (95% CI)
4-Variable ≥14	25	93	79	3.7	0.8	4.5 (3.5–5.8)	0.59 (0.57–0.61)
STOP ≥2 positive	62	56	58	1.4	0.67	2.1 (1.8–2.4)	0.58 (0.56–0.61)
STOP-Bang ≥3 positive	87	43	51	1.5	0.3	5.1 (4.0–6.4)	0.64 (0.62–0.66)
ESS ≥11	39	71	65	1.4	0.85	1.6 (1.4–1.8)	0.53 (0.52–0.56)

In this cohort of 120 patients, the 4-Variable screening tool showed the highest specificity (93%) and correctly classified 87% of patients, making it particularly reliable for confirming severe SDB, while its sensitivity was moderate (42%). The STOP-Bang and STOP questionnaires demonstrated higher sensitivities (70% and 69%, respectively) but lower specificity (~60%), suggesting that they are better suited for initial screening to identify potential severe SDB cases. The ESS showed moderate sensitivity (46%) and specificity (70%), reflecting its limited standalone predictive value. The odds ratio was highest for the 4-Variable tool (OR 9.8), indicating a strong association with severe SDB, whereas STOP-Bang and ESS had lower ORs, consistent with their more sensitive but less specific profiles. The area under the ROC curve (AUC) values were highest for the 4-Variable tool (0.67) and STOP-Bang (0.66), indicating reasonable discriminative ability (Table 3).

Table 3: Predictive parameters of 4-Variable screening tool, STOP, STOP-Bang, and ESS for severe SDB

Screening Tool	Sensitivity (%)	Specificity (%)	Correctly Classified (%)	LR+	LR−	Odds Ratio (95% CI)	AUC (95% CI)
4-Variable ≥14	42	93	87	6.1	0.63	9.8 (7.5–12.7)	0.67 (0.65–0.70)
STOP ≥2 positive	69	60	59	1.5	0.69	2.1 (1.8–2.5)	0.65 (0.62–0.67)
STOP-Bang ≥3 positive	70	60	61	1.7	0.49	3.5 (2.7–4.4)	0.66 (0.64–0.67)
ESS ≥11	46	70	69	1.6	0.76	2.0 (1.6–2.5)	0.58 (0.55–0.60)

DISCUSSION

The present study, shown assessed breathing disturbances in adult patients presenting with sleep-related complaints using the STOP-Bang questionnaire. The results the high prevalence of obstructive sleep apnoea risk factors in this population, supporting existing literature that underscores the importance of routine screening for OSA in clinical situations.

OSA remains an extensively underdiagnosed disorder, particularly in developing countries, despite its known association with significant cardiovascular, metabolic, and neurocognitive complications (17). In the current study, a substantial proportion of patients scored ≥3 on the STOP-Bang questionnaire, categorizing them as high risk for OSA. This result is consistent with global and regional data. For example, studies by Chung et al. and Nagappa et al. established that a STOP-Bang score of ≥3 has a high sensitivity (>85%) for detecting moderate-to-severe OSA, even though its specificity is lower (18,19). These properties make STOP-Bang an ideal screening tool, but not a diagnostic one, emphasizing the need for confirmatory polysomnography in high-risk individuals.

The STOP-Bang questionnaire evaluates multiple risk factors, including snoring, daytime tiredness, witnessed apnea, hypertension, BMI >35 kg/m², age >50 years, neck circumference >40 cm, and male gender (20). In the current study, male patients, older age groups, and individuals with obesity were more probable to score higher on the questionnaire, consistent with prior epidemiological studies (21). OSA is more common in men due to differences in upper airway anatomy and fat distribution patterns, which increase the propensity for airway collapse during sleep (22). However, postmenopausal women also face increased OSA risk, likely due to hormonal changes that affect airway patency (23).

Obesity was an important risk factor in the studied population. Previous studies have shown that obesity, particularly central obesity, is strongly correlated with OSA (7). The deposition of adipose tissue in the neck region reduces airway diameter, predisposing to pharyngeal collapse during sleep (24). In Indian populations, even non-obese individuals may develop OSA due to craniofacial anatomical differences such as retrognathia and smaller mandible dimensions, contributing to airway narrowing (25). Therefore, while the BMI cutoff of >35 kg/m² is used globally, some researchers suggest that lower BMI thresholds may be more appropriate for Asian populations to improve screening sensitivity (26).

Another serious result is the association between OSA risk and comorbid conditions. Hypertension, diabetes, and metabolic syndrome were frequently observed in patients with high STOP-Bang scores. These associations are well-documented in the literature. The Sleep Heart Health Study showed that OSA increases the risk of hypertension, stroke, and coronary artery disease, independent of other factors (27). The mechanisms include intermittent hypoxia, sympathetic nervous system activation, oxidative stress, and endothelial dysfunction (28). In addition, OSA is implicated in insulin resistance and poor glycaemic control, contributing to the pathophysiology of type 2 diabetes mellitus (29).

Given these associations, early identification of OSA risk is essential for preventing long-term difficulties. The STOP-Bang questionnaire facilitates this by allowing non-specialists to screen for OSA in outpatient departments, general practice, and perioperative situations. Its role in preoperative assessments is mainly noteworthy because undiagnosed OSA is associated with increased perioperative morbidity and mortality (30). Studies have shown that OSA patients are more prone to respiratory complications, difficult airway management, and prolonged hospital stays following surgery (31). For this reason, the American Society of Anaesthesiologists and the Canadian Anaesthesiologists' Society commend STOP-Bang screening in surgical patients (32).

In spite of its advantages, the STOP-Bang questionnaire has limitations. Its specificity decreases in populations with a high prevalence of obesity and hypertension, leading to potential overestimation of OSA danger (19). Moreover, self-reported variable quantities such as snoring, witnessed apnea, and daytime sleepiness can be

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subjective, and patients may underreport or overreport symptoms due to social stigma or lack of awareness (33). To mitigate this, clinician-administered questionnaires with standardised explanations may yield more reliable results.

The current study is in line with previous investigations suggesting that the STOP-Bang questionnaire is a valuable initial screening tool, particularly in settings where access to PSG is limited. However, it should be used as part of a complete clinical assessment. Individuals identified as high risk require more assessment with objective diagnostic tests such as overnight PSG or home sleep apnoea testing to confirm OSA diagnosis and to determine its severity (24).

This study reinforces the role of the STOP-Bang questionnaire in identifying adult patients at high risk for OSA, facilitating timely referrals for sleep studies and subsequent management. Specified the growing awareness of the impact of OSA on public health, integrating simple, validated screening tools into routine clinical practice is a serious need, mainly in countries like India, where OSA remains underdiagnosed and undertreated (21).

CONCLUSION

The study has concluded that the STOP-Bang questionnaire demonstrated the highest sensitivity (87%) in identifying patients at high risk for obstructive sleep apnoea (OSA), making it an effective screening tool, especially in hypertensive individuals. Although its specificity was lower (43%), it is highly useful for initial screenings, enabling early identification of potential OSA cases. This tool, with its simplicity and high sensitivity, is valuable for timely referral and further diagnostic evaluation in clinical settings.

The effectiveness of the STOP-Bang questionnaire as a primary tool for screening patients at high risk for obstructive sleep apnoea (OSA) in a cohort of 120 hypertensive patients. The STOP-Bang questionnaire demonstrated the highest sensitivity (87%) for identifying moderate-to-severe sleep-disordered breathing (SDB), making it the most effective tool among the screening methods tested. Its high sensitivity is particularly valuable in identifying individuals at risk of OSA, although its specificity was lower (43%), suggesting that while it is highly effective in identifying at-risk individuals, there may be some false positives. This characteristic positions STOP-Bang as a useful tool for initial screening rather than for definitive diagnosis.

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