

# Effectiveness of the STOP-BANG Questionnaire in Screening of Suspected Obstructive Sleep Apnea Hypopnea Syndrome

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## Abstract

**Background:** Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS) patients are often asymptomatic and can remain misdiagnosed and untreated. Polysomnography (PSG), the gold standard for the diagnosis of OSAHS is costly and accessibility is limited. It is imperative that there simple but accurate screening instruments be available to identify high-risk patients with this illness. Thus, this study was conducted to evaluate the effectiveness of the STOP-BANG questionnaire in screening for OSAHS.

**Methods:** This analytical cross-sectional study was conducted among suspected 127 of OSAHS patients with suspected OS AHS. The subjects were selected purposively and semi-structured data collection form was used to obtain information that included STOP-BANG questionnaire. All the participants went through PSG in the sleep study lab at Dhaka Medical College Hospital and their Apnoea Hypopnea Index (AHI) was determined. Statistical analyses for determining the association and correlation of the STOP-BANG score and AHI were performed with SPSS version 26.0. A p value of <.05 was considered as significant. ROC curve was plotted and used to find out the sensitivity, specificity of STOP-BANG scoring.

**Results:** A significant association and positive correlation between the STOP-BANG score and the AHI score were established ( $p < 0.001$  for both). The correlation coefficient ( $r$ ) was 0.745. A STOP-BANG cut-off  $\geq 3$  had a sensitivity, specificity, PPV, NPV and accuracy of 81.42%, 64.29%, 94.84%, 30% and 83.42% for predicting OSAHS ( $AHI \geq 5$ ). A cut-off score of  $\geq 4$  had sensitivity, specificity, PPV, NPV and accuracy of 72%, 82.69%, 85.71%, 67.18% and 85.18% for predicting severe OSAHS ( $AHI > 30$ ).

**Conclusion:** The STOP-BANG questionnaire is a very effective screening tool for patients suspected with OSAHS.

**Keywords:** STOP-BANG Questionnaire, Screening Tool, Obstructive Sleep Apnea Hypopnea Syndrome.

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## Introduction

Various techniques have been recommended and validated for predicting OSAHS in different population, including questionnaires and clinical models. Thus, a variety of screening tools have been created as part of the process of pre-selection, including the Epworth sleepiness scale (ESS)<sup>1</sup>, STOP-BANG questionnaire (SBQ)<sup>2</sup> and Berlin questionnaire (BQ)<sup>3</sup>. However, the majority of these use

difficult scoring systems, feature many items, and some require the use of a computer to perform mathematical calculations, making them undesirable for public use.<sup>2,3</sup> The optimal approach is often a matter of debate.<sup>3,4</sup>

The STOP-BANG questionnaire, which consists of our self-reportable (STOP: Snoring, Tiredness, Observed Apnea, and High Blood Pressure) and same number of demographic (BANG: BMI, Age,

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Neck circumference, and Gender) items, was created as an OSA screening tool.<sup>5</sup> The SBQ questionnaire showed a sensitivity of 84%, 93%, and 100% to detect all, mild, moderate, and severe OSA, respectively, in the initial validation research.<sup>4,5</sup> The STOP-BANG questionnaire is widely used due to its excellent diagnostic accuracy, simplicity of use, and unambiguous thresholds for risks stratification.<sup>5,6</sup> BMI and neck circumference, two SBQ items, are influenced by region-specific physical features, which may affect the STOP-BANG questionnaire's performance in various geographical areas. In this context this study intended to assess the effectiveness of SBQ in our population. In the general adult population, 80% to 90% of OSA cases go misdiagnosed or untreated. Thus, it is imperative to consider strategies focusing on early diagnosis and treatment of OSAHS.<sup>6</sup> However, in our country the facilities of performing polysomnography (PSG) in sleep laboratories, which is the gold standard to diagnose OSAHS, is very limited. Only few government and some non-government institutes have the opportunity. Moreover, PSG is a difficult, time-consuming process that needs qualified personnel, the right equipment, and assistance. In our local settings, it is difficult to done PSG for every suspected patient due to cost and limited availability opportunity. Therefore, for suitable investigations or preventative care programs, it is desirable to have a simple and reliable technique for identifying high-risk individuals. STOP-BANG questionnaire is one of the most popular tools for identifying OSAHS patients.<sup>6,7</sup> Moreover, it is simple, easy to perform, applicable in inpatient and outpatient basis and is cost effective.<sup>7</sup> Therefore, in this study we aimed to determine the utility of STOP-BANG in screening for OSAHS in Bangladeshi population.

The objective of this present study to determine the utility of the STOP-BANG as an OSAHS screening tool to patients referred to sleep clinics in Bangladesh.

## Materials and Methods

This cross-sectional analytical study was conducted to evaluate the effectiveness of the STOP-BANG questionnaire as a screening tool for suspected OSAHS in tertiary care hospital. The study parameters included the scoring of STOP-BANG questionnaire of the participants, The apnea Hypopnea Index (AHI) score by Polysomno-graphy, the severity of OSAHS by AHI score in the patients, the correlation between STOP-BANG questionnaire score and AHI score, cut-off value of STOP-BANG questionnaire score for prediction of OSAHS and severe OSAHS against Polysomnography based AHI score. Total of 127 study subjects of age  $\geq 18$  years were suspected obstructed Sleep Apnea Hypopnea Syndrome (OSAHS) patients attending in sleep study clinic at department of Respiratory Medicine in Dhaka Medical College Hospital (DMCH). Patient with recent myocardial infarction, acute severe asthma, acute exacerbation of chronic obstructive pulmonary disease (COPD), recent upper airway surgery and pregnancy were excluded from this study. Here purposive-sampling method was used. Patients, who fulfilled the selection criteria purposively were selected for this study. According to the American Academy of Sleep Medicine Clinical Practice Guideline, sleep studies can be categorized as Type I, Type II, Type III and Type IV.<sup>8</sup> Type I is in-laboratory full polysomnography (PSG) and in this study, this type of sleep study was used. It includes electro-encephalogram (EEG), electrocardiography (ECG), chin electromyogram (EMG), electro-oculogram (EOG), respiratory airflow, respiratory movements, leg movements, notification of body position and oxygen saturation. In this study PSG was performed using computerized system (DOMINO 2.4.0, SOMNO medics) according to the American Academy of Sleep Medicine's (AASM) manually.<sup>9</sup> Number of obstructive apneas and hypopneas per hour of total sleep time (TST) used to generate the total obstructive Apnea/Hypopnea Index (AHI). The OSAHS classification according to AHI was considered as follows-

**Table I**  
*Classification of AHI*

| AHI [(apneas +hypopneas) /sleep hours] | OSAHS level |
|----------------------------------------|-------------|
| AHI<5                                  | Normal      |
| 5≤ AHI≤15                              | Mild        |
| 15<AHI≤30                              | Moderate    |
| AHI>30                                 | Severe      |

The STOP-BANG questionnaire includes of eight questions; presence of loud snoring (louder than talking/ loud enough to be heard through closed door) (S), tiredness/fatigue/sleepy during the day (T), observed apnea (anyone observed stop breathing during sleep) (O), high BP (P), a BMI of greater than 35kg/m<sup>2</sup> (B), age greater than 50(A), a neck circumference greater than 40cm (N), and male gender (G). Each of the questions of the STOP-BANG given 1 point if the answer is yes. Thus, each patient had a score ranging from zero to eight. A semi-structured data collection sheet included relevant patient demographic information, disease related (sign/symptom/presentation and smoking/alcohol/drug history) information, relevant laboratory findings (PSG and AHI findings) and STOP-BANG scorings. Microsoft Excel 2019 and 'Statistical Package for the Social Sciences' software (SPSS version 26) was used for data analysis. The continuous data were expressed in mean with standard deviation (±SD) and discrete data were presented and utilized as percentages or proportions. For determining the association and co-relation between the final assessment variables (STOP-BANG score and AHI) Fisher Exact test, ANOVA test and Pearson correlation test were used respectively. Tests of significance performed according to the objectives as needed at the 95% confidence level, the p value < 0.05. Receiver Operating Characteristic (ROC) curves drawn to find out a cut of value of STOP-BANG score and its specificity & sensitivity in the prediction of both abnormal AHI level and severe AHI level.

## Results

Among the participants, 120 (94.5%) of the patients had snoring, 81 (63.8%) had tiredness/day time sleepiness and 27 (21.3%) had history of observed apnea.

**Table II**  
*Clinical presentation of the study subjects/ patients (n=127)*

| Clinical presentation         | Frequency (n) | Percentage (%) |
|-------------------------------|---------------|----------------|
| Snoring                       | 120           | 94.5%          |
| Tiredness/day time sleepiness | 81            | 63.8%          |
| Observed apnea                | 27            | 21.3%          |

Regarding the STOP-BANG score, among all, majority 65 (51.2%) had STOP-BANG score more than 5, followed by 50 (39.4%) patients who had a score from 3 to 4 and 12 (9.4%) had 1 to 2. Mean STOP-BANG score was 4.5 (±1.5).

**Table III**  
*Distribution of the patients according to STOP-BANG score (n=127)*

| STOP-BANG score | Frequency (n) | Percentage (%) |
|-----------------|---------------|----------------|
| 1-2             | 12            | 9.4            |
| 3-4             | 50            | 39.4           |
| ≥5              | 65            | 51.2           |
| Mean (±SD)      | 4.5 (±1.5)    |                |

**Table IV**  
*Distribution of the patients according to AHI score (n=127).*

| AHI score              | Frequency (n) | Percentage (%) |
|------------------------|---------------|----------------|
| AHI <5 (normal)        | 14            | 11             |
| 5 ≤AHI ≤15 (mild)      | 15            | 11.8           |
| 15<AHI ≤ 30 (moderate) | 23            | 18.1           |
| AHI >30 (severe)       | 75            | 59.1           |
| Mean(±SD)              | 43.2 (±30)    |                |

Among all, 75 (59.1%) had AHI above 30 followed by 23 (18.1%) had 15<AHI ≤30 score and 15 (11.8%) had AHI score 5 ≤AHI ≤15, whereas 14 (11%) patients had AHI score normal that was below 5. Mean AHI score was 43.2 (±30).

**Table V***Association of STOP-BANG score levels and AHI score levels of the patients (n=127).*

| STOP- BANGscore | AHI<5<br>(normal) | 5 ≤AHI ≤15<br>(mild) | 15<AHI ≤30<br>(moderate) | AHI >30<br>(severe) | p-<br>value* |
|-----------------|-------------------|----------------------|--------------------------|---------------------|--------------|
| 1-2             | 6 (42.9)          | 1 (6.7)              | 3 (12)                   | 2 (2.7)             | <0.001       |
| 3-4             | 7 (50)            | 12 (80)              | 13 (56.5)                | 18 (24)             |              |
| ≥5              | 1 (7.1)           | 2 (13.3)             | 7 (30.4)                 | 55 (73.3)           |              |

\*p-value was determined using Fisher Exact test. Data were presented with frequency (%) and within parenthesis percentage over column in total.

It was found that, STOP-BANG score of the patients was significantly associated with AHI score.

**Table VI***Association of mean STOP-BANG scores and mean AHI score of the patients (n=127).*

| STOP-BANG<br>score | AHI<br><5(normal) | 5 ≤AHI ≤15<br>(mild) | 15<AHI ≤30<br>(moderate) | AHI >30<br>(severe)       | p-<br>value |
|--------------------|-------------------|----------------------|--------------------------|---------------------------|-------------|
| Mean(±SD)          | 2.7 (±1.4)        | 3.3 (±0.9)           | 3.9 (±1.1) <sup>α</sup>  | 5.2 (±1.2) <sup>αβγ</sup> | <0.001*     |

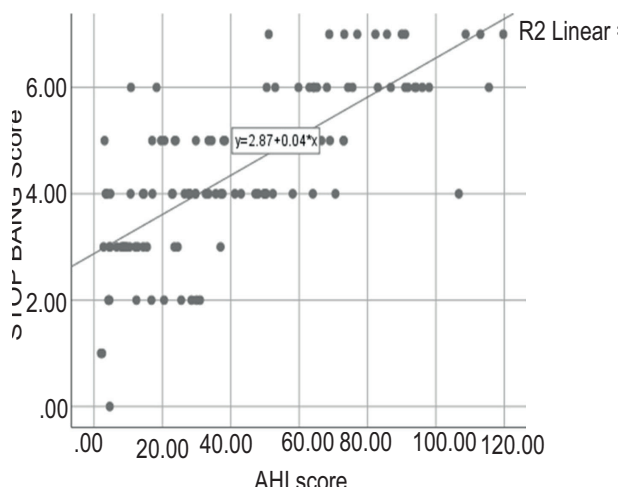
p-value determined by Post-Hoc analysis by Bonferroni test of One-way ANOVA test.

<sup>α</sup> denotes significant difference between AHI <5 group vs AHI 15 to 30 group and AHI > 30 group.

<sup>β</sup>denotes significant difference between AHI 5 to15group vs AHI > 30group.

<sup>γ</sup>denotes significant difference between AHI 15 to 30group vs AHI > 30 group.

It is shown that increased STOP-BANG score showing increased AHI score. The association is statistically highly significant (p <0.001).

**Figure 1:** Scattered plot showing correlation between STOP-BANG score and AHI level.

This scattered plot showing positive correlation (r=0.745) between STOP-BANG score and AHI score. This correlation was found statistically significant.

**Table VII***Correlation of STOP-BANG score with AHI score of the patients (n=127)*

|                                 | Correlation<br>coefficient (r) | p-<br>value* |
|---------------------------------|--------------------------------|--------------|
| STOP-BANG score<br>vs AHI score | 0.745                          | <0.001       |

\*p-value determined by Pearson correlation test. According to findings, STOP-BANG score positively correlated with AHI score and that correlation was statistically significant.

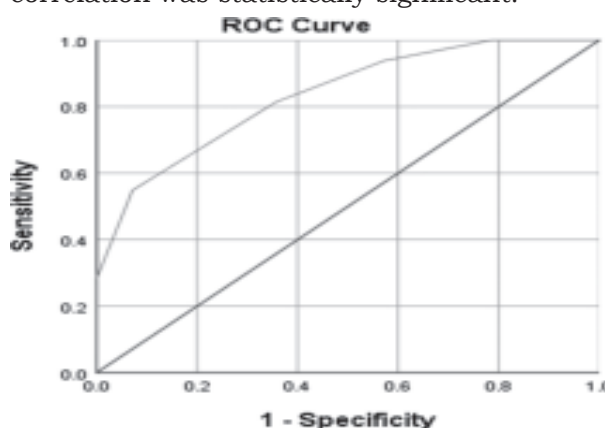
**Figure 2:** Receiver Operating Characteristic (ROC) curve analysis of STOP- BANG score in the prediction of abnormal AHI (AHI ≥5) in suspected OSAHS.

**Table VIII**

Area under curve (AUC) found from ROC analysis (abnormal AHI)

| AUC   | 95% CI      |             | p-value |
|-------|-------------|-------------|---------|
|       | Lower Bound | Upper Bound |         |
| 0.834 | 0.732       | 0.936       | <0.001  |

A cut off value of STOP-BANG score  $\geq 3$  (Area Under the Curve (AUC)= 0.834, 95% CI=0.732-0.936,  $p<0.001$ ) in the prediction of abnormal AHI (AHI  $\geq 5$ ) in suspected OSAHS showed sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy was 81.42%, 64.29%, 94.84%, 30% and 79.52% accordingly.

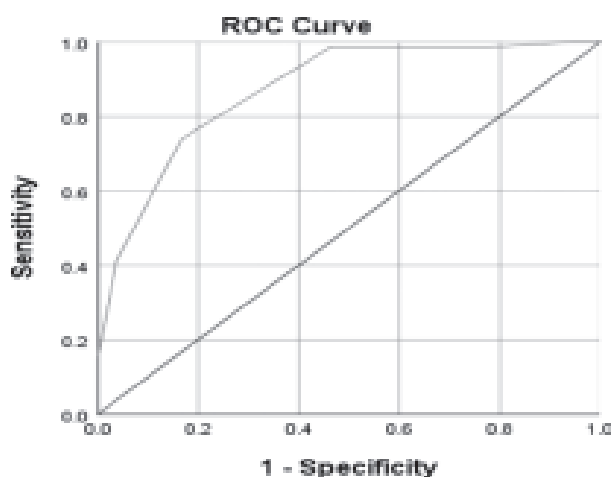


**Figure 4:** ROC curve analysis of STOP-BANG score in the prediction of severe AHI (AHI >30) in suspected OSAHS.

**Table IX**

Area under curve (AUC) found from ROC analysis (severe AHI)

| AUC   | 95% CI      |             | p-value |
|-------|-------------|-------------|---------|
|       | Lower Bound | Upper Bound |         |
| 0.851 | 0.784       | 0.918       | <0.001  |

A cut off value of STOP-BANG score  $\geq 4$  (AUC=0.851, 95% CI=0.784-0.918,  $p<0.001$ ).

### Discussion:

This study initially used the STOP-BANG score for every study subject suspected with OSAHS, which was followed by full polysomnography (PSG) to determine Apnea-Hypopnea Index

(AHI). The STOP-BANG score distribution showed only 12 (9.4%) of the patients had a score  $<3$  and most of them 115 (90.6%) had a score  $\geq 3$ . This finding has its similarity with a study working with a sample size of 1671 suspected obstructed sleep apnoea patients and using STOP-BANG score.<sup>8,9</sup> They had a STOP-BANG score  $\geq 3$  among almost 72% of their patients.<sup>9</sup> In our current study, in the PSG, patients with STOP-BANG 1-2 had largest of the (42.9%) normal (AHI  $<5$ ) outcome, STOP-BANG 3-4 had most of the (80%) mild (AHI 5-15) OSAHS, and STOP-BANG score  $\geq 5$  had the majority (73.3%) of diagnosed with severe OSAHS (AHI  $>30$ ) in between them. Both the association and correlation of STOP-BANG score and the AHI score was found notably significant ( $p<0.001$  in both cases). This finding is in line with the finding of another study which showed the greater the STOP-BANG score, the greater the probability of mild/moderate and/or severe obstructed sleep apnoea among patients.<sup>10,11,12</sup> This statistically significant association and correlation of progressively increasing STOP-BANG score and severity of OSAHS in term of AHI provides the background for scientifically considering STOP-BANG as a screening tool for OSAHS in Bangladeshi population.<sup>13,14</sup> It was calculated and plotted Receiver Operating Characteristic (ROC) analysis of the STOP-BANG score for both in the prediction of abnormal AHI ( $\geq 5$ ) and severe AHI ( $>30$ ) level. The area under the curve (AUC) for abnormal AHI at cut of value of STOP- BANG  $\geq 3$  was 0.834 and for severe AHI at cut of value of  $\geq 4$  was 0.851 respectively. This signifies that, STOP-BANG score  $\geq 3$  can actually predict both actual negative and actual positive OSAHS patients (interm of AHI) with more than 79.52% accuracy, while STOP-BANG score  $\geq 4$  can predict actual negative and/or actual positive severe OSAHS patients (in term of AHI) with an accuracy of more than 76.38%.

The identification of OSAHS patients (AHI  $\geq 5$ ) with STOP-BANG, the score  $\geq 3$  possesses sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) values that are, respectively, 81.42%, 64.29%, 94.84%, and 30%. Prediction of severe OSAHS (AHI  $>30$ ) with STOP-BANG score  $\geq 4$  has a

sensitivity, specificity, PPV, and NPV 72%, 82.69%, 85.71%, and 67.18% respectively in this current study. These findings almost reflect the efficacy of STOP-BANG in AHI  $\geq 5$  among global population (sensitivity range 89-94%, specificity range 26-41%, PPV range 85-86%, and NPV range 45-49%).<sup>14,15</sup> For the cases of AHI  $>30$ , the findings of the current study are similarly in line with the global population findings (sensitivity range 80-98%).<sup>15,16</sup> However, the specificity range (19-30%) and PPV range (45-47%) in global population is notably lower than that of the current study (82.69% and 85.71% respectively).<sup>17,18,19</sup>

From the discussion of the results of this study it was evident that, STOP-BANG score can screen both OSAHS and severe OSAHS patients at the cut-off margin of  $\geq 3$  and  $\geq 4$  respectively with high sensitivity and specificity.

### Limitations

For this research, a relatively small sample size from a single center was used. Patients were included in the study using a purposive sampling strategy; therefore, generalizing the results must be done with caution.

### Conclusions

Progressively higher STOP-BANG score significantly corresponds with greater AHI score in polysomnography (PSG). STOP-BANG questionnaire score  $\geq 3$  showed high sensitivity and PPV for any OSAHS (AHI cutoff  $\geq 5$ ). The STOP-BANG score cutoff of  $\geq 4$  also showed high sensitivity and PPV in cases of severe OSAHS (AHI  $>30$ ). Therefore, it can be concluded that STOP-BANG questionnaire is an effective screening tool for suspected OSAHS patients.

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### Conflict of Interest:

The author has no conflict of interest. All authors have approved the manuscript.

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