Value of STOP-BANG and Berlin questionnaires in the diagnosis and severity prediction of obstructive sleep apnea hypopnea syndrome

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Background Obstructive sleep apnea (OSA) screening questionnaires are used for predicting OSA in sleep clinics or in general population because of the unavailability and time-consuming nature and cost of polysomnography (PSG).

Aim of the study This study was conducted to assess the value of STOP-BANG questionnaires as well as Berlin questionnaire in the diagnosis and severity prediction of OSA.

Patients and methods This study was conducted on 50 patients suspected to have obstructive sleep apnea hypopnea syndrome (OSAHS) recruited from sleep clinic. STOP-BANG and Berlin questionnaires were administered to all patients with documentation of results and assessment of the validity of these results when compared with full-night PSG.

Results The overall mean age of the studied patients was 45.80±10.97 years. Eighty percent constituted OSAHS patients and 20% constituted non-OSAHS patients. The cutoff point of STOP-BANG questionnaire for the diagnosis of OSAHS patients in this study was 2.5 with 82.5% sensitivity and 90% specificity ($P<0.001$). The cutoff point of Berlin questionnaire *N* for the diagnosis of OSAHS patients was 1.5 with 90% sensitivity and 80% specificity ($P<0.001$). For prediction of severity, the cutoff point of STOP-BANG questionnaire for severity scoring of OSAHS patients was 5.5 with 90% sensitivity and 100% specificity ($P<0.001$). The cutoff point of Berlin questionnaire for the prediction of severe OSAHS patients was 2.5 with 75% sensitivity and 55% specificity ($P=0.058$).

Conclusion STOP-BANG and Berlin questionnaires are considered valid tools for the diagnosis and severity prediction of OSA with high sensitivity and specificity in comparison with PSG, and hence the number of patients referred for PSG could be decreased.

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Introduction

Obstructive sleep apnea hypopnea syndrome (OSAHS) is recognized as a major health problem and serious condition due to its high prevalence rate [1].

Polysomnography (PSG) is considered the gold standard for the diagnosis of OSA but its use is limited because it requires special centers, expert technicians, and admission in sleep laboratory, which is relatively expensive, as well as long waiting lists [2].

Most of the OSA screening questionnaires and clinical screening models have been used for patients suspected to suffer from OSA as a predictor screening tool before PSG [3].

The Berlin questionnaire was developed in 1996. It is a valuable questionnaire that is used to identify individuals who are at risk for OSA in primary and some nonprimary care settings [4,5].

The STOP-Bang questionnaire was developed in 2008 [6]. It is a simple, applicable screening method that includes four subjective items [snoring, tiredness, observed apnea, and high blood pressure (STOP) and four demographics items body mass index, age, neck circumference (NC), and gender (BANG)] [6]. The aim of this study was to determine the value of STOP-BANG and Berlin questionnaires in the diagnosis and severity scoring of OSAHS in sleep-related breathing disorders unit, Chest Department, Mansoura University Hospital, El-Mansoura, Egypt.

Patients and methods

This prospective cohort study was conducted in sleep-related breathing disorders Unit, Chest Department, Mansoura University hospital. Patients were recruited from October 2014 to August 2016. The study was carried on 50 middle-aged patients above 18 years, suspected to suffer from OSAHS. All patients in the study underwent full history taking with emphasis on age, sex, occupation, and symptoms suggestive

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of OSAHS (excessive daytime sleepiness, nocturnal choking, snoring, witnessed apnea, etc.), OSA screening questionnaire (STOP-BANG and Berlin questionnaire), and general examination with stress on BMI (kg/m^2), NC (cm), cardiac, chest, and ENT examinations. Routine investigations in the form of complete blood count, liver and kidney functions, arterial blood gases, chest radiograph, ECG, and spirometry were performed.

PSG data were recorded using a computerized PSG system (SOMNOScreen^{TM} plus, SOMNO Medics, Germany). This included a standardized montage: two-channel electroencephalograms (C4/A1, C3/A2), bilateral electro-oculograms, submental electromyogram, bilateral leg electromyograms, and ECG. Airflow was measured using a thermistor (Healthdyne Technologies, SOMNO Medics, Germany) inductance plethysmography was used to determine respiratory effort, and oxygen saturation. The data were interpreted according to the last manual scoring criteria [7]. The patients were diagnosed as OSA or normal participant according to the Third International Classification of Sleep Disorders [8].

Statistical analysis

SPSS (Statistical Package for Social Sciences; SPSS, California), version 15 was used for data analysis. Qualitative data were presented as number and percent. Quantitative data were tested for normality using the Kolmogrov–Smirnov test. Normally distributed data were presented as mean±SD. Comparison between two groups was made using the Student *t*-test. However, the χ^2-test was used to compare between groups. The receiver operating characteristic curve analysis can discriminate diseased cases from normal cases. *P* less than 0.05 was considered to be statistically significant.

Results

Fifty individuals were involved in the study; the overall mean age was 45.80±10.97 years. Thirty (60%) were men and 20 (40%) were women (Table 1). Forty of the 50 individuals (80%) were diagnosed with OSAHS, of whom 12 (24%) had mild, eight (16%) had moderate, and 20 (40%) had severe OSAHS. Ten of the 50 (20%) studied individuals were negative on PSG (Table 2 and Fig. 1). STOP-BANG and Berlin were statistically significantly higher in OSAHS versus non-OSAHS ($P<0.001$ and <0.001, respectively).

Table 1 Characteristics of all studied participants

Age (mean±SD) (years)	45.80±10.97
Sex [*n* (%)]	
Male	30 (60)
Female	20 (40)
BMI (mean±SD) (kg/m^2)	39.53±8.60
NC (mean±SD) (cm)	43.99±4.48
FEV1/FVC%	89.48±10.84

FEV1/FVC%, forced expiratory volume in first second/forced vital capacity; NC, neck circumference.

In this study, the cutoff point of STOP-BANG questionnaire for the diagnosis of OSAHS patients was 2.5 with 82.5% sensitivity, 90% specificity, 97% positive predictive value (PPV), and 56% negative predictive value (NPV) (highly significant $P<0.001$) (Table 3 and Fig. 2).

The cutoff point of Berlin questionnaire for diagnosing patients with OSAHS was 1.5 with 90% sensitivity, 80% specificity, 94.7% PPV, 66.7% NPV, and highly significant ($P<0.001$) (Table 3 and Fig. 2).

For assessment of severity, the cutoff point of STOP-BANG questionnaire for the prediction of severe OSAHS patients was 5.5 with 90% sensitivity, 100% specificity, 100% PPV, 90% NPV and highly significant *P* value of less than 0.001 (Table 4 and Fig. 3).

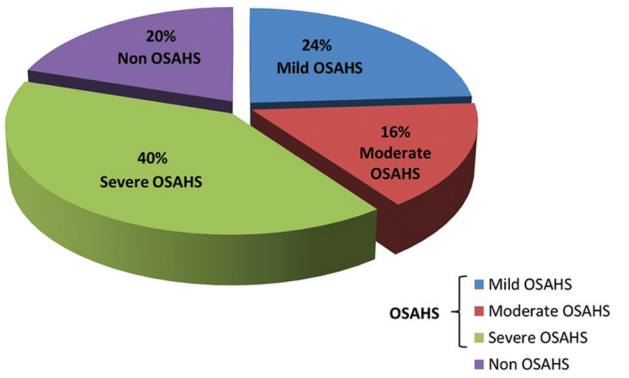
The cutoff point of Berlin questionnaire for the prediction of severe OSAHS patients was 2.5 with

Table 2 Screening questionnaires of the studied patients

	Non-OSAHS (*N*=10)	OSAHS (*N*=40)	*t*	*P* value
STOP-BANG	3.50±0.53	5.03±1.29	5.788	<0.001*
Berlin	1.20±0.42	2.50±0.68	7.593	<0.001*

t, Student *t*-test OSAHS, obstructive sleep apnea hypopnea syndrome. *Significant $P<0.05$.

Figure 1



Pie chart of studied cases and classification according to polysomnography. OSAHS, obstructive sleep apnea hypopnea syndrome

Table 3 Values of Berlin and STOP-BANG questionnaires in the diagnosis obstructive sleep apnea hypopnea syndrome patients

	STOP-BANG questionnaire	Berlin questionnaire
Cutoff point	2.5	1.5
Area under the curve	0.880	0.910
Sensitivity (%)	82.5	90
Specificity (%)	90	80
PPV (%)	97	94.7
NPV (%)	56	66.7
Accuracy (%)	84	80
P value	<0.001*	<0.001*

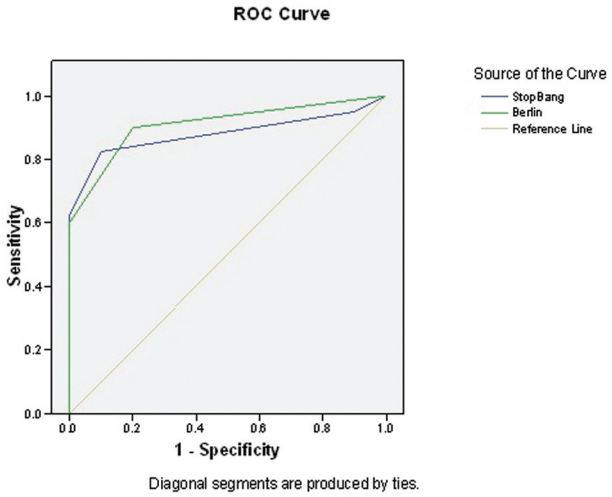
NPV, negative predictive value; PPV, positive predictive value.
*Significant $P<0.05$.

Table 4 Value of STOP-BANG questionnaire and Berlin questionnaires for the prediction of severe obstructive sleep apnea hypopnea syndrome patients

	STOP-BANG questionnaire	Berlin questionnaire
Cutoff point	5.5	2.5
Area under the curve	0.995	0.675
Sensitivity (%)	90	75
Specificity (%)	100	55
PPV (%)	100	62.5
NPV (%)	90	68.75
Accuracy (%)	95	65
P value	<0.001*	0.058

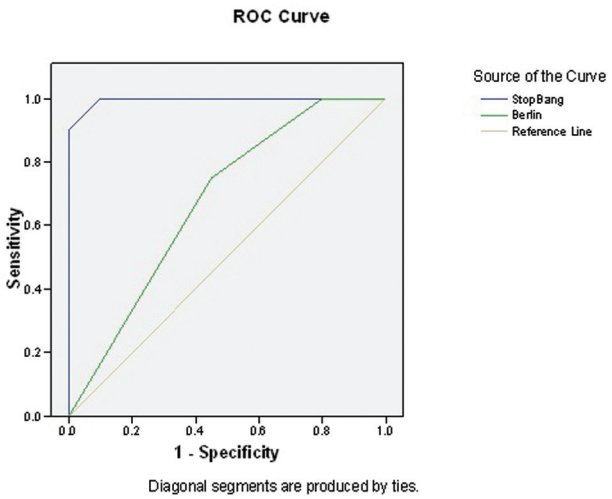
NPV, negative predictive value; PPV, positive predictive value.
*Significant $P<0.05$.

Figure 2



Receiver operating characteristic (ROC) curve analysis of STOP-BANG questionnaire and Berlin questionnaire for diagnosis OSAHS patients. OSAHS, obstructive sleep apnea hypopnea syndrome

Figure 3



Receiver operating characteristic (ROC) curve analysis of STOP-BANG questionnaire and Berlin questionnaire for the prediction of severe OSAHS patients. OSAHS, obstructive sleep apnea hypopnea syndrome

75% sensitivity, 55% specificity, 62.5% PPV, and 68.75% NPV (P=0.058) (Table 4 and Fig. 3).

Discussion

PSG is the gold standard test for diagnosing OSA. However, it is technically difficult, time-consuming, and expensive. Prediction of OSA using questionnaires, clinical features, and physiological examination has been previously studied as a predictive method for diagnosing OSA patients [9].

The Berlin questionnaire and STOP-BANG questionnaires are used for the identification and screening of individuals with OSA in primary care settings and general population [10,11].

This study was conducted to assess the value of OSA screening questionnaire STOP-BANG questionnaire as well as Berlin questionnaire in the prediction of OSA and severity scoring against the PSG-based AHI as the 'gold standard' for diagnosis.

This prospective observational study was applied on 50 patients suspected to have OSAHS; 30 of them were men and 20 were women with a mean age of 45.80±10.97 years, mean BMI of 39.53±8.60 kg/m^2, and mean NC of 43.99±4.48 cm.

The result of the current study revealed that OSA screening questionnaires (STOP-BANG and Berlin) were statistically significantly higher in OSAHS versus non-OSAHS (P<0.001 and <0.001, respectively) (Table 2). This is in accordance with the study by Lü *et al.* [12] and Trimer *et al.* [13], who documented that the STOP-BANG was higher in the OSAHS group in comparison with the control group.

Moreover, Chung *et al.* [14] reported that, on increasing the score of STOP-BANG to 7 or 8, the probability of severe OSAHS increases. Nagappa *et al.* [15] also reported increased probability of severe OSAHS up to 75% in the sleep clinic and in up to 65% in the surgical population.

Our results revealed that the sensitivity and specificity of STOP-BANG questionnaire for diagnosing patients with OSAHS were 82.5 and 90%, respectively, whereas for the detection of severe OSAHS patients the sensitivity and specificity were 90 and 100%, respectively.

Nagappa *et al.* [15] reported that the sensitivity of the STOP-BANG in predicting OSAHS, moderate-to-severe OSAHS, and severe OSAHS was 90, 94, and 96%, respectively, in sleep clinic patients. Kuhlmey *et al.* [16] reported that the sensitivity of STOP-BANG questionnaire reaches up to 100% in severe OSAHS. Sharma *et al.* [17] reported that the STOP-BANG questionnaire has a high sensitivity in obese patients, and El-Sayed [18] reported that the STOP-BANG questionnaire had a highest sensitivity to predict OSAHS (97.55%) and severe OSAHS (98.65%). Moreover, Silva *et al.* [19] reported that there was a higher sensitivity of STOP-BANG in predicting moderate-to-severe (87.0%) and severe (70.4%) sleep-disordered breathing.

However, Nagappa *et al.* [15] reported that the specificity of the STOP-BANG score 3 in predicting OSAHS diagnosis, moderate-to-severe OSAHS, and severe OSAHS was 49, 34, and 25%, respectively, in sleep clinic patients. Moreover, El-Sayed [18] found that the STOP-BANG questionnaire had a very low specificity for OSAHS patients (26.32%) and severe OSAHS patients (5.36%). In addition, Silva *et al.* [19] demonstrated that the sensitivity of the STOP-BANG questionnaire decreased with increased severity. Our study documented that the sensitivity and specificity of Berlin questionnaire for the diagnosis of OSAHS patients were 90 and 80%, respectively, whereas that for the prediction of severity were 75 and 55%, respectively. These results are in accordance with Khaledi-Paveh *et al.* [20], who reported that the sensitivity of Berlin questionnaire in diagnosing OSAHS was 77.3% and specificity was 73.1%, and in agreement also with Boese *et al.* [21], who have demonstrated that the sensitivity of Berlin questionnaire in the diagnosis and severity assessment was 68.9–87.2% and specificity was 43–87%.

El-Sayed [18]reported that Berlin questionnaire had the highest sensitivity to predict OSAHS diagnosis and severity (97.3 and 95.07%, respectively); however, very lower specificity was found for OSAHS diagnosis (25%) and severity (10.71%).

The difference between results of different studies may be due to the different number of cases and variable selection of patients, the target population in different studies to evaluate sleep questionnaires were either 'patients with sleep disorders' [22] or 'patients without sleep disorders' [23]. In our study, the target population comprised patients with symptoms suggestive of OSA attendant to our sleep clinic; this may lead to bias in the evaluation of different questionnaires to identify patients at risk for OSA resulting in marked increase in the sensitivity and specificity of the questionnaires [24].

Conclusion

STOP-BANG and Berlin questionnaires are considered valid tools for the diagnosis and severity prediction of OSA with high sensitivity and specificity in comparison with PSG, and hence the number of patients referred for PSG could be decreased.

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Conflicts of interest

There are no conflicts of interest.

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