Value of STOP-BANG and Berlin questionnaires in the diagnosis and severity prediction of obstructive sleep apnea hypopnea syndrome
Lucy A. Suliman, Nesrien M. Shalabi, Ahmed S. Elmorsy, Mona K. Moawed

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 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.

Egypt J Bronchol 2017 11:367–371
© 2017 Egyptian Journal of Bronchology

Keywords: Berlin questionnaire, obstructive sleep apnea, STOP-BANG questionnaire

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
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/m²), 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™ 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 χ²-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).

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 1 Characteristics of all studied patients

| Characteristic          | Mean±SD       |
|-------------------------|---------------|
| Age (years)             | 45.80±10.97   |
| Sex [n (%)]             |               |
| Male                    | 30 (60)       |
| Female                  | 20 (40)       |
| BMI (kg/m²)             | 39.53±8.60    |
| NC (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.
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/m², 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. Kuhlmeier 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.

**Acknowledgements**
The authors thank all members of Sleep Disorders Breathing Unit, Chest Department, Mansoura University (professors, colleagues, and technicians) for their support and cooperation in our study.

**Financial support and sponsorship**
Nil.

**Conflicts of interest**
There are no conflicts of interest.

**References**

1. Mannarino MR, Di Filippo F, Pirro M. Obstructive sleep apnea syndrome. *Eur J Intern Med* 2012; 23:586–593.
2. Corral-Penafiel J, Jean-Louis P, Barbe F. Ambulatory monitoring in the diagnosis and management of obstructive sleep apnoea syndrome. *Eur Respir Rev* 2013; 22:312–324.
3. Deegan PC, McNicholas WT. Predictive value of clinical features for the obstructive sleep apnoea syndrome. *Eur Respir J* 1996; 9:117–124.
4. Netzer NC, Hoegel JJ, Loube DD. Prevalence of symptoms and risk of sleep apnea in primary care. *Chest* 2003; 4:1406–1414.
5. Chung F, Yegneswaran B, Liao P. Validation of the Berlin questionnaire and American Society of Anesthesiologists checklist as screening tools for obstructive sleep apnea in surgical patients. *Anesthesiology* 2008; 108:822–830.
6. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: tool to screen patients for obstructive sleep apnea. *Anesthesiology* 2008; 108:812–821.
7. Berry RB, Brooks R, Gamaldo CE, Harding SM, Loyd RM, V B. The AASM manual for the scoring of sleep and associated events: rules, terminology and technical specifications, version 2. 3. Darien, IL: American Academy of Sleep Medicine; 2016.
Value of STOP-BANG & Berlin in OSA prediction  Suliman et al.  371

8 American Academy of Sleep Medicine. Chapter 2. Satela M, editor International classification of sleep disorders. 3rd ed. Darien, IL: American Academy of Sleep Medicine; 2014. pp. 114–122.
9 Pang KP, Terris DJ. Screening for obstructive sleep apnea: an evidence based analysis. Am J Otolaryngol 2006; 27:112–118.
10 Ramachandran SK, Josephs LA. A meta-analysis of clinical screening tests for obstructive sleep apnea. Anesthesiology 2009; 110:928–939.
11 Tan A, Yin JD, Tan LW, van Dam RM, Cheung YY, Lee CH. Using the Berlin questionnaire to predict obstructive sleep apnea in the general population. J Clin Sleep Med 2017; 13:427–432.
12 Lü XP, Zhang C, Ma J, Su L, Jia P, Luo YP, et al. Application of Berlin questionnaire in the screening of obstructive sleep apnea hypopnea syndrome. Chin J Tuberc Respir Dis 2011; 34:515–519.
13 Trimer R, Ricci PA, Costa FSM, Mendes RG, Arena R, Cabiddu R, et al. Correlation between desaturation indices of oxygen saturation variability in sever obstructive sleep apnea: a pilot study. J Respir Cardiovass Phys Ther 2016; 4:3–11.
14 Chung F, Abdullah HR, Liao P. Stop-Bang questionnaire: a practical approach to screen for obstructive sleep apnea. Chest 2016; 149:631–638.
15 Nagappa M, Liao P, Wong J, Auckley D, Ramachandran SK, Memtsoudis S, et al. Validation of the Stop-Bang questionnaire as a screening tool for obstructive sleep apnea among different populations: a systematic review and meta-analysis. PLoS One 2015; 10:122–145.
16 Kuhlemayr F, Klotz E, Voik T, Höld M, Spies C, Flietze I, et al. Obstructive sleep apnea syndrome-prevalence and screening in the pre admission clinic. J Anesth Clin Res 2015; 6:1.
17 Sharma S, Mather PJ, Elfrid JT, Kahn D, Shiue KY, Cheema M, et al. Obstructive sleep apnea in obese hospitalized patients: a single center experience. J Clin Sleep Med 2015; 7:717–723.
18 El-Sayed IH. Comparison of four sleep questionnaires for screening obstructive sleep apnea. Egypt J Chest Dis Tuberc 2012; 61:433–441.
19 Silva GE, Vana KD, Goodwin JL, Sherrill DL, Quan SF. Identification of patients with sleep disordered breathing: comparing the four variable screening tool, Stop, Stop-Bang, and Epworth Sleepiness Scales. J Clin Sleep Med 2011; 7:467–472.
20 Khaledi-Paveh B, Khazaie H, Nosouri M, Ghadami MR, Tahmasian M. Evaluation of Berlin questionnaire validity for sleep apnea risk in sleep clinic populations. Basic Clin Neurosci 2016; 7:43–48.
21 Boese ML, Ransom RK, Roadfuss RJ, Todd A, McGuire JM. Utility of the Berlin Questionnaire to screen for obstructive sleep apnea among patients receiving intravenous sedation for colonoscopy. AANA J 2014; 82:38–45.
22 Haraldsson PO, Carenfelt C, Knutsson E. Preliminary report: validity of symptom analysis and daytime polysomnography in diagnosis of sleep apnea. Sleep 1992; 15:261–263.
23 Sharma SK, Vasudev C, Sinha S. Validation of the modified Berlin questionnaire to identify patients at risk for the obstructive sleep apnea syndrome. Indian J Med Res 2006; 124:281–290.
24 Abrishami A, Khajehdehi A, Chung F. A systematic review of screening questionnaires for obstructive sleep apnea. Can J Anesth 2010; 57: 423–438.