

STOPBANG versus NOSAS in screening patients with severe obstructive sleep apnea

Performance des questionnaires STOP-BANG et NoSAS dans le diagnostic du syndrome d'apnée obstructive de sommeil sévère

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ABSTRACT

Introduction: Obstructive sleep apnea (OSA) is a prevalent sleep disorder characterized by repeated upper airway obstruction during sleep. It can lead to significant health risks, and early detection is essential for effective management.

Aim: To evaluate the diagnostic performance of STOP-BANG and NoSAS questionnaires in identifying severe OSA.

Method: Patients with confirmed sleep disorders by ventilator polygraphy were enrolled in this cross-sectional study conducted over 18 months in the Pneumology department of Charles Nicolle Hospital of Tunis. All participants completed STOP-BANG and NoSAS questionnaires.

Results: A total of 172 patients diagnosed with OSA were enrolled, with a mean age of 54.4 years. OSA severity was classified as mild in 63 patients (36.6%), moderate in 45 patients (26.2%), and severe (apnea-hypopnea index ≥ 30 /h) in 64 patients (37.2%). Severe OSA was significantly associated with male ($p=0.04$), older age ($p=0.019$), higher BMI ($p<0.001$), larger neck circumference ($p<0.001$), and greater fatigue ($p=0.037$). STOP-Bang and NoSAS scores demonstrated high discriminative value, with areas under the curve (AUC) of 0.61 and 0.64, respectively. STOP-BANG score showed higher sensitivity (65.2%) compared to NoSAS (34.8%), while NoSAS exhibited superior specificity (85.6% vs 53.8%). Positive predictive values were comparable between scores, but NoSAS had a slightly higher negative predictive value (82.9% vs 81.5%).

Conclusion: These findings suggest that while STOP-BANG is more sensitive for identifying severe OSA, NoSAS offers better specificity, making it a valuable tool for screening in specific populations. Combining both scores may enhance diagnostic accuracy and improve early detection of severe OSA, thereby optimizing patient outcomes.

Key words: Sleep apnea, screening, score, severity, STOPBANG questionnaire, NoSAS score

RÉSUMÉ

Introduction: Le syndrome d'apnée obstructive du sommeil (SAOS) est un trouble du sommeil fréquent, souvent sous-diagnostiqué, augmentant la morbi-mortalité des sujets à risque et nécessitant une prise en charge précoce et efficace.

Objectif: Évaluer la performance diagnostique des questionnaires STOP-Bang et NoSAS dans l'identification du SAOS sévère.

Méthode: Une étude transversale était menée sur 18 mois au service de pneumologie de l'hôpital Charles Nicolle de Tunis incluant des patients ayant un SAOS confirmé par polygraphie ventilatoire et ayant répondu aux questionnaires de STOP-Bang et NoSAS.

Résultats: Nous avons inclus 172 patients, avec un âge moyen de 54,4 ans. La sévérité du SAOS était légère chez 63 patients (36,6 %), modérée chez 45 patients (26,2 %) et sévère chez 64 patients (37,2 %). Le SAOS sévère était significativement associé au genre masculin ($p=0,04$), à un âge avancé ($p=0,019$), à un IMC élevé ($p<0,001$), à un tour de cou important ($p<0,001$) et à une fatigue accrue ($p=0,037$). Les scores STOP-Bang et NoSAS montraient une bonne valeur discriminative, avec des AUC sous la courbe de 0,61 et 0,64 respectivement. Le score STOP-Bang présentait une sensibilité supérieure (65,2% vs 34,8%), tandis que NoSAS offrait une meilleure spécificité (85,6% vs 53,8 %). Les valeurs prédictives positives étaient comparables, mais NoSAS montrait une valeur prédictive négative légèrement supérieure (82,9% vs 81,5 %).

Conclusion : Cette étude suggérait que le STOP-Bang était plus sensible pour dépister le SAOS sévère, alors que le NoSAS était plus spécifique. L'association des deux scores pourrait favoriser le diagnostic précoce du SAOS sévère.

Mots clés : Apnée du sommeil, dépistage, score, gravité, questionnaire STOPBANG, score NoSAS

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INTRODUCTION

Obstructive sleep apnea (OSA) is a sleep disorder characterized by repeated obstruction of the upper airway during sleep, leading to breathing cessation that can be either "complete" for periods of "apnea" or "partial" for periods of "hypopnea" lasting at least 10 seconds as defined by the American Academy of Sleep Medicine (AASM), followed by arousals and hyperpnea (1). As this condition involves multiple episodes of partial or complete closure of the upper airway and causes interruptions in breathing during sleep it may eventually lead to severe health consequences if left untreated. Effective treatments are available, including lifestyle changes, such as weight loss (2,3) and positional therapy for OSA that is more prominent in the supine position (4) as well as medical devices like continuous positive airway pressure (CPAP) machines(5) and oral appliances for patients unable or unwilling to use CPAP or those unable to access electricity reliably (6). In some cases, surgery may be recommended to alleviate airway obstruction (7).

Early recognition and management of obstructive sleep apnea are crucial for improving sleep quality, reducing associated health risks, and enhancing overall quality of life. Effective screening methods help to identify individuals who may benefit from further evaluation and intervention to improve sleep quality and overall health. In this context, various questionnaires such as Berlin Questionnaire, STOP-BANG and NoSAS scores are available to identify individuals at risk for OSA. Through this study, we aimed to evaluate the performance of STOP-Bang and NoSAS scores as screening tools for severe OSA in patients diagnosed with sleep apnea syndrome, compared to a gold standard (polygraphy).

METHODS

Study design

A cross-sectional study was conducted from January 2023 to June 2024, targeting patients with a suspicious sleep disorder, referred by primary care physicians or pre-anesthesia to the sleep unit for clinical evaluation and ventilator polygraphy (PG) in Charles Nicolle University Hospital of Tunis. The oral consent of patients was obtained before their enrollment. Data regarding age, gender, high blood pressure (blood pressure $\geq 140/90$ mmHg or treatment for hypertension), snoring, observed apnea, neck circumference, body mass index (BMI) and tiredness evaluated by Pichot score were collected. Patients with a polygraph recording of insufficient quality (insufficient recording time, missing oximetry, etc.), who had a polygraph recording at home and patients with central sleep apnea were not included.

Screening questionnaires

All patients included were required to fulfill the NoSAS and STOP-Bang questionnaires, as follows:

-STOPBANG questionnaire: A total of eight items comprises:

BANG (BMI >35 kg/m²; age >50 years; neck circumference >40 cm; male sex) and STOP (snoring, fatigue, observed apnea and elevated blood pressure); evaluated by yes (1point) or no (0point). The overall score is between 0 and 8 (8).

-NoSAS score: A total of six items comprises neck circumference >40 cm (4points), BMI between 25-30kg/m² (3 points), BMI >30 kg/m² (5points), snoring (2points), age >55 years (4points) and male sex (2points). A NoSAS score ≥ 8 is suggestive of being at high risk for OSA (9).

Sleep studies

All PGs were taken in hospital, using the patient's usual bedtime, overnight. A standardized setting made up of surface electrodes was used and included: oronasal airflow (thermistor and flow sensor), thoracic and abdominal respiratory effort, snoring pulse oximetry and body position sensors. A certified PG technician scored the PG recordings, and a sleep physician reviewed the final reports. The sleep technician and physician were both blinded to the study report (clinical information, NoSAS, and STOP-Bang questionnaires). The scoring was made manually, following the recommendations of the American Academy of Sleep Medicine (1). Apnea was defined as a decrease of at least 90% of airflow from baseline, lasting 10 seconds or longer. Hypopnea was defined as a decrease of at least 30% of airflow from baseline, lasting 10 seconds, associated with either arousal or a $\geq 3\%$ O₂ saturation decrease. Obstructive event was retained when thoraco-abdominal movement was present. The mean number of apneas and hypopneas per hour (apnea-hypopnea index [AHI]) was calculated. Both diagnosis and severity of OSA were classified based on the AHI: <5 /h=No OSA; 5-15/h=mild OSA, 15-30/h=moderate OSA, and ≥ 30 /h=severe OSA (1).

Statistical Analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences (IBM SPSS®).

To evaluate the diagnostic performance of the NoSAS and STOP-Bang scores for various apnea-hypopnea index (AHI) cut-off points, the area under the receiver operating characteristic (ROC) curve was calculated. Additionally, the optimal cut-off points for each score, maximizing both sensitivity and specificity, were identified.

RESULTS

A total of 172 patients were diagnosed with OSA. The apparent female gender was predominant (137 females (79.7%) and the mean age was 57.4 ± 13 years. Mild OSA was diagnosed in 63 patients (36.6%), moderate OSA in 45 patients (26.2%) and severe OSA (IAH ≥ 30 /h) in 64 patients (37.2%). We divided patients into two groups: Group 1 with severe OSA (n=64 patients) and Group 2 mild to moderate OSA (n=108 patients) and we compared clinical features and STOPBANG and NoSAS items between the two groups. Summary of descriptive statistics are displayed in table I.

Table 1. Descriptive analysis of the study sample

Variables	Patients (n)
Age (years)	57.42±13
Sexe	
Male	35
Female	137
Blood High pressure	107
Snoring	169
Observed apnea	49
BMI >35 Kg/m ²	98
BMI <25 Kg/m ²	4
BMI [25-30 Kg/m ²]	19
BMI [30-40 Kg/m ²]	87
BMI>40 Kg/m ²	61
Neck circumference (cm)	35.91±5
waist circumference	127±11
Tiredness: Pichot score	13.81±8.8
Epworth	8.09±4
OSA severity	
• Mild	63
• Moderate	45
• severe	64

Most patients suffering from severe OSA were predominantly males (54.3% males vs 35.3% females, $p=0.04$) with a statistically significant correlation between age and the severity of the OSA, with older patients suffering from OSA (Group 1: 59 ± 10 years vs Group 2: 56 ± 14.3 ; $p=0.019$). Severe obesity (BMI >35 Kg/m²) was more present in severe OSA (54.6% versus 45.4%; $p<0.001$). The neck circumference in centimeters (cm) was larger in patients with severe OSA (G1: 37.6 ± 5.1 cm versus G2: 34.7 ± 4.5 cm; $p<0.001$). Tiredness was evaluated by Pichot, and the score was deeper in patients with severe OSA ($p=0.037$).

High blood pressure, snoring, and observed apnea were not statistically different between the two groups (respectively p -values of $p=0.4$; 0.6 ; 0.09).

NoSAS score was significantly higher in patients with severe OSA (Group 1: 11.4 ± 2.7 vs Group 2: 10 ± 2.8 ; $p=0.001$), similarly for STOPBANG score (4.06 ± 1.2 in Group 1 vs 3.5 ± 1.1 in Group 2; $p=0.004$).

A detailed comparison of scores' items in severe OSA (G1) and non-severe OSA (G2) groups is displayed in Table 2.

The area under the curve (AUC) was high for both scores, indicating a high discriminative value for both scores. This prediction was slightly greater for the NoSAS score than for the stop Bang score (0.64 CI [0.56-0.73] vs 0.61 CI [0.53-0.70]). The cut-off value was 12 for NoSAS score and 3.5 for STOP-BANG score.

The study showed that STOP-BANG score was more sensitive than NoSAS score in identifying potential patients suffering from severe OSA, with sensitivities of 65.2% compared to 34.8% for NoSAS. While NoSAS score was

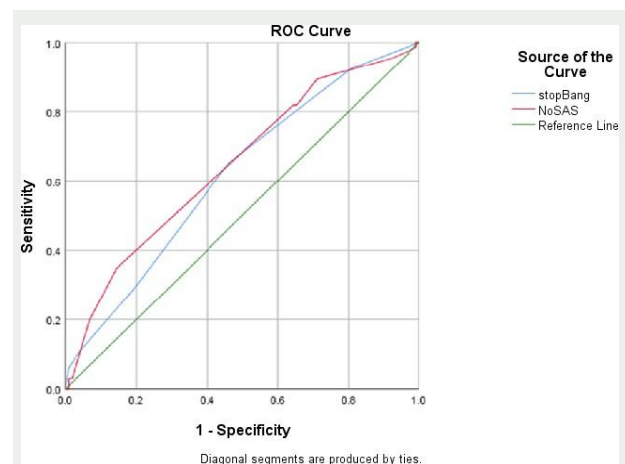
more specific with 85.6% compared to 53.8% for STOP-BANG.

Table 2. Comparison of scores items in severe OSA (G1) vs non-severe OSA (G2) groups

Variables	Severe OSA (IAH>30/h)		P
	Group1: yes (n=64 patients)	Group2: no (n=108 patients)	
Age (years)	59±10	56±14.3	0.019
Male	54.3%	45.7%	0.04
Female	35.3%	64.7%	
Blood High pressure	44	76	0.4
Snoring	66	129	0.6
Observed apnea	24	33	0.09
BMI >35 Kg/m²	54.6%	45.6%	0.001
Neck circumference (cm)	37.6±5.1	34.7±4.5	0.001
Tiredness: Pichot score	15.6±8	13±9	0.037
NoSAS score	11.4±2.7	10±2.8	0.001
STOPBANG score	4.06±1.2	3.5±1.1	0.004

STOP-BANG score had a lower positive predictive value of 43% compared to NoSAS score's 44.4% and a lower negative predictive value of 81.5% vs 82.9% for NoSAS score.

The Receiver Operating Characteristic (ROC) Curve Analysis of diagnostic performance of STOP-Bang and NoSAS Scores for severe obstructive sleep apnea is shown in Figure 1.

**Figure 1.** Receiver Operating Characteristic (ROC) Curve Analysis: Diagnostic Performance of STOP-Bang and NoSAS Scores for Severe Obstructive Sleep Apnea

DISCUSSION

This study revealed that both STOP-BANG and NoSAS questionnaires are good tools to predict the severity of obstructive sleep apnea disorder. In fact, age, male gender, severe obesity with BMI >35 Kg/m², neck circumference and Pichot score had a statistically significant correlation

with the OSA severity; making both studied scores performant in the screening of severe OSA.

It is essential to note that our study has the advantage of including a large sample, but it has the limitation of being a monocentric study.

Referring to the available literature, we found that several studies assessed the STOP-Bang score regarding its effectiveness (10), demonstrating a sensitivity often exceeding 80% in diverse populations. This high sensitivity makes this score particularly important for initial screening, especially in settings with a high prevalence of OSA or where a quick assessment is required.

However, the broad criteria of STOP-BANG also contribute to its lower specificity. This can result in a higher rate of false positives, which may lead to unnecessary confirmatory testing and increased healthcare costs. And while this score is adept at identifying patients who are likely to have severe OSA, it can also flag individuals who may not have clinically significant disease (11).

The NoSAS score includes fewer variables, which simplifies the screening process (9). This tool has been shown to have good performance in identifying moderate to severe OSA but generally demonstrates lower sensitivity compared to the STOP-BANG score (12). The NoSAS score's simplicity is advantageous in regions with limited resources where traditional screening methods may be lacking, as it allows for a quick and easy assessment without requiring extensive patient history or physical examination(13).

Nevertheless, the limited number of variables in NoSAS may result in a reduced ability to identify all patients with severe OSA. This can lead to missed diagnoses, particularly in individuals with atypical presentations or those who do not fit neatly into the parameters of the NoSAS criteria(13). Despite its practicality, the tool's lower sensitivity highlights the need for supplementary diagnostic methods when screening results are suggestive of OSA.

Referring to the available literature, we found that the Epworth Sleepiness Scale (ESS) used to assess daytime sleepiness has shown a correlation with the degree of severity of OSA: Studies indicate that higher ESS scores suggesting that patients report excessive daytime sleepiness are more likely to have severe OSA as mean ESS scores of patients with mild, moderate, and severe obstructive SDB are respectively 9.5 , 11.5 , and 16.0. However, its efficacy may be affected by factors such as mood disorders or medication use leading to false positives(14,15). We found also that the Berlin Questionnaire may be a significant tool to stratify patients based on their risk of OSA, identifying those at high risk of developing sleep disorders(16).

Among the various subjective questionnaires, STOP-BANG and NoSAS scores remain the best among other tools for screening severe OSA, each with distinct advantages and limitations. The choice between STOP-BANG and NoSAS often depends on the context and the specific needs of the population. STOP-BANG's high sensitivity makes it a solid choice for initial screening, Conversely, NoSAS's ease of use and fewer variables makes it a practical option in settings where resources are constrained or where a rapid assessment is needed.

More studies should focus on enhancing the specificity of both screening tools to reduce false positives and improve

diagnostic accuracy.

CONCLUSION

These results indicate that although the STOP-Bang questionnaire demonstrates better sensitivity in detecting severe OSA, the NoSAS score provides superior specificity, making it particularly useful for screening in targeted populations. Utilizing both scores in combination could improve diagnostic accuracy and facilitate earlier identification of severe OSA, ultimately leading to better patient outcomes

Declaration of generative AI and AI-assisted technologies in the writing process.

During the preparation of this work, the authors used Perplexity IA to improve the readability and language of the manuscript. After using this service, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article

REFERENCES

1. Kapur VK, Auckley DH, Chowdhuri S, Kuhlmann DC, Mehra R, Ramar K, et al. Clinical Practice Guideline for Diagnostic Testing for Adult Obstructive Sleep Apnea: An American Academy of Sleep Medicine Clinical Practice Guideline. *J Clin Sleep Med*. 2017 Mar 15;13(03):479–504.
2. Ng SSS, Tam WWS, Lee RWW, Chan TO, Yiu K, Yuen BTY, et al. Effect of Weight Loss and Continuous Positive Airway Pressure on Obstructive Sleep Apnea and Metabolic Profile Stratified by Craniofacial Phenotype: A Randomized Clinical Trial. *Am J Respir Crit Care Med*. 2022 Mar 15;205(6):711–20.
3. Grunstein RR, Stenlöf K, Hedner JA, Peltonen M, Karason K, Sjöström L. Two Year Reduction In Sleep Apnea Symptoms and Associated Diabetes Incidence After Weight Loss In Severe Obesity. *Sleep*. 2007 Jun;30(6):703–10.
4. Lee KI, Choi JH. Positional Therapy for Obstructive Sleep Apnea: Therapeutic Modalities and Clinical Effects. *Sleep Med Res*. 2023 Sep 30;14(3):129–34.
5. Qiao M, Xie Y, Wolff A, Kwon J. Long term adherence to continuous positive Airway pressure in mild obstructive sleep apnea. *BMC Pulm Med*. 2023 Sep 1;23(1):320.
6. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, et al. Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015. *J Clin Sleep Med JCSM Off Publ Am Acad Sleep Med*. 2015 Jul 15;11(7):773–827.
7. Elshaug AG, Moss JR, Southcott AM, Hiller JE. Redefining success in airway surgery for obstructive sleep apnea: a meta analysis and synthesis of the evidence. *Sleep*. 2007 Apr;30(4):461–7.
8. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP Questionnaire. *Anesthesiology*. 2008 May 1;108(5):812–21.
9. Marti-Soler H, Hirotsu C, Marques-Vidal P, Vollenweider P, Waeber G, Preisig M, et al. The NoSAS score for screening of sleep-disordered breathing: a derivation and validation study. *Lancet Respir Med*. 2016 Sep;4(9):742–8.
10. Chung F, Abdullah HR, Liao P. STOP-Bang Questionnaire. *Chest*. 2016 Mar;149(3):631–8.
11. Pivetta B, Chen L, Nagappa M, Saripella A, Waseem R, Englesakis M, et al. Use and Performance of the STOP-Bang Questionnaire for Obstructive Sleep Apnea Screening Across Geographic Regions: A Systematic Review and Meta-Analysis. *JAMA Netw Open*. 2021 Mar 1;4(3):e211009.
12. Georgakopoulou VE, Pantazis N, Tsiafaki X, Nena E, Amfilochiou

A, Steiropoulos P. Validation of NoSAS score for the screening of obstructive sleep apnea. *Med Int.* 2023;3(2):14.

13. Peng M, Chen R, Cheng J, Li J, Liu W, Hong C. Application value of the NoSAS score for screening sleep-disordered breathing. *J Thorac Dis.* 2018 Aug;10(8):4774–81.
14. Johns MW. Reliability and Factor Analysis of the Epworth Sleepiness Scale. *Sleep.* 1992 Jul;15(4):376–81.
15. Johns MW. A New Method for Measuring Daytime Sleepiness: The Epworth Sleepiness Scale. *Sleep.* 1991 Nov 1;14(6):540–5.
16. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. *Ann Intern Med.* 1999 Oct 5;131(7):485–91.