Turk Thorac J 2019; 20(2): 103-7 DOI: 10.5152/TurkThoracJ.2018.18074

Original Article

Diagnostic Accuracy of a Modified STOP-BANG Questionnaire with National Anthropometric Obesity Indexes

Nilüfer Aylin Acet Öztürk[1], Aslı Görek Dilektaşlı[2], Ezgi Demirdöğen Çetinoğlu[2], Ahmet Ursavaş[2], Mehmet Karadağ[2]

[1]Clinic of Pulmonary Medicine, Gemlik Hospital, Bursa, Turkey
[2]Department of Pulmonary Medicine, Uludağ University School of Medicine, Bursa, Turkey

Cite this article as: Acet Öztürk NA, Dilektaşlı AG, Demirdöğen Çetinoğlu E, et al. Diagnostic Accuracy of a Modified STOP-BANG Questionnaire with National Anthropometric Obesity Indexes. Turk Thorac J 2019; 20(2): 103-7.

Abstract

OBJECTIVES: Obstructive sleep apnea (OSA) is a very common sleep-related disorder and has many medical complications. Although the STOP-BANG questionnaire is an attractive screening tool because of high sensitivity, it lacks power in specificity. The aim of the present study was to evaluate and compare the diagnostic accuracy of standard STOP-BANG and a modified STOP-BANG questionnaire, using national cut-off values for neck circumference that determined OSA, in a sleep center population.

MATERIALS AND METHODS: One hundred eighty-five participants who were referred to the sleep-disordered breathing clinic were consecutively enrolled. We used 40 cm and 36 cm as the cut-off values for neck circumference, thus scoring patients accordingly and creating a modified STOP-BANG score with national anthropometric obesity indexes.

RESULTS: The median neck circumferences were 41 (39-44) cm, 40 (37-42) cm, and 43 (40-45) cm for total population, female gender, and male gender, respectively. The mean STOP-BANG score was 4.5±1.5, and the mean modified STOP-BANG score was 4.9±1.5. Discrimination of OSA measured by area under the curve for both questionnaires is comparable (p>0.05). Sensitivity to define OSA (apnea-hypopnea index (AHI)≥5) was 92.2% and 93.8% for original and modified STOP-BANG questionnaire, respectively. Sensitivity for moderate (AHI≥15) and severe OSA (AHI≥30) was identical for both questionnaires.

CONCLUSION: The STOP-BANG questionnaire has an excellent sensitivity, but modest specificity and adding national obesity indexes for neck circumference achieved similar results in terms of sensitivity and specificity with the original questionnaire.

KEYWORDS: National anthropometric index, obstructive sleep apnea, STOP-BANG

Received: *12.05.2018* ***Accepted:*** *19.06.2018*

INTRODUCTION

Obstructive sleep apnea (OSA) is a very common sleep-related disorder and has many medical complications, such as hypertension, cardiovascular diseases, neurovascular diseases, and metabolic syndrome [1]. The aim of a sleep questionnaire is to help sleep clinicians to prioritize their patients and to efficiently allocate limited resources for polysomnography (PSG). Sleep questionnaires help patients receive treatment in time and avoid associated complications.

The STOP-BANG questionnaire was developed by Chung et al. [2] in 2008 and has since been validated in many languages, such as Danish, Portuguese, Chinese, and Turkish [3-6]. It is a validated screening tool for OSA in different populations [7].

Although the STOP-BANG questionnaire is an attractive screening tool because of high sensitivity, it lacks power in specificity. Several studies aimed to improve validity specially to decrease false-positive cases by increasing specificity [8]. Alternative scoring models [9-11] adding serum bicarbonate levels [12] and body type [13] to calculations are evaluated for this purpose. However, the validity and effect of cut-off values for neck circumference in the STOP-BANG questionnaire in different nationalities remain unknown.

Several studies investigated the association between anthropometric measurements and OSA severity. Neck circumference was found to be better associated with OSA than body mass index (BMI) and waist circumference [14-17]. Soylu et al. [14] evaluated the relationship between anthropometric obesity indexes and OSA in a Turkish population and described neck circumferences 40 and 36 cm as a risk factor for OSA in male and female patients, respectively. In a Colombian population, a neck circumference of 36.9 cm for female and 41.2 cm for male gender is found to be associated with OSA symptoms [18]. However, in a study from Australia, male patients with OSA have 44, and female patients with OSA have 38 cm neck circumference [19]. These findings highlight the differences of OSA-associated neck circumference across populations.

Address for Correspondence: Aslı Görek Dilektaşlı, Department of Pulmonary Medicine, Uludağ University School of Medicine, Bursa, Turkey
E-mail: asligorekd@gmail.com

We aimed to evaluate and compare the diagnostic accuracy of standard STOP-BANG and a modified STOP-BANG questionnaire, using national cut-off values for neck circumference that determined OSA, in a sleep center population.

MATERIALS AND METHODS

Study Design and Patient Selection

Patients who were evaluated in a tertiary care hospital pulmonary outpatient clinic and referred to the sleep-disordered breathing clinic were consecutively enrolled between September 1, 2013 and March 31, 2014. Exclusion criteria were age <18 years, previously diagnosed and treated for OSA, and incomplete questionnaire.

As part of the study, a sleep physician evaluated the patient's medical history, sleep-related complaints, and brief physical examination. Demographic and anthropometric measurements, such as weight, height, and neck circumference were recorded. Measurements were made with the same equipment for all patients. Neck circumference was measured in the upright position at the level of the cricothyroid membrane.

Ethics committee approval was received for this study from the ethics committee of Uludağ University in 16/07/2013, decision number 2013-13/7. Written informed consent was obtained from all of the patients.

Polysomnography

Overnight PSG was performed to all patients using the Compumedics E-series Sleep System (Compumedics Sleep, Melbourne, Australia) device. Manual sleep staging and associated respiratory events were scored according to the American Academy of Sleep Medicine guideline [1].

A diagnosis of OSA was made if the apnea-hypopnea index (AHI) was ≥5/h and the presence of clinical symptoms or AHI≥15/h. OSA severity was classified as mild (AHI 5-14/h), moderate (AHI 15-29/h), and severe (AHI≥30/h). Participants with AHI <5 were defined as the control group.

Table 1. Population characteristics

Age (year)	48.2±10.9
Gender (male)	121 (65.4%)
BMI (kg/m^2)	35.5±11
Neck circumference	41 (39-44)
Epworth Sleepiness Scale	9 (0-24)
STOP-BANG score	4.5±1.5
Modified STOP-BANG score	4.9±1.5
AHI (event/h)	21.9 (0-130.2)
ODI 3% (event/h)	17.6 (0-116)
Mean oxygen desaturation	5 (0-23)
Time with O_2 sats <90% (%)	5 (0-100)
Apnea-hypopnea duration (min)	50.2 (0-325.6)
All OSA, n (%)	153 (82.7)
Severe OSA, n (%)	73 (39.1)

BMI: body mass index; AHI: apnea-hypopnea index; ODI: oxygen desaturation index; OSA: obstructive sleep apnea

Questionnaires

The STOP-BANG questionnaire is an 8-item questionnaire, each item scored as 1. Patients with higher scores have higher probability of OSA [20]. The STOP-BANG questionnaire is validated in Turkish [6].

It has been shown that with a stepwise increase of the STOP-BANG score, the probability of OSA increases [7]. The STOP-BANG questionnaire with a score ≥3 consistently demonstrated high sensitivity to detect OSA in different populations [7]. In accordance with previous studies, we used a cut-off value of 3.

The cut-off values for neck circumferences in the original STOP-BANG questionnaire are 43 cm and 41 cm for male and female gender, respectively. We used 40 cm and 36 cm as the cut-off values for neck circumference, thus scoring patients accordingly and creating a modified STOP-BANG score with national anthropometric obesity indexes.

Daytime sleepiness was measured by the Epworth Sleepiness Scale (ESS). ESS is a self-administered, simple and reliable questionnaire that consists of eight questions. Each item is scored 0-3 points, and having high scores indicates having worse daytime sleepiness. ESS is validated in Turkish [21].

Statistical Analysis

Data were analyzed using the IBM Statistical Package for the Social Sciences (IBM SPPS Statistics Corp.; Armonk, NY, USA) version 22. Variables were analyzed for normal distribution by using visual (histograms and probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test). Means and standard deviations were reported for normally distributed continuous data, and medians and interquartile ranges for non-normally distributed continuous data. Correlation between normally distributed and non-normally distributed data was calculated by Pearson test and Spearman test, respectively. Comparison of two groups with normally and non-normally distributed data was analyzed by Student's t-test and Mann-Whitney U test, respectively. For the assessment of the performance of the STOP-BANG and modified STOP-BANG scores, multiple 2×2 contingency tables were used to calculate sensitivity, specificity, positive predictive value, negative predictive value (NPV), and likelihood ratio for each cut-off value of AHI. Receiver operating characteristic (ROC) curve analysis was used to calculate the area under the curve (AUC) for each cut-off value of AHI. MedCalc was used for comparison of AUC values. A p value <0.05 was considered statistically significant.

RESULTS

The study population consisted of 185 participants who were 48.2±10.9 years old. Of the patients, 65.4% were male. The median neck circumferences were 41 (39-44) cm, 40 (37-42) cm, and 43 (40-45) cm for total population, female gender, and male gender, respectively. One hundred fifty-two (82.7%) had OSA (AHI≥5), 115 (62.2%) had moderate or severe OSA (AHI≥15), and 73 (39.1%) had severe OSA (AHI≥30). The mean STOP-BANG score was 4.5±1.5, and the mean modified STOP-BANG score was 4.9±1.5. Table 1 shows the population characteristics.

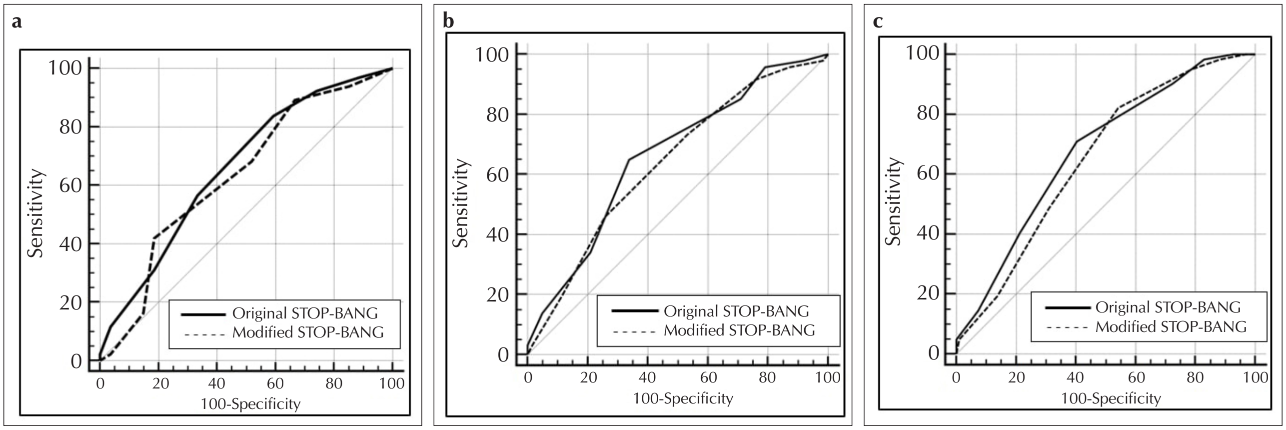

Figure 1. a-c. ROC curves for original and modified STOP-BANG questionnaires. (a) ROC curves for original and modified STOP-BANG scores for AHI ≥5 (AUC: 0.661, 95% CI [0.581-0.735]; AUC: 0.635, 95% CI [0.554 - 0.710], respectively); (b) ROC curves for original and modified STOP-BANG scores for AHI ≥15 (AUC: 0.662, 95% CI: [0.582 - 0.736]; AUC: 0.639, 95% CI [0.558 - 0.714], respectively); (c) ROC curves for original and modified STOP-BANG scores for AHI ≥30 (AUC: 0.679, 95% CI: [0.600 - 0.751]; AUC: 0.652, 95% CI [0.572 - 0.727], respectively). Solid lines represent the ROC curves for the original STOP-BANG scores, and dashed lines represent the modified STOP-BANG scores

Table 2. Correlation of the original and modified STOP-BANG questionnaire with clinical characteristics

	STOP-BANG score		Modified STOP-BANG score	
	r	p	r	p
Age (year)	0.325	<0.001	0.336	<0.001
BMI (kg/m^2)	0.246	0.002	0.244	0.002
Epworth Sleepiness Scale	0.324	<0.001	0.314	<0.001
AHI (event/h)	0.378	<0.001	0.338	<0.001
Apnea-hypopnea duration (min)	0.378	<0.001	0.326	<0.001
ODI 3% (event/h)	0.460	<0.001	0.420	<0.001
Mean oxygen desaturation	-0.391	<0.001	0.369	<0.001
Time with O_2 sats <90% (%)	0.465	<0.001	0.439	<0.001
Lowest O_2 sats	-0.486	<0.001	0.379	<0.001

BMI: body mass index; AHI: apnea-hypopnea index; ODI: oxygen desaturation index

Correlation analysis showed that both original and modified STOP-BANG scores are statistically significantly correlated with age, BMI, daytime sleepiness, AHI, oxygen desaturation index, and oxygen desaturation (Table 2).

Discrimination of OSA measured by AUC is poor for both questionnaires, and results are comparable (p>0.05). Figure 1 shows the ROC curve of the original and modified STOP-BANG questionnaires at different OSA severity. Sensitivity to define OSA (AHI≥5) was 92.2% and 93.8% for original and modified STOP-BANG questionnaire, respectively. Sensitivity for moderate (AHI≥15) and severe OSA (AHI≥30) was identical for both questionnaires. However, specificity remained low for both questionnaires. Table 3 shows the predictive values of the questionnaires for scores ≥3.

DISCUSSION

In our study, the STOP-BANG scores modified with national neck circumference values showed similar diagnostic accuracy with the original STOP-BANG scores (STOP-BANG AUC=0.661 vs. modified STOP-BANG AUC=0.635, p>0.05). Sensitivity for all OSA (AHI≥5), moderate (AHI≥15), and severe OSA (AHI≥30) was 93.8%, 95.74%, and 98.38% and 92.25%, 95.74%, and 98.38% for modified and original STOP-BANG scores, respectively. Changing the original neck circumference cut-off values with national indexes did not improve specificity. The specificity of STOP-BANG score ≥3 for OSA (AHI≥5), moderate (AHI≥15), and severe OSA (AHI≥30) was 25.9%, 20.9%, and 17%, respectively. When national neck circumference cut-off values were added to the STOP-BANG score ≥3, the specificity changed into 14.8%, 12.9%, and 11.7% for all OSA (AHI≥5), moderate (AHI≥15), and severe OSA (AHI≥30), respectively. Our findings are in accordance with previous studies, proving that the STOP-BANG questionnaire is a useful tool as a screening questionnaire with a good sensitivity and NPV.

The sensitivity results of our study are in accordance with a large meta-analysis of 9206 patients. Whereas in specificity, our results for both original and modified STOP-BANG are lower. Among the sleep clinic population, the sensitivity to detect any OSA (AHI>5), moderate to severe OSA (AHI>15), and severe OSA (AHI>30) was 90%, 94%, and 96%, respectively [7]. The specificity was 49%, 34%, and 25% for all OSA (AHI>5), moderate to severe OSA (AHI>15), and severe OSA (AHI>30), respectively [7].

Table 3. Predictive value of questionnaires

	STOP-BANG score ≥3	Modified STOP-BANG score ≥3
AHI≥5		
AUC	0.661	0.635
Sensitivity (%)	92.25 (86.21-96.22)	93.80 (88.15-97.2)
Specificity (%)	25.93 (11.11-46.28)	14.81 (4.19-33.73)
PPV (%)	85.61 (82.56-88.21)	84.03 (81.7-86.1)
NPV (%)	41.18 (22.64-62.61)	33.3 (13.95-60.66)
Likelihood ratio	1.25 (0.99-1.57)	1.1 (0.94-1.3)
AHI≥15		
AUC	0.662	0.639
Sensitivity (%)	95.74 (89.46-98.83)	95.74 (89.46-98.83)
Specificity (%)	20.97 (11.66-33.18)	12.90 (5.74-23.85)
PPV (%)	64.75 (66.61-67.77)	62.50 (60-64.92)
NPV (%)	76.49 (52.62-90.46)	66.67 (38.62-86.41)
Likelihood ratio	1.21 (1.06-1.39)	1.10 (0.99-1.22)
AHI≥30		
AUC	0.679	0.652
Sensitivity (%)	98.39 (91.34-99.96)	98.39 (91.34-99.96)
Specificity (%)	17.02 (10.05-26.16)	11.70 (5.99-19.97)
PPV (%)	43.88 (41.51-46.28)	42.36 (40.42-44.33)
NPV (%)	94.12 (68.52-99.16)	91.67 (59.29-98.81)
Likelihood ratio	1.19 (1.08-1.31)	1.11 (1.03-1.21)

AUC: area under the curve; PPV: positive predictive value; NPV: negative predictive value

Our sensitivity and specificity results are both better than those reported by Acar et al. [6]. In a Turkish validation study, STOP-BANG had 93.2%, 92.3%, and 96.9% sensitivity, in addition to 2.8%, 3.4%, and 6.4% specificity for all OSA, moderate, and severe OSA, respectively [6].

Ong et al. [22] used lower BMI cut-off and different cut-offs for neck circumference to improve the sensitivity. Changing neck circumference did not significantly affect sensitivity or predictive accuracy of the questionnaire. Although using lower BMI cut-off resulted in better sensitivity, it led to a significant decrease in specificity.

Neck circumference is found to be the best single clinical measurement for predicting OSA [23,24]. It is found to be associated with disease severity in both genders, especially in men [19]. The neck circumference-to-height ratio is shown to be associated with AHI, independent from visceral fat level especially in non-obese patients [25]. Hip circumference and neck circumference normalized by height are significant predictors of OSA in female patients [26]. Results about neck circumference suggest that fat distribution in the upper airway can be an important risk factor in OSA development.

The strength of our study is that all patients completed diagnostic overnight PSG, which is the gold standard of diagnosis of OSA [1]. Using pre-screened subjects referred to the sleep laboratory is the limitation of our study because it decreases generalizability.

The STOP-BANG questionnaire has an excellent sensitivity, but modest specificity and adding national obesity indexes for neck circumference achieved similar results in terms of sensitivity and specificity with the original questionnaire.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Uludağ University (date 16/07/2013, decision number 2013-13/7).

Informed Consent: Written informed consent was obtained from all of the patients.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – N.A.A.Ö., A.G.D., E.D.Ç., A.U., M.K.; Design – N.A.A.Ö., A.G.D., E.D.Ç.; Supervision – A.G.D., A.U., M.K.; Resources – N.A.A.Ö., A.G.D., A.U., M.K.; Materials – A.U., M.K.; Data Collection and/or Processing – N.A.A.Ö., A.G.D., E.D.Ç., A.U., M.K.; Analysis and/or Interpretation – N.A.A.Ö., A.G.D., E.D.Ç., A.U., M.K.; Literature Search – N.A.A.Ö., A.G.D.; Writing Manuscript – N.A.A.Ö., A.G.D., E.D.Ç., A.U., M.K.; Critical Review – N.A.A.Ö., A.G.D., E.D.Ç., A.U., M.K.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Kapur VK, Auckley DH, Chowdhuri S, 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; 13: 479-504. **[CrossRef]**
2. Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology 2008; 108: 812-21. **[CrossRef]**
3. Bille J, Bille-Hasselstrøm C, Petersen CG. Translation and validation of the Stop-Bang Questionnaire for obstructive sleep apnoea into Danish. Dan Med J 2015; 62: A5158.
4. Reis R, Teixeira F, Martins V, et al. Validation of a Portuguese version of the STOP-Bang questionnaire as a screening tool for obstructive sleep apnea: Analysis in a sleep clinic. Rev Port Pneumol (2006) 2015; 21: 61-8. **[CrossRef]**
5. Ha SC, Lee DL, Abdullah VJ, et al. CA. Evaluation and validation of four translated Chinese questionnaires for obstructive sleep apnea patients in Hong Kong. Sleep Breath 2014; 18: 715-21. **[CrossRef]**
6. Acar HV, Kaya A, Yücel F, et al. Validation of the STOP-Bang Questionnaire: an Obstructive Sleep Apnoea Screening Tool in Turkish Population Turk J Anaesthesiol Reanim 2013; 41: 115-20. **[CrossRef]**
7. Nagappa M, Liao P, Wong J, 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: e0143697. **[CrossRef]**
8. Nagappa M, Wong J, Singh M, et al. An update on the various practical applications of the STOP-Bang questionnaire in anesthesia, surgery, and perioperative medicine. Curr Opin Anaesthesiol 2017; 30: 118-25.
9. Chung F, Yang Y, Brown R, Liao P. Alternative scoring models of STOP-bang questionnaire improve specificity to detect undiagnosed obstructive sleep apnea. J Clin Sleep Med 2014; 10: 951-8. **[CrossRef]**

10. Nahapetian R, Silva GE, Vana KD, et al. Weighted STOP-Bang and screening for sleep-disordered breathing. Sleep Breath 2016; 20: 597-603. [CrossRef]
11. Farney RJ, Walker BS, Farney RM, et al. The STOP-Bang equivalent model and prediction of severity of obstructive sleep apnea: relation to polysomnographic measurements of the apnea/hypopnea index. J Clin Sleep Med 2011; 7: 459-65B. [CrossRef]
12. Chung F, Chau E, Yang Y, et al. Serum bicarbonate level improves specificity of STOP-Bang screening for obstructive sleep apnea. Chest 2013; 143: 1284-93. [CrossRef]
13. Sangkum L, Klair I, Limsuwat C, et al. Incorporating body-type (apple vs. pear) in STOP-BANG questionnaire improves its validity to detect OSA. J Clin Anesth 2017; 41: 126-1 31.
14. Soylu AC, Levent E, Sarıman N, et al. Obstructive sleep apnea syndrome and anthropometric obesity indexes. Sleep Breath 2012; 16: 1151-8. [CrossRef]
15. Dancey DR, Hanly PJ, Soong C, et al. Gender differences in sleep apnea: the role of neck circumference. Chest 2003; 123: 1544-50. [CrossRef]
16. Hoffstein V, Mateika S. Differences in abdominal and neck circumferences in patients with and without obstructive sleep apnoea. Eur Respir J 1992; 5: 3 77-81.
17. Davies RJ, Stradling JR. The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnoea syndrome. Eur Respir J 1990; 3: 509-14.
18. Ruiz AJ, Rondon Sepúlveda MA, Franco OH, et al. The associations between sleep disorders and anthropometric measures in adults from three Colombian cities at different altitudes. Maturitas 2016; 94: 1-10. [CrossRef]
19. Simpson L, Mukherjee S, Cooper MN, et al. Sex differences in the association of regional fat distribution with the severity of obstructive sleep apnea. Sleep 2010; 33: 467-74. [CrossRef]
20. Chung F, Subramanyam R, Liao P, et al. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. Br J Anaesth 2012; 108: 768-75. [CrossRef]
21. Izci B, Ardic S, Firat H, et al. Reliability and validity studies of the Turkish version of the Epworth Sleepiness Scale. Sleep Breath 2008;12: 161-8. [CrossRef]
22. Ong TH, Raudha S, Fook-Chong S, et al. Simplifying STOP-BANG: use of a simple questionnaire to screen for OSA in an Asian population. Sleep Breath 2010; 14: 371-6. [CrossRef]
23. Dixon JB, Schachter LM, O'Brien PE. Predicting sleep apnea and excessive day sleepiness in the severely obese: indicators for polysomnography. Chest 2003; 123: 1134-41. [CrossRef]
24. Bouloukaki I, Kapsimalis F, Mermigkis C, et al. Prediction of obstructive sleep apnea syndrome in a large Greek population. Sleep Breath 2011; 15: 657-64. [CrossRef]
25. Mazzuca E, Battaglia S, Marrone O, et al. Gender-specific anthropometric markers of adiposity, metabolic syndrome and visceral adiposity index (VAI) in patients with obstructive sleep apnea. J Sleep Res 2014; 23: 13-21. [CrossRef]
26. Kawaguchi Y, Fukumoto S, Inaba M, et al. Different impacts of neck circumference and visceral obesity on the severity of obstructive sleep apnea syndrome. Obesity (Silver Spring) 2011; 19: 276-82. [CrossRef]