Association between Anthropometric Indices and OSA: A Hospital-based Study

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ABSTRACT

Background: Obesity is an important risk factor for the development of obstructive sleep apnea (OSA). Although clinical and epidemiological studies have shown that OSA and obesity are strongly associated, few studies have examined the associations between anthropometric obesity indices and OSA, especially in the South Indian population. This study aimed to evaluate the influence of anthropometric obesity indices on OSA in an Indian population.

Materials and Methods: Anthropometric indices, such as neck circumference (NC), waist circumference (WC), and body mass index (BMI), were assessed in 50 subjects with suspected OSA.

Results: Of the 50 subjects assessed, 39 (78%) were diagnosed with OSA, and 11 (22%) had no OSA. Of these, 37 (74%) were males and 13 (26%) were females. Patients with OSA had a significantly higher age, BMI, WC, and NC than patients without OSA. The mean cut-off values of NC, WC, and BMI in males were 39, 93.8, and 29.8 respectively. The mean cut-off values of NC, WC, and BMI in females were 39.3, 96.5, and 30 respectively.

Conclusion: Increased anthropometric indices were significantly associated with the presence and severity of OSA in the Indian population. This study also demonstrated the mean cut-off values for increased OSA risk for body mass index, waist circumference, and neck circumference. When the means of different variables are compared with three degrees of severity of OSA it was observed that BMI and NC had a significant difference while WC had no significant difference based on severity.

Keywords: Body mass index, Neck circumference, Obstructive sleep apnea, Waist circumference.

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ABBREVIATIONS USED IN THIS ARTICLE

BMI = Body mass index; OSA = Obstructive sleep apnea; PSG = Polysomnography; ROC = Receiver operating characteristic; WC = Waist circumference.

INTRODUCTION

Obstructive sleep apnea (OSA) is typified by recurrent episodes of upper airway obstruction that occur during sleep and can lead to hypoxemia, snoring, and repeated airflow termination (apnea). These consequences manifest as a reduced ability to focus during the day, a higher frequency of accidents, and a decreased quality of life. It is linked to considerable morbidity and elevated mortality and is a substantial risk factor for conditions like pulmonary hypertension, coronary artery disease, hypertension, and stroke. The definitive method for diagnosing OSA is polysomnography (PSG), a multi-parameter study that is extensive and comprehensive. Due to restricted access to sleep laboratories for PSG, OSA is underdiagnosed even though there is an effective treatment available. Therefore, a simple and low-cost approach is required.

According to epidemiologic research, Males are two to three times as likely to have OSA, and postmenopausal women have a three times higher risk of developing OSA than do premenopausal women. Obstructive sleep apnea prevalence based on studies from different parts of India is 2.4–4.96% in men and 1–2% in women.

Prior research has indicated that obesity, specifically central obesity, is substantially linked to a higher OSA prevalence in the broader population. This is because obesity encourages soft tissue enlargement in the airway’s surrounding structures, which greatly contributes to pharyngeal airway narrowing.

We assessed anthropometric indicators’ ability to predict OSA because a number of studies have shown that they have a substantial impact on the severity of OSA.

MATERIALS AND METHODS

Study Design

An observational cross-sectional study.
Association between Anthropometric Indices and OSA

Study Place
In patient ward, Department of Respiratory Medicine, Government Hospital for Chest and Communicable Diseases (GHCCD), Guntur, Andhra Pradesh, India.

Period of Study
Two years from January 2020 to December 2022.

Sample Size
This study included 50 suspected OSA patients who presented to respiratory medicine OPD. Patients were then admitted to wards of GHCCD, Guntur, Andhra Pradesh, India.

Inclusion Criteria
- Age more than 18 years.
- Patients suspected to be having OSA based on clinical symptoms.

Exclusion Criteria
- Age below that of 18.
- Conditions (such as central sleep apnea, hypoventilation, and sleep-related hypoxemia) that put the patient at higher risk of non-obstructive sleep-disordered breathing. Significant cardiac disease, possible respiratory muscle weakness from neuromuscular diseases, a history of stroke, and long-term use of opiate medications are a few examples of these conditions.
- A serious non-respiratory sleep disorder or disorders that need to be evaluated, such as central hypersomnolence disorders, parasomnias, or sleep-related movement disorders, or that significantly impair the accuracy of the HSAT.
- Those receiving CPAP therapy were not allowed to participate in the study.

Procedure of Study
It is a cross-sectional observational study. All patients will undergo the following:

(A) History: People who have sleep apnea frequently report having symptoms throughout the day as well as at night (witnessed apnea, waking up in the night, instances of choking or gasping while sleeping, sweating at night, headaches in the morning, inadequate sleep, excessive drowsiness during the day, vehicle or occupational accidents, irritability, cognitive impairment, attitude shift, low libido). Bed mates are important sources of information about nocturnal events, and when OSA is suspected, obtaining a thorough medical history from the bed partner is essential. The most common complaint from the bedmate is snoring. Demographic data, including age and sex, were collected.

(B) General examination: Parameters like weight, height, neck circumference, and waist circumference were noted. Body mass index (BMI) was calculated.

(C) Overnight polysomnography: Diagnostic PSG was done using a type III sleep study. All patients had their PSG results gathered, and they were categorized as no, mild, moderate, or severe OSA patients according to their AHI. None of the following describe their OSA:

- Mild (AHI 5 but <15),
- Moderate (AHI 15 but <30), or
- Severe (AHI ≥ 30).  

Limitations of Type III Sleep Study
(A) Conditions (such as central sleep apnea, hypoventilation, and sleep-related hypoxemia) that put the patient at higher risk of non-obstructive sleep-disordered breathing. Significant cardiac disease, possible respiratory muscle weakness from neuromuscular diseases, a history of stroke, and long-term use of opiate medications are a few examples of these conditions.

(B) A serious non-respiratory sleep disorder or disorders that need to be evaluated, such as central hypersomnolence disorders, parasomnias, or sleep-related movement disorders, or that significantly impair the accuracy of the HSAT.

(C) Environmental or individual variables that hinder the proper collection and analysis of HSAT data.

Statistical Analysis
For continuous variables, the data were reported as mean ± standard deviation; for categorical variables, they were expressed as numbers and percentages, n (%). Student’s t-tests were used to compare continuous variables, and an χ² or Fisher’s exact test was used to compare categorical variables when applicable. A Pearson’s correlation test was used to evaluate the relationships between the variables. After adjusting for age and sex, a logistic regression analysis was performed to ascertain the significance of each anthropometric indicator for the incidence of OSA. Using a receiver operating characteristic (ROC) curve analysis using the Youden index, the optimal cut-off value for each of the several anthropometric indices—BMI, NC, and WC, for example: For predicting OSA in both men and women was determined. For all statistical studies, SPSS version 24 (Chicago, Illinois, USA) was utilized. p-values were deemed statistically significant if they were less than 0.05.

Results
In the present study group, 37 (74%) were males, and 13 (26%) were females. Out of which 39 (78%) had OSA and 11 (22%) had no OSA. Males 27 (69.3%) and females 12 (30.7%) were in OSA group. In comparison to patients without OSA, the percentage of male patients was noticeably higher in the former group. Compared to patients without OSA, those with OSA had significantly greater age, BMI, WC, and NC.

These results show a significant difference (p < 0.05) in the mean values of age, BMI, and NC between the OSA and non-OSA groups.

Neck circumference is found to have higher AUC than BMI and WC, which suggests that NC can be used as an important predictor of OSA, which is also statistically significant (p < 0.05).

Neck circumference and body mass index are found to have higher AUC values than WC in women, suggesting that these values are better in predicting OSA than WC.

Based on these results, it can be inferred that the risk of OSA is 1.44 times higher in patients with a higher NC, 1.36 times more in patients with a higher BMI, and 1.0 times more in patients with a higher WC. BMI and NC were statistically substantially higher in OSA patients.

When the means of different variables are compared using ANOVA test with three degrees of severity of OSA it was observed that BMI and NC had a significant difference while WC had no significant difference based on severity.

When different grades of OSA were compared with different parameters BMI and NC had statistically significant difference and WC had no significant difference.
The present study shows a significant difference (p < 0.05) in the mean values of age, BMI, and NC between the OSA and non-OSA groups (Table 1). In men, NC is found to have higher AUC than BMI and WC, suggesting that NC can be used as an important predictor of OSA, which is also statistically significant (p < 0.05) (Table 2). In women, BMI and NC have higher AUC values than WC, suggesting that these values better predict OSA than WC (Table 3). The mean cut-off values of NC, BMI, and WC in males were 39, 29.8 and 93.8, respectively (Table 4 and Fig. 1). In women, the mean cut-off values of NC, BMI, and WC were 39.3, 30 and 96.5, respectively (Table 5, Fig. 2 and Table 6). When the means of different variables are compared using ANOVA Test with three degrees of severity of OSA it was observed that BMI and NC had a significant difference while WC had no significant difference based on severity (Table 7). When different grades of OSA were compared with different parameters BMI and NC had statistically significant difference and WC had no significant difference (Table 8).

Hannon et al., in their study, which was done among 37 severely obese patients, results suggested that higher BMI (concordant with the present study) and higher WC were associated more with the severity of OSA in terms of SaO₂.

Table 1: The clinical parameters of the participants under study

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Non OSA (11)</th>
<th>OSA (39)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.73 ± 10.35</td>
<td>52.56 ± 7.95</td>
<td>0.004</td>
</tr>
<tr>
<td>BMI</td>
<td>28.57 ± 5.01</td>
<td>33.38 ± 0.62</td>
<td>0.000</td>
</tr>
<tr>
<td>NC</td>
<td>37.81 ± 2.44</td>
<td>39.12 ± 1.37</td>
<td>0.025</td>
</tr>
<tr>
<td>WC</td>
<td>88.27 ± 6.16</td>
<td>90.71 ± 6.15</td>
<td>0.251</td>
</tr>
</tbody>
</table>

BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm. Bold value indicates p-value < 0.05 statistically significant

Table 2: Prediction of OSA in males

<table>
<thead>
<tr>
<th>Test</th>
<th>AUC</th>
<th>95% CI</th>
<th>Significance (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>0.857</td>
<td>0.55–1.0</td>
<td>0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.709</td>
<td>0.55–1.0</td>
<td>0.053</td>
</tr>
<tr>
<td>WC</td>
<td>0.685</td>
<td>0.30–1.0</td>
<td>0.087</td>
</tr>
</tbody>
</table>

AUC, area under the curve; 95% CI, confidence interval; BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm. Bold value indicates p-value < 0.05 statistically significant

Table 3: Prediction of OSA in females

<table>
<thead>
<tr>
<th>Test</th>
<th>AUC</th>
<th>95% CI</th>
<th>Significance (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>0.833</td>
<td>0.55–1.0</td>
<td>0.285</td>
</tr>
<tr>
<td>BMI</td>
<td>0.833</td>
<td>0.55–1.0</td>
<td>0.285</td>
</tr>
<tr>
<td>WC</td>
<td>0.708</td>
<td>0.30–1.0</td>
<td>0.504</td>
</tr>
</tbody>
</table>

BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm

Table 4: Sensitivity (%) and specificity (%) by mean cut-off values in males

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cut-offs</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>39.0</td>
<td>90</td>
<td>81.48</td>
<td>64.29</td>
<td>95.65</td>
</tr>
<tr>
<td>BMI</td>
<td>29.8</td>
<td>90</td>
<td>51.85</td>
<td>40.91</td>
<td>62.16</td>
</tr>
<tr>
<td>WC</td>
<td>93.8</td>
<td>100</td>
<td>37.04</td>
<td>37.04</td>
<td>100</td>
</tr>
</tbody>
</table>

BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm

Table 5: Sensitivity (%) and specificity (%) by cut-off values in females

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cut-offs</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>39.3</td>
<td>100</td>
<td>66.67</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>BMI</td>
<td>30.0</td>
<td>100</td>
<td>66.67</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>WC</td>
<td>96.5</td>
<td>100</td>
<td>41.67</td>
<td>12.5</td>
<td>100</td>
</tr>
</tbody>
</table>

BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm

Table 6: Analyzing logistic regression to determine the importance of anthropometric indices

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OSA (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>1.44 (1.21–16.2)</td>
<td>0.02</td>
</tr>
<tr>
<td>BMI</td>
<td>1.36 (0.14–0.84)</td>
<td>0.02</td>
</tr>
<tr>
<td>WC</td>
<td>1.0 (0.45–2.45)</td>
<td>0.89</td>
</tr>
</tbody>
</table>

BMI, body mass index – kg/m²; NC, neck circumference – cm; WC, waist circumference – cm. Bold value indicates p-value < 0.05 statistically significant.
Association between Anthropometric Indices and OSA

4.24

1

6

2

1

7

8

0.348

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22

54x640

significant circumference – cm. Bold value indicates BMI, body mass index – kg/m²

across-sectional approach, skewed results could have been produced by unexplained confounding variables. The gender distribution was unbalanced because sleep clinic referrals often involved more men than women. The results should not be applied to the general population without caution, as only high-risk participants who were suspected of having OSA were included. According to the current study’s findings, an examination of anthropometric indices may offer data that is helpful in making a presumptive OSA diagnosis. Furthermore, it is simple to apply the selected cut-off values in the clinical setting.

**CONCLUSION**

Based on the present study results, it can be extrapolated that the risk of OSA is 1.44 times higher in individuals with a higher NC, similar to BMI and WC. Compared to other anthropometric indices, BMI and NC were statistically significantly higher in patients with OSA, suggesting that they could be more useful in the prediction of OSA (Table 6). The present study also demonstrated the cut-off values for OSA prediction in males and females.

**REFERENCES**