

Article

Association of neck circumference with obstructive sleep apnoea in young adults: A cross sectional study

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Abstract: Prevalence of Obstructive sleep apnoea (OSA) has been increasing owing to increase in its risk factors. The pathophysiology of OSA is related to narrowing or obliteration of upper airway. Neck circumference (NC) is a measure which predicts the neck fat and hence narrowing of airway. Modified Berlin's Questionnaire is a validated tool to assess the risk of OSA in Indian setting. The present study was designed to determine the association of NC with the risk of OSA in young adults. 1500 subjects of both genders between 18 to 30 years of age were recruited, their NC was measured and they were administered screening questionnaire first. Those who gave one or more positive response were administered modified Berlin questionnaire and risk of OSA was assessed and it was compared with NC. There was a significant increase in risk of OSA in subjects with higher NC with a cut off of 36 cm in males and 32 cm in females. NC is an important anthropometric measurement to predict risk of OSA.

Keywords: Obstructive sleep apnoea; Neck circumference; Modified Berlin's questionnaire.

1. Introduction

In the recent past, sleep related disorders have gained a lot of importance. There are several categories of sleep disorders recognized such as insomnia, sleep related movement disorders etc but one of the most common category is breathing disorders during sleep. It is now well known that quality of life degrades secondary to sleep related breathing disorders as it may result in cardiac diseases, stroke, and diabetes in future. Obstructive sleep apnea (OSA) is a common sleep related breathing disorder which is characterized by the recurrent collapse of the pharyngeal airway during sleep, which generally requires arousal to reestablish airway patency and resume breathing. Thus, the patient suffers from both sleep fragmentation (frequent arousal) and the recurrent hypoxemia and hypercapnia resulting from the respiratory pause [1,2].

In India, the obesity has become an epidemic especially in young adults due to improper dietary intake and sedentary lifestyle. The obesity can lead to several severe health impairments like cardiovascular, metabolic disorders. This may drive obstructive sleep apnoea syndrome (OSAS) to an increasingly important public health issue over the next few years [3]. A study showed the prevalence of OSA in adults was 13.7% [4]. Another study showed that young adults had 5.93% risk of developing OSA [5].

It has been proved in a study that in Indian population, obese individuals were nearly four times more prone to develop OSA than non obese after adjusting for age and gender [4]. Obesity is considered as an important risk factor for developing OSA as obesity can increase fat deposits around the upper airway, narrow the upper airway, and diminish the activity of the muscles in this region, collapsing the airway during sleep. Neck circumference (NC) is relatively new anthropometric measure which can predict upper airway soft tissue enlargement due to deposition of fat [6,7].

The present study was designed to determine the association between neck circumference and risk of OSA.

The diagnosis of OSA is typically confirmed by overnight polysomnography, during which sleep is recorded while breathing, and respiratory effort, oxygen saturation, and electrocardiogram are simultaneously

monitored. But the risk of developing OSA can be easily assessed by Modified Berlin questionnaire. It is a reliable and valid instrument to determine the occurrence of risk factors for OSA and includes questions related to snoring behavior, wake-time, hypertension [2].

2. Objective

1. To determine the association of neck circumference with obstructive sleep apnoea in young adult males & females.
2. To assess the cut off value for neck circumference related to increased risk of OSA.

3. Methodology

3.1. Sample size

A study done by Sharma *et al.*, showed the prevalence of OSA to be 13.7% [3]. Taking 99% confidence interval and a standard error of 2.5%, the study sample came out to be 1240 which was rounded off to 1500.

3.2. Subjects

The study was conducted in the department of Physiology, Teerthankar Mahaveer Medical College & Research Center, Moradabad after obtaining ethical clearance from Institutional ethical committee. It included 1500 young adult subjects of 18 – 25 years of age of either gender who volunteered for the study. Written informed consent was taken from all the subjects. Subjects with history of alcoholism, chronic anxiolytic/sedative drug use, associated respiratory, renal, hepatic or cardiovascular disease or upper respiratory tract infection within the past one week as well as those who were pregnant were excluded from the study. The subjects reported to department of Physiology and their NC was measured and they were administered Modified Berlin's Questionnaire.

3.3. Measurement of neck circumference

NC was measured in centimeters in all the subjects at mid-neck, between the mid-cervical spine and the mid-anterior neck standing upright and facing forwards, with shoulders relaxed using a non-elastic measuring tape [8].

3.4. Procedure to assess risk of OSA by Modified Berlin's Questionnaire

Modified Berlin's Questionnaire includes 2 parts viz a screening questionnaire and a detailed version. The screening questionnaire included leading questions on snoring, wake time, tiredness, obesity and BP status. The subjects were called with their room mates to enquire about snoring details. Subjects who gave at least one positive response to the four screening questions of the questionnaire were administered detailed modified Berlin questionnaire.

The detailed version of Modified Berlin's Questionnaire consists of three categories of questions. Category one consists six questions related to snoring, category two consists of five questions related to sleepiness while awake and category three consists of questions related to BMI & high blood pressure. Categories one was enquired from subjects and their room-mates & the subjects themselves gave response for category two and BMI & blood pressure were measured by standard procedures for category three. BMI $> 25\text{kg}/\text{m}^2$ was taken as obesity criteria. JNC 8 guidelines were considered while labelling a subject as hypertensive with BP > 140 mm Hg and/or diastolic BP > 90 mm taken as high BP. Category one & two as positive were labelled as positive if there were positive responses for > 2 questions. While for category three to considered positive either BMI $> 25\text{kg}/\text{m}^2$ or Blood pressure is high. If any subject had two or more categories as positive, he was labelled as increased risk of OSA [6].

4. Statistics

Descriptive analysis was carried out to determine the general characteristics of the subjects. The association of NC with risk of OSA in both male and female subjects was analyzed by Independent t-test. Receiver operating characteristic (ROC) analysis was used to find the optimal, maximal sensitivity and

specificity for NC against risk of OSA. A p value of ≤ 0.05 was considered significant. SPSS 25 was used to analyze the data thus obtained.

5. Results

As shown in Figure 1, out of 1500 subjects 43% were males and 57% were females. The mean age in male subjects was 20.82 ± 2.36 whereas in females it was 19.96 ± 2.01 .

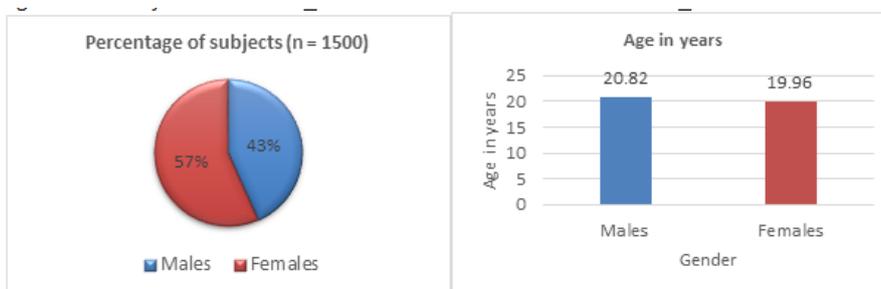


Figure 1. a) Gender distribution b) Distribution of mean age in males & females

The NC was significantly higher in males with high risk of OSA as compared to low risk (38.09 ± 3.75 vs 33.32 ± 2.99 cm; $p < 0.01$ respectively). Similar results were obtained in females also with NC 33.89 ± 3.89 cm in high risk group vs 29.52 ± 2.70 cm in low risk; $p < 0.01$), see Table 1.

Table 1. Independent t test showing association of NC with risk of OSA in both males & females

Mean \pm SD	Gender	Low risk of OSA	High Risk of OSA	Significance
NC (cm)	Males	33.32 ± 2.99	38.09 ± 3.75	$P < 0.01$
	Females	29.52 ± 2.70	33.89 ± 3.89 cm	$P < 0.01$

In the ROC analysis that was used to determine the optimal cut-off values of NC for predicting OSA was > 36 cm (sensitivity 81.5%; specificity 73.6%) in males with area under the curve 0.845 whereas in females it was > 32 cm (sensitivity 80%; specificity 75.2%) with area under the curve 0.804, see Figure 2.

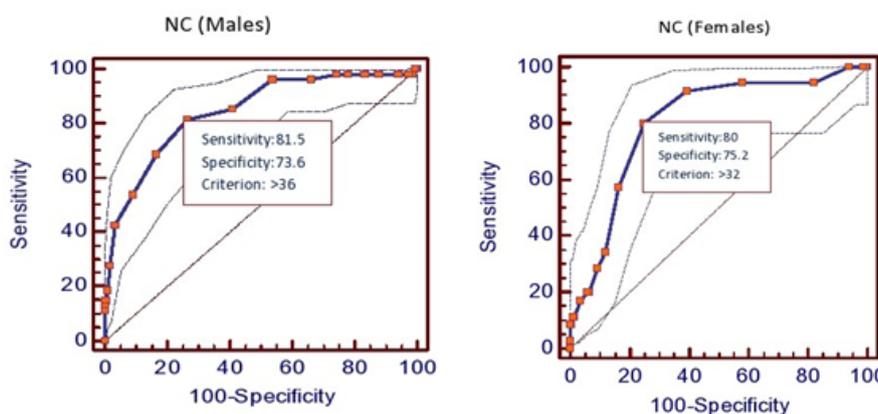


Figure 2. ROC Curve for NC cut off for determining high risk of OSA in males & females

6. Discussion

The present study was designed to determine association between NC with risk of OSA and also to assess the cut off value for NC related to increased risk of OSA. We found that there was an increased risk of OSA as assessed by Modified Berlin’s Questionnaire in subjects with higher NC in both males & females.

The pathogenesis of OSA is believed to be due to unfavorable pharyngeal anatomy that promote reduction in diameter of pharyngeal opening including cervical soft tissue, vessels, and bony structures. Many of these factors promote pharyngeal collapsibility by decreasing the caliber of the upper airway or by

increasing the upper airway surrounding pressure [9]. As evident from our study, increased NC is associated with higher risk of OSA as it is linked to increased neck fat deposition which may be an important factor promoting pharyngeal narrowing and hence predispose an individual to OSA [10,11].

Another study has proven that external NC, internal NC and degree of obesity are important factors which may predict sleep apnea, hence it can be said that obesity produces OSA due to deposition of fat in the neck. It suggested that fatty tissue deposited in the neck affected pharyngeal size modulated by the dynamic loading of the airway may also be the mechanism of development of OSA [12].

Our study results are comparable to other similar studies done in India and abroad. A study done by Ahbab *et al.*, stated that NC is an independent risk factor for severe OSAS. NC in severe OSAS patients was significantly higher than in non-severe OSAS patient [13]. Another study done by Cizza *et al.*, in short-sleeping obese men and premenopausal obese women also revealed an association of greater NC with OSAS and metabolic syndrome [14]. Obese patients with sleep apnoea had fatter necks than equally obese non-apnoeic snorers was the conclusion of Hoffstein *et al.*, implying that NC could be a significant determinant of apnoea and snoring [15].

Another study which compared various risk factors of OSA with apnea-hypopnea index found that neck girth correlated with AHI of 15 or more independently and significantly with an odds ratio of 1.5 [16].

The present study also aimed to assess the cut off value for neck circumference related to increased risk of OSA and found that males with NC > 36 cm and females with > 32 cm NC (cut off values) were at a higher risk of developing OSA. These results are also comparable with other studies. A study done by Onat *et al.*, showed that NC was associated significantly associated with OSAS and it gave 39 cm and 35.5 cm NC as optimal cutoff points among males and females respectively for development of OSAS [17]. Another study showed this cut off point greater than 43 cm (17 in) in men and 37 cm (15 in) in women for development of OSA [18]. Similarly another study done by Akhtar *et al.*, proved NC as an independent screening tool to predict OSA and ≥ 40 cm NC as the optimal cut-off value [19]. A study done in OSA patients by Gupta *et al.*, found the NC was larger and the incidence of retrognathia was found to be significantly higher in the OSA patients and NC of 40 cm or more in all the cases of OSA [20].

NC is associated with increased risk of OSA and hence can be used to predict the risk of OSA. A NC of > 36 cm in males and > 32 cm in females could be effective in screening the individuals for OSA.

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Conflicts of Interest: "The authors declare no conflicts of interest."

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