Neck circumference: A novel anthropometric tool for screening obesity in adults

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Abstract

Background: Obesity is as result of minor energy imbalance leading to gradual and persistent weight gain for a considerable period. To evaluate obesity in adults, Body mass index and waist circumference are recommended but, have some disadvantages. Neck circumference devoid of these disadvantages and has good correlation with body mass index and waist circumference in different studies, has to been included in the study for evaluation of obesity.

Objectives: This study was conducted to study the correlation of neck circumference with body mass index and waist circumference and to find critical cut off points for neck circumference for adults of central India.

Methodology: A community based cross sectional study was conducted in 479 adults in urban field practice area of a tertiary care hospital in central India. The people having established thyroid disease or enlargement, neck abnormalities, pregnant women and critically ill subjects were excluded. Socio demographic profile and anthropometric measurements were documented.

Results: Our study infers that there is a weak to moderate correlation between neck circumference and body mass index. Further, also that there is moderate correlation between neck circumference and waist circumference. On the basis of ROC analysis, we conclude that neck circumference is a fair test to evaluate obesity in adults. The cut off of 36.50cm in males and 32.50cm in females will help to screen the population of Asian Indian origin. The sensitivity of this screening test for this cut off was 84.85% and 73.68% in males and females respectively.

Discussion and conclusion: For a developing country like India which is facing a double burden of nutrition transition, neck circumference will be a feasible method to screen obesity in adults. It is cheap, socially acceptable, time saving and less cumbersome method to screen obesity.

Key words: Neck circumference, Obesity, Screening, Central India

Introduction and Background

Obesity is as result of minor energy imbalance leading to gradual and persistent weight gain for a considerable period. This 'New World Syndrome' is an adverse outcome of modernization or acculturation process, to the extent that, it is a major public health concern. [1] Obesity is a major modifiable risk factor which if not reversed will sequel to long term metabolic disturbances. Further, obesity increases risk of hypertension and other cardiovascular diseases, respiratory problems and psychological disturbances. The prevalence of obesity had doubled since 1980 attributing to about 3.4 million deaths in adults. [2] The Global health repository data reports that the age standardized prevalence of obesity and overweight are 39% and 13% in adults who are 18 years and older around the world. According to the reports of World Health Organisation, the prevalence of overweight/ obesity in adults of India was 23.7% in the year 2010, which rose to 26.9% in the year 2014. [3]

Various methods like Computed tomography (CT), Magnetic resonance and Dual Energy X-ray Absorption (DEXA) are used for evaluation of adiposity. CT can differentiate the intra-abdominal fat and subcutaneous fat, accumulation of which has been associated with morbidities.[4-5] Due to high cost and technical difficulties, this is not feasible method to be used for general population as an epidemiological tool. [6] DEXA can quantify the amount of total fat mass and regional fat mass, but has problems with delineation of anatomical landmarks and high cost. [7-11] Body mass index or Quetelet index has been presently recommended by World health Organization to evaluate overweight and obesity in general population. However, it does not depict the true body composition1. Body mass index doesn't give any idea of central adiposity or visceral fat, which has been implicated in cardiovascular risk. So, other methods like waist circumference and waist to hip ratios are used to identify central obesity. [12] But waist circumference measurement varies with respiration and with post prandial distension of abdomen.

Neck circumference being devoid of these disadvantages, can be used to classify normal and obese people. Increased neck circumference has been implicated in increased cardiovascular risk of an individual. [13-16] A study by Li et al done in Chinese adults inferred that the neck circumference has significant correlation with the visceral adipose tissue as documented by CT scans. [17] Many studies have postulated good correlation of neck circumference with age, weight, waist circumference, hip circumference and body mass index. [18-21] Thus, this study was conducted to study the correlation of neck circumference with body mass index and waist circumference and to find critical cut off points for neck circumference for adults of central India.

Methodology

Urban field practice area of Indira Gandhi Government Medical College, Nagpur caters 500 families with approximate population of 35000. This community based cross sectional study was conducted among adults in field practice area for duration of 6 months (May 2016 to October 2016). All adults who were permanent residents of the area and gave consent for the study were included and the people having established thyroid disease or enlargement, neck abnormalities,

pregnant women and critically ill subjects were excluded. The houses were selected by simple random sampling method. Further, the selection of study subjects was done as per guidelines of Kish grid technique. [22]

According to study conducted by Indian Centre Medical Research the prevalence of generalized obesity was found to be 16.6% overall in Maharashtra. [23] Considering this prevalence, with a 95% confidence interval and 3.5% absolute precision the minimum sample size we found was 410. We considered 479 study subjects taking into account the non-response rate. Ethical committee permission was sought before the start of the study. Eligible Study subjects were interviewed using a pretested, predesigned questionnaire which contained socio demographic variables etc. Anthropometric measurements like height (in meters), weight (in Kilograms), waist circumference (in centimeters) and hip circumference (in centimeters) was measured according to standard procedure guidelines. [24] Neck circumference was measured in the midway of the neck, between mid-cervical spine and mid anterior neck, to within 1 mm, with non-stretchable plastic tape with the subjects standing upright. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. [12] Body mass index was calculated by using weight and height of the individual obtained. Body mass index cut off values were used according to South East Asian Guidelines. [25]

Statistical analysis

Data entry and compilation was done using Epi Info version 7.1 and analysis was done by Statistical Package for Social Sciences version (SPSS) 20.00. The socio demographic variables were expressed in percentages. The correlation between two variables was done by Pearson's correlation. ROC (Receiver Operating Characteristic) curves were constructed. The Area under the curve was interpreted accordingly. [26] Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated for best cutoff in the sample for both the gender. Significance level was set at 5 % ($p < 0.05$).

Results

Out of total 479 study subjects, 39.87% were males and 60.13% were females (Table 1). Majority of the study subjects belonged to age group of 20-30 years (29.44%), followed by <20 years age group (27.55%) and >60 years age group (21.09%).

In males, the correlation of neck circumference with body mass index and waist circumference was weak (r=0.494) and moderate correlation (r=0.556) respectively. In females the correlation of neck circumference was moderate with body mass index (r=0.590) and waist circumference (r=0.614). Overall, the correlation was weak between neck circumference and body mass index (r=0.405) and was moderate between neck circumference and waist circumference (r=0.544). We also found, a moderate correlation between neck circumference and weight (r=0.584), overall weak correlation between neck circumference and height (r=0.362) and weak correlation of neck circumference with hip circumference (r=0.320) (Table 2).

ROC analysis was for done separately for males and females. The area under the curve for males and females was 0.800 (0.729-0.871) and 0.800 (0.747-0.853) respectively (Figures 1 and 2). So, neck circumference can be used for evaluation of obesity in both males and females. We found that the best cut off for males and females to be 36.5cm and 32.5cm respectively. Further, using these cut offs we found the sensitivity, specificity, positive and negative predictive value and diagnostic accuracy (Table 3).

Discussion

This study infers that there was correlation of neck circumference with height, weight, body mass index, waist circumference and hip circumference. There was a weak correlation between neck circumference and body mass index; moderate correlation between neck circumference and waist circumference. On the basis of ROC analysis, it can be interpreted that neck circumference is a fair test to evaluate obesity in adults in both the gender.

Studies conducted by Ben Noun et al [12] and Qan Yan et al [20] in Chinese adults showed correlation stronger than our study. Ben noun et al [12] found the correlation between neck circumference and body mass index to be 0.828 (0.00) and 0.710 (0.00) in males and females respectively. They also found the correlation between neck circumference and waist circumference to be 0.857 (0.00) and 0.845 (0.00) in males and females respectively. This stronger correlation can be attributed to the larger sample in both males and females in their study. Another study conducted in Karachi by Hingorojo et al [27] on under graduate dental students concluded the correlation between neck circumference and body mass index to be strongly positive in males (r=0.861) and moderately positive in case of females (r=0.703). Further, in the same study the neck circumference was found strongly positive in case of males and moderately positive in females when correlated with waist circumference of the study subjects.

Another study conducted in Chinese adults also was in accordance with our study. The correlation coefficients were weak to moderate in case of males (r=0.52) and females (r=0.41) between neck circumference and body mass index. Neck circumference when correlated with waist circumference had weak correlation in both the genders(r=0.49 in males and r=0.32 in females). [28] A study conducted by Adamu et al in Nigeria showed very weak correlations between neck circumference and body mass index and neck circumference and waist circumference. [29]

Studies conducted in India by Aswathappa et al [18] and Sunilkumar et al [19] the correlation coefficients were in concordance with our study. Moderate correlation between neck circumference and body mass index in case of males (r=0.559) and a weaker correlation in females (r=0.334) was found in the study conducted by Aswathappa et al [18] in Kolar district of Karnataka, India. Further, when neck circumference was correlated with waist circumference in the same study, they found a moderate correlation in both genders (r=0.705 in males and r=0.637 in females). Study conducted by Sunilkumar et al [19] in central India showed moderate correlation between neck circumference and body mass index (r=0.59 in males and r=0.74 in females).

Among males the critical cut off points were ranging from 32cm to 39cm in various studies conducted across the world. Studies by Ashwathappa et al [18] (≥38cm in males and ≥34cm in females), Sunilkumar et al [19] (≥38cm in males and ≥34.7cm in females) and Qan Yan et al [20] (≥38cm in males and ≥35cm in females) showed the cut off points to be higher when compared to our study in both the genders. Similarly, cut off points interpreted by Yang et al [21] (≥35cm), Ben noun et al [12] (≥34cm) and Hingorojo et al [27] (≥32cm) were lower among males when it was compared with our study. Cut off points studied by Hingorojo et al [27] for females was slightly higher compared to our study. This varied range of cut off can be explained by the fact that we used South East Asian guidelines for body mass index for classify as obese/overweight or normal. A study by Xuhong Wang et al [28] showed the crictical cut off points for central obesity to be ≥38.5cm in males and ≥34.5cm in females. In this study the waist circumference was taken as a standard method to determine central obesity.

The diagnostic accuracy of our study was less when compared to the study conducted by Ben noun et al [12] and Xuhong Wang et al [28]. A study by Ashwathappa et al [18] showed the sensitivity and specificity for their critical cut off point to be 71.25% and 80.61% in males respectively; in females it was 63.99% and 68% respectively. Our study showed higher sensitivity and lower specificity in males and females as compared to their study. A study conducted by Sunilkumar et al [19] also showed lower sensitivity but higher specificity in males when compared to our study; in females the sensitivity and specificity were higher when compared to our study. Studies by Sunilkumar et al [19] and Ashwathappa et al [18] have used similar guidelines for Body mass index as used in our study.

First limitation of the study is that it has been conducted in a particular geographic location, which affects the external validity of the study. So, these critical cut off points will be generalizable only to that particular population. Second, the standard for ROC used was body mass index, which gives an idea of the overall fat distribution. But, waist circumference and neck circumference are the indicators of fat accumulation which is associated with high cardiovascular risk. Third, the quantification of fat cannot be done with this method. Fourth, we could not establish repeatability of the screening test in our study. Strength of the study is that it was community based, making it more precise in the results and wider age groups have been included in the study. In spite of all the limitations, measuring upper body fat by neck circumference is a reasonable method to evaluate the obesity status.

Conclusion and recommendations

According to the World health Organisation's criteria for a good screening test, our tool to measure neck circumference for evaluation of overweight and obesity fulfilled majority of the criteria. To mention, measuring neck circumference of an individual to evaluate obesity and overweight was found to be a fair screening test. The cut off of 36.50cm in males and 32.50cm in females will help to screen the population of Asian Indian origin. The sensitivity of this screening test for this cut off was 84.85% and 73.68% in males and females respectively. Measuring neck circumference is socially acceptable, easy to measure, less time consuming and involves less cumbersome procedures when compared to measurement of waist circumference. On financial point of view, it is very cost effective method. Thus, this method can be used to

screen individuals for obesity in peripheral areas, where the facility of measuring the weight is not available. Training for peripheral workers is easy, because it is a simple to teach them. Hence, for a developing country like India which is facing a double burden of nutrition transition, neck circumference will be a feasible method to screen obesity in adults. Studies with larger sample size, in different ethnicity, geographic locations are recommended. Studies to establish the intra observer variation and inter observer variations have conducted.

Abbreviations

ROC-Receiver operating curves.

Institutional Review Board permission

The permission has been taken from IRB of Indira Gandhi Government Medical College (Registration number of IEC-ECR/485/Inst/MH/2013) Ref no IGGMC/ Pharmacology/ IEC/ 484/ 2016 dated on 10/05/2016.

Conflict of Interest

Nill.

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Table 1: Socio demographic characteristics of study subjects

Variable	Frequency	Percentage
Age group (in years)		
<20	132	27.55
20-30	141	29.44
30-40	19	3.96
40-50	43	8.98
50-60	43	8.98
>60	101	21.09
Gender		
Male	191	39.87
Female	288	60.13

Table 2: Pearson's correlation coefficient between neck circumference and other anthropometric indices of male and female

Anthropometric Parameter	Male (n=191)		Female (n=288)		Overall (N=479)	
	r	P value	r	P value	r	P value
Height	0.119	0.10	-0.006	0.92	0.362	<0.01
Weight	0.505	<0.01	0.583	<0.01	0.584	<0.01
Body mass index	0.494	<0.01	0.590	<0.01	0.405	<0.01
Waist circumference	0.556	<0.01	0.614	<0.01	0.544	<0.01
Hip circumference	0.519	<0.01	0.561	<0.01	0.320	<0.01

Table 3: Evaluation of neck circumference in both the genders

Critical cut off	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Diagnostic accuracy
36.50cm (males)	84.85%	66.40%	57.14%	89.25%	72.77%
32.50cm (females)	73.64%	65.17%	56.66%	80%	68.4%

Figure 1: Receiver Operating Characteristic Curves for Males

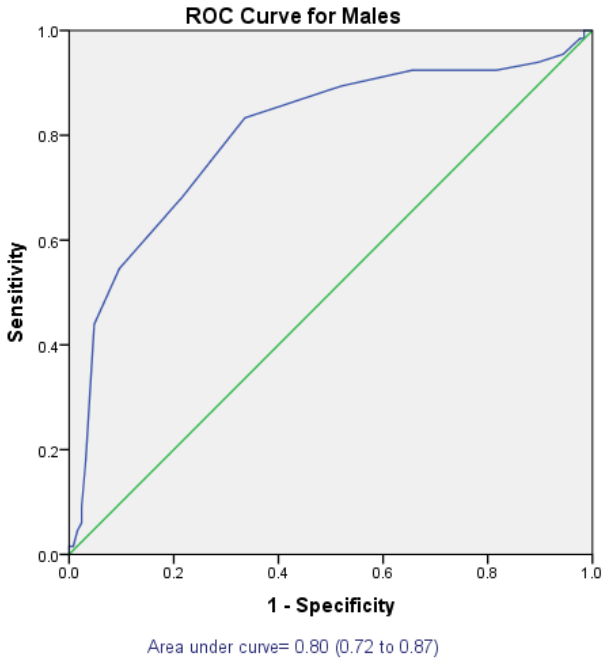

Figure 2: Receiver Operating Characteristic Curves for Females