

## ORIGINAL ARTICLE

# A Cross-sectional Study to Assess Neck Circumference as an Indicator of Central Obesity among Healthy Adults in Rural Karnataka

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## ABSTRACT

**Background:** Neck circumference (NC) is a measure of upper body fat. The present study was planned to determine if NC is a valid measure of obesity in rural Karnataka. **Objectives:** The objectives of the study were as follows: (1) To determine the validity of NC for the assessment of central obesity among healthy adults in a rural field practice area of SSIMS and RC and (2) to assess the prevalence of obesity among these adults. **Materials and Methods:** A cross-sectional community-based study was done at rural field practice area of SSIMS and RC. The required sample size was 260 and proportionate sample was chosen from each subcenter with equal number of males and females purposively. Adults >18 years and apparently healthy individuals, willing to participate in the study, were selected. Data were collected using a semi-structured questionnaire which consists of sociodemographic details, personal and family history of any chronic illness. Following measurements were taken – NC, waist circumference (WC), hip circumference (HC), height, and weight. **Analysis:** Statistical analysis was done using statistical software SPSS 20. Analysis was done for mean, SD, frequency, and percentage. Sensitivity and specificity were analyzed by receiver operating characteristic (ROC) curve. **Results:** Among 260 participants, males were found to be 50.8% and females were 49.2%. Age group 18–30 years found to be 28.8%. The mean and SD of anthropometric measurements, that is, NC, WC, and body mass index (BMI) were  $34.16 \pm 3.31$  cm,  $85.04 \pm 12.44$  cm, and  $23.66 \pm 4.57$  cm. Considering WC as an indicator of central obesity, the sensitivity and specificity of NC were estimated using ROC curve. The cutoff point of NC was found to be 35.75 cm in males and 31.5 cm in females. The prevalence of central obesity using NC was found to be 35.2%. The prevalence of obesity was slightly higher among males compared to females using BMI criteria, while the prevalence was higher among females using all other criteria, that is, WC, WHR, and NC. **Conclusion:** The prevalence of obesity based on the NC was found to be 35.2%, prevalence of obesity based on BMI was found to be 48.8%, and prevalence of obesity based on WC was found to be 50.7%. NC measurement is a simple, convenient, inexpensive screening measure to identify central obesity among males and females.

**Key words:** Adults, neck circumference, obesity, rural Karnataka, validity

## INTRODUCTION

Overweight/obesity is considered to be one of the most obviously visible neglected public health problems.<sup>[1]</sup> Growing rates of overweight and obesity worldwide are linked to a rise in chronic diseases such as cancer, cardiovascular disease, and diabetes, conditions that are life-threatening and very difficult to treat in places with limited resources and already overburdened health systems.<sup>[2]</sup> It is emerging as the most significant contributor to ill health and mortality and is affecting not only adults but also children and adolescents.<sup>[3,4]</sup>

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It becomes important to detect childhood overweight/obesity at the earliest to carry out intervention at the critical point. Overweight/obesity is often detected by anthropometric measurements such as body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR).<sup>[5-7]</sup> Each of these methods has certain merits and demerits. However,

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among these, BMI is the most frequently used measurement to assess total body fat. The limitations of BMI are that it cannot differentiate between muscle mass and body fat, cannot locate the site of fat, and does not account for variables such as age, race/ethnicity, sex, and maturation stage.<sup>[8,9]</sup> WC and HC also have certain limitations such as unclothing, inconvenience of ambient temperature, variation with fasting – satiety status, health problems affecting abdominal wall (e.g., lipoabdominoplasty and dyspepsia), and sociocultural reasons of measurement with light clothes.<sup>[10,11]</sup>

Recently, neck circumference (NC) has been utilized as an easier, low cost screening tool in place of WC as it eliminates the need for scales and undressing the individual.<sup>[12,13]</sup> It is also considered as an excellent tool to mark upper body subcutaneous adipose tissue which is more associated with metabolic disorders such as glucose intolerance, diabetes, gout, and hypertriglyceridemia than lower body obesity.<sup>[14]</sup>

Many studies have reported significant association between NC and other anthropometric measurements such as BMI, WC, and WHR in adults. NC, as an index of upper body subcutaneous adipose tissue distribution, is a quick method for the assessment of overweight and obesity. Due to cultural inhibitors, measurement of hip, thigh, or WC is cumbersome in females. If the NC could be a more valid tool for screening obesity, it would be a better test to use in the community settings compared to the other tests. Besides, dearth of such studies in the study area makes the need for the present study.

## Objectives

The objectives of the study were as follows:

1. To determine the validity of NC for the assessment of central obesity among healthy adults in a rural field practice area of SSIMS and RC.
2. To assess the prevalence of obesity among these adults.

## MATERIALS AND METHODS

### Inclusion Criteria

Adults >18 years who were apparently healthy and residing in Lokikere PHC area since at least 6 months and who are willing to participate in the study were included in the study.

### Exclusion Criteria

Adults with a history of thyroid disease, cystic or mass lesion in neck, kyphosis, scoliosis, those with any anatomical abnormality of the waist and hip region, pregnancy, and severely ill patients were excluded from the study.

### Methodology

A cross-sectional study was done at rural field practice area of a medical college SSIMS and RC, Davanagere, that is, Lokikere

PHC area. This was conducted during June–August 2019. Ethical clearance was obtained from the Institutional Ethical Review Board. Considering specificity of NC as 50%, precision as 7%, and prevalence of obesity as 22.1,<sup>[5]</sup> the required sample size was 252, which was rounded off 260. In Lokikere PHC area, there were three subcenters, Lokikere A, Lokikere B, and Shagale. Proportionate sample was chosen from each subcenter with equal number of males and females purposively. Informed consent was obtained from participants. Data were collected using a pretested, semi-structured questionnaire which consisted of sociodemographic details, history of comorbidities, and family history of any chronic illness.

The WC, HC, and NC and height were measured using a non-stretchable tape and measured to the nearest of 0.1 cm and weight was measured using a bathroom weighing scale to the nearest of 0.5 kg.

1. WC was measured at the midpoint between the inferior costal margin and the upper iliac crest (cutoff was  $\geq 90$  cm for men,  $\geq 80$  cm for women)
2. HC was obtained at the level of the femoral trochanters (widest part of the hip) (cutoff was  $>0.90$  for men,  $>0.80$  for women)<sup>[14]</sup>
3. NC was measured just below the laryngeal prominence and at the level of the midcervical spine<sup>[15-19]</sup>
4. Height was measured in standing position and weight.

### Analysis

Statistical analysis was done using SPSS v20. Data were entered into Microsoft Excel sheet and analyzed for frequencies, mean, and standard deviation. Sensitivity and specificity of NC were calculated using receiver operating characteristic (ROC) curve, agreement using Kappa statistics.

## RESULTS

Total number of participants included in this study was 260, which had equal number of males and females. The mean age was  $41.58 \pm 14.43$  years and ranged from 18 to 86 years. Majority (28.8%) of the adults were in the age group of 18–30 years, belonged to Hindu religion (99.2%), and had completed secondary education (41.1%). Majority were working as clerical/shop/farmers (30.7%) details are explained in Table 1.

History of comorbidities was asked and majority had no comorbidities (79.2%). Family history of chronic illness (like H/o hypertension, CVD, and diabetes mellitus) was asked and 82.7% of the participants had no family history.

Mean NC mean was  $34.16 \pm 3.318$  cm and ranged from 27 to 44 cm, WC mean was  $85.04 \pm 12.49$  cm and ranged from 51 to 117 cm, WHR mean was  $0.89 \pm 0.08$  cm and ranged from 0.53 to 1.13 cm, and the mean BMI was  $23.66 \pm 4.57$  kg/m<sup>2</sup> and ranged from 13.33 to 41.13 kg/m<sup>2</sup>.

**Table 1:** Sociodemographic details of the study participants

S. No.	Variants	Subvariants	Frequency (n=260)	Percent
1.	Age (years) Mean: 41.58± 14.43 Range: 18– 86 years	18–30	75	28.8
		31–40	68	26.2
		41–50	53	20.4
		51–60	40	15.4
		>60	24	9.2
2.	Sex	Males	132	50.8
		Females	128	49.2
3.	Religion	Hindu	250	96.1
		Muslims	8	3.1
		Jain	2	0.8
4.	Education	Illiterates	62	23.8
		Primary education	85	32.6
		Secondary education	107	41.2
		Degrees and masters	6	2.4
5.	Occupation	Professional	24	9.2
		Semi-professional	21	8.1
		Clerical/shop/farm	80	30.7
		Skilled worker	19	7.4
		Semi-skilled worker	18	6.9
		Unskilled worker	27	10.4
		Unemployed	71	27.3

**Table 2:** Prevalence of obesity using various criteria

S. No.	Measurements	Cutoff values	Males (n,%)	Females (n, %)	Total (n, %)
1.	Waist circumference	≤90 cm = M, ≤80 cm = F	78 (60.9)	50 (39.1)	128 (100)
		≥90 cm = M, ≥80 cm = F	54 (40.9)	78 (59.1)	132 (100)
2.	Waist-hip ratio	≤0.9 = M, ≤0.8 = F	41 (65.1)	22 (34.9)	63 (100)
		≥0.9 = M, ≥0.8 = F	91 (46.2)	106 (53.8)	197 (100)
3.	Neck circumference	≤35.75 cm = M, ≤31.50 cm = F	71 (59.2)	49 (40.8)	120 (100)
		≥35.75 cm = M, ≥31.50 cm = F	61 (43.6)	79 (56.4)	140 (100)
4.	BMI	Normal (18.5– 22.9 kg/m <sup>2</sup> )	51 (48.6)	54 (51.4)	105 (100)
		Obese (≥23 kg/m <sup>2</sup> )	65 (51.2)	62 (48.8)	127 (100)

## DISCUSSION

In the present study, NC was found to be a better indicator of central obesity with sensitivity and specificity for males being 75.9% and 66.7% and females 83.3% and 70%, respectively, and the cutoff values for NC males were 35.75 cm and 31.5 cm among females. Kappa values showed fair and moderate agreement for the males and females NC obesity.

Saka *et al.* study done in Turkey showed that the mean NC of the men and women was 40.27 ± 3.4 cm and 33.43 ± 3.2 cm, respectively. The 85.1% of men and 38.8% of women had NC ≥37 cm and ≥34 cm, respectively. Higher cutoff values of NC were found as compared to the present study which might be because of racial difference. NC correlated positively with bodyweight, WCs, HCs, WHR, and BMI ( $P < 0.05$ ).<sup>[20]</sup>

A study done by Qureshi *et al.* in Dhaka, Bangladesh, showed that Pearson's correlation coefficients indicated a strong agreement between NC with WC (men,  $r = 0.6$ ; women,  $r = 0.46$ ;  $P < 0.0001$ ). The present study showed moderate agreement for males ( $r = 0.4$ ) and fair agreement for females ( $r = 0.5$ ). By ROC curve analysis, NC ≥35.25 cm in male and NC ≥31.2 cm in women were the best cutoff value for WC ≥90 cm in men and ≥ 80 cm in women, respectively, which was almost similar to the present study (NC ≥35.7 cm in males and NC ≥31.1 cm in females).<sup>[21]</sup>

Verma *et al.* study done at Chandigarh found that NC had higher cutoff values of 36.5 cm for males and 34.05 cm for females compared to the present study, the present study showed that the NC cutoff values for males were ≥35.7 cm and females were ≥31.5 cm with maximum sensitivity (males: 63.2% and females: 66.9%) and specificity (males: 84.8% and females: 86.6%) might be because of study had not

The prevalence of obesity was slightly higher among males compared to females using BMI criteria, while the prevalence was higher among females using all other criteria, that is, WC, WHR, and NC as explained in Table 2.

### Validity of NC

This was assessed using ROC curve. Area under the curve for males was 0.8, which suggests that NC is a good indicator to differentiate central obesity from non-obese state (WC was used as the gold standard). Cutoff value was 35.7 cm for males and 31.5 cm for females, with sensitivity 75.9% and specificity 66.7%, as shown in Figures 1 and 2. The prevalence of obesity based on the NC among males was found to be 43.6%, as shown in Table 2.

Area under the curve for female ROC curve was 0.7, which signifies that NC can fairly differentiate central obesity from non-obese state (WC was the gold standard). Cutoff value was 31.5 cm, with sensitivity of 83.3% and specificity 70%. The prevalence of obesity based on NC among females was found to be 56.4%, as shown in Table 2.

Kappa values with respect to WC were 0.4 and 0.5 for males and females, respectively, which depict fair and moderate agreement.

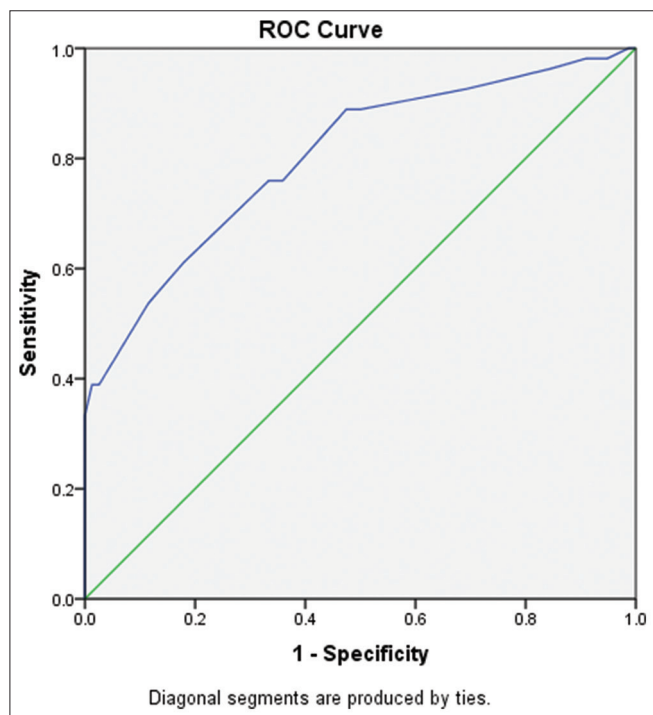


Figure 1: Male receiver operating characteristic curve

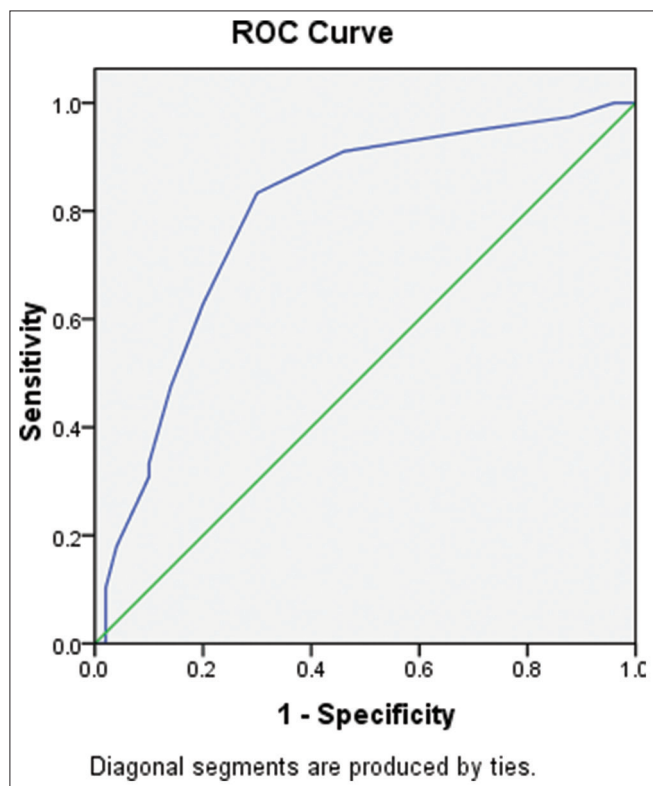


Figure 2: Female receiver operating characteristic curve

excluded the neck swelling and other related diseases, might have affected for the higher cutoff values. The prevalence of obesity based on BMI was found to be 51.48% in females and 47.77% in males, whereas in the present study found higher obesity among males compared to females, might be because of sedentary lifestyle.<sup>[13]</sup>

Study by Yashoda *et al.* in Bangalore, Karnataka, showed that the cutoff value of NC for boys with high BMI was 32 cm with sensitivity of 81.8%, while the present study showed higher cutoff of 35.7cm with sensitivity 75.9% and specificity 66.7% among males. The NC cutoff for females in the same study was 30 cm with sensitivity of 84.8% and specificity of 87.5% which was almost similar with the present study with NC cutoff value of 31.5 cm (sensitivity of 83.3% and specificity 70%). NC had a strong positive correlation with other anthropometric measures BMI, WC, and WHR in both boys and girls ( $P < 0.001$ ).<sup>[22]</sup>

## CONCLUSION

Cutoff value of NC was 35.7 cm for males and 31.5 cm for females, with sensitivity of 75.9% and specificity of 66.7% for males and sensitivity of 83.3% and specificity 70% for females. The prevalence of obesity based on the NC was found to be 35.2%, prevalence of obesity based on BMI was found to be 48.8%, and prevalence of obesity based on WC was found to be 50.7%. Therefore, NC measurement is a simple, convenient, inexpensive screening measure to identify central obesity among males and females.

## Recommendations

NC is an easier tool to measure obesity and should be implicated in hospitals (OPDs) as a routine. Training was given to PHC staff nurses for measuring NC. Awareness session on risk factors of cardiovascular diseases and importance of reducing weight was given to adults at Anganwadi in each village.

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