

Original Research Article

Neck circumference and wrist circumference as a screening tool for obesity in early adolescents: a cross-sectional study

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ABSTRACT

Background: Obesity in adolescents is a growing public health problem. Neck circumference (NC) and wrist circumference (WrC) were suggested as simple and cheap alternatives for obesity screening. The objective of this study was to determine the prevalence of obesity and the utility of NC and WrC in rural adolescent.

Methods: A community based cross-sectional study was conducted among 318 rural adolescents aged 11-14 years. Anthropometric measurements of height, body weight, NC and WrC were performed using standard procedures. Obesity was defined as BMI-for-age Z score (BAZ). Pearson correlation and receiver operating characteristic (ROC) curve analysis was done.

Results: Prevalence of obesity was 4.1% (13/318). NC showed statistically significant negative correlation with BAZ ($r=-0.180$, $p=0.001$) while WrC showed a stronger negative correlation with BAZ ($r=-0.390$, $p<0.001$). The ROC analysis showed acceptable diagnostic performance for NC (AUC=0.707, 95% CI: 0.549-0.865) and good diagnostic performance for WrC (AUC=0.832, 95% CI: 0.748-0.917). The optimal cutoff values were 29.25 cm for NC and 16.25 cm for WrC.

Conclusions: Both NC and WrC were able to identify obesity in rural adolescents, with WrC performing better in diagnosis than NC. WrC could be a simple and feasible anthropometric marker for screening of obesity in community settings. These findings need to be confirmed in further studies.

Keywords: Adolescents, BMI-for-age Z-score, Neck circumference, Obesity, Rural adolescents, Wrist circumference

INTRODUCTION

Obesity is now a major public health problem in all age groups, particularly among children and adolescents.¹ Obesity has overtaken underweight as the most common form of malnutrition among school children and adolescents in the world.¹ The global prevalence of obesity among 5-19 years age group has increased from 2% in 1990 to 8% in 2022.² It is estimated that 27 million children and adolescents with obesity in India will contribute to 11 percent of the world burden by 2030.¹

The growing incidence of obesity in adolescence may lead to its persistence in adulthood. Obesity is associated with an increased risk of diabetes, hypertension, cardiovascular disease and other metabolic diseases. The early identification is essential for the application of preventive strategies. The prevention in adolescence is important to avoid future consequences in adulthood.

BMI and waist circumference are widely accepted surrogate markers for the assessment of obesity.² However, BMI has a limitation that it may not accurately differentiate between lean body mass and fat mass.³

Various advanced approaches provide more precise assessment of body composition, like bioelectric impedance analysis (BAI), dual energy x-ray absorption (DEXA), computed tomography (CT), and magnetic resonance; these methods are impractical and expensive to use in community settings.⁴ Although waist circumference reflects central obesity, it is influenced by meal consumption, heavy clothing, measurement variability, and respiratory movements.

Hence the need for economical, bedside, non-invasive, anthropometric markers that are viable for all ages in community settings. Neck circumference (NC) has appeared as a possible alternative method due to its ease and speed in measurement, and its minimal sensitivity to respiratory movements and food consumption. Previous studies have reported an association between NC and obesity, diabetes and cardiovascular risk factors.^{5,6} Similarly, wrist circumference (WrC) WrC is another simple anthropometric index that reflects skeletal frame and metabolic risk.⁷ WrC has been suggested as a useful screening marker for obesity and related health outcomes.⁸

Many studies have been in urban or clinical settings. There is little evidence that they work in rural settings. The relationship between these anthropometric measures and obesity may be influenced by differences in growth patterns, nutritional status, body composition and lifestyle characteristics between rural and urban populations. Thus, outcomes for urban populations may not be generalizable to rural communities. Also, the present study was conducted to evaluate the usefulness of neck circumference and wrist circumference as a screening tool for obesity in early adolescents.

METHODS

Study design and setting

A community-based cross-sectional study was conducted in the rural field practice area of a tertiary care teaching hospital in central Maharashtra from August 2025 to February 2026.

Study population

Study population was adolescents 11-14 years of age living in rural field practice area during the study period. The reason why the age group of 11-14 years was chosen is that it is a period of rapid growth and developmental changes in adolescence, which makes it suitable for the assessment of anthropometric indicators of obesity. Adolescents who consented to participate and whose parents/guardians provided informed consent were included in the study. Children with neck deformities or neck pathologies like Cushing's disease, torticollis, neck swelling and enlarged thyroid gland were excluded. We also excluded adolescents who were seriously ill at the time of data collection.

Sample size

The sample size was determined by applying the following formula:

$$n = Z^2pq/d^2$$

where p is the prevalence, q=1-p and d is the absolute precision. To maximize variability, a prevalence of 50% was assumed due to the unknown prevalence of obesity in the study population. The minimum sample size was calculated based on 95% confidence level (Z=1.96) and absolute precision of 5%, which resulted in a sample size of 384 participants.

The total enumeration method was used to include all eligible adolescents in the rural field practice area during the study period although the minimum sample size calculated was 384. After applying pre-determined inclusion and exclusion criteria 318 adolescents were available for the final analysis.

Sampling technique

The total enumeration method was used. The study period included visits to all households in the rural field practice area. The survey commenced from a randomly selected direction within the village. Then we went from one household to another systematically until all households in the field practice area were covered. All eligible adolescents aged 11-14 years in the study area were invited to participate in the study. Therefore, all adolescents who met the inclusion criteria at the time of the study were included in the study. Written informed consent was obtained from parents/guardians and assent from the adolescents prior to enrolment.

Study instruments and measurements

Height and weight were measured using standard procedures and recorded to the nearest 0.1 cm and 0.1 kg respectively. Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared.

The neck circumference (NC) was measured at the level of thyroid cartilage using a non-stretchable measuring tape. The participant was in erect position with head held in Frankfurt horizontal plane.

Wrist circumference (WrC) was measured at the distal prominences of ulna and radius in the non-dominant hand with a non-stretchable tape measure.

Data analysis

Data were entered in Microsoft Excel 2021 and analyzed using Jamovi version 2.7.17. BMI-for-age Z-scores (BAZ) were calculated using the WHO AnthroPlus software. Descriptive statistics were used to explain the characteristics of participants. A Pearson correlation

analysis was conducted to test the relation between NC, WrC and BAZ. Receiver operating characteristic (ROC) curve analysis was employed to assess the diagnostic performance of NC and WrC in the detection of obesity. A p value <0.05 was considered as statistically significant.

RESULTS

In the final analysis, 318 adolescents aged 11-14 years were included. Of these, 136 (42.8%) were males and 182 (57.2%) were females. The mean age of the participants was 12.5±1.14 years. The mean weight, height and BMI were 34.8±9.27 kg, 143.2±8.28 cm, and 16.8±3.58 kg/m², respectively. The mean of neck and wrist circumference was 29.5±2.54 cm and 16.6±2.12 cm, respectively (Table 1).

Table 1: Baseline characteristics of the study participants (n=318).

Characteristics	Value
Age (years), mean±SD	12.5±1.14
Male, N (%)	136 (42.8)
Female, N (%)	182 (57.2)
Height (cm), mean±SD	143.2±8.28
Weight (kg), mean±SD	34.8±9.27
BMI (kg/m ²), mean±SD	16.8±3.58
Neck circumference (cm), mean±SD	29.5±2.54
Wrist circumference (cm), mean±SD	16.6±2.12

Table 2: Prevalence of obesity among adolescents aged 11-14 years (n=318).

Obesity status	N (%)
Obese	13 (4.1)
Non-obese	305 (95.9)

Table 4: Diagnostic performance of neck circumference and wrist circumference for identifying obesity among adolescents (n=318).

Variables	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Cut-off (cm)	P value
Neck circumference	0.707 (0.549-0.865)	84.6	49.5	29.25	0.010
Wrist circumference	0.832 (0.748-0.917)	92.3	61.0	16.25	<0.001

ROC curve analysis revealed that neck circumference had an area under the curve (AUC) of 0.707 (95% CI: 0.549-0.865, p=0.010) for detecting obesity in adolescents. The sensitivity and specificity at the optimal cut-off value of 29.25 cm were 84.6% and 49.5%, respectively (Table 4).

Wrist circumference showed better diagnostic performance with AUC 0.832 (95% CI: 0.748-0.917, p<0.001). Sensitivity and specificity were 92.3% and 61.0% at an optimum cut-off value of 16.25cm. Neck circumference had a lower AUC value (0.707 versus

A total of 318 adolescents were included in the study and 13 were classified as obese based on BMI-for-age Z-score criteria, resulting in a prevalence of obesity of 4.1% (Table 2).

Pearson correlation analysis showed that neck circumference was statistically negative correlation with BAZ (r=-0.180, p=0.001). Wrist circumference was also significantly negatively correlated with BAZ (r=-0.390, p<0.001) (Table 3).

Table 3: Correlation of neck circumference and wrist circumference with BMI-for-age Z-score (BAZ) among adolescents (n=318).

Variables	Pearson's r	P value
Neck circumference versus BAZ	-0.180	0.001
Wrist circumference versus BAZ	-0.390	<0.001

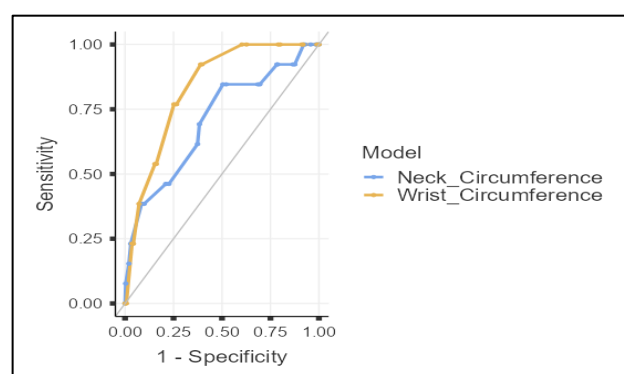


Figure 1: Receiver operating characteristic (ROC) curves for neck circumference and wrist circumference in identifying obesity among adolescents.

0.832) therefore had less discriminative ability when compared to wrist circumference (Table 4).

DISCUSSION

The present study was to evaluate the usefulness of neck circumference and wrist circumference as anthropometric markers of obesity among adolescents aged 11-14 years in a rural setting. The prevalence of obesity among the study participants was 4.1%. Both neck circumference and wrist circumference had statistically significant

negative correlation with BMI-for-age Z-score (BAZ). ROC curve analysis indicated that both measurements have the ability to identify obesity, and wrist circumference showed a better diagnostic performance than neck circumference (AUC: 0.832 versus 0.707). These findings indicate that wrist circumference might be a useful anthropometric measure for obesity screening among adolescents in this population.

The prevalence of obesity among adolescents in the present study was 4.1%. This finding is in the range of recent Indian literatures. A recent scoping review of Indian adolescents showed wide variations in obesity prevalence (0.3% to 24.6%) related to the geographic areas, study settings and characteristics of the populations studied.⁹ The prevalence observed in the present study was lower than that reported by Jain et al. among urban adolescents of Meerut, Uttar Pradesh (6.88%).¹⁰ However, our results were higher than the prevalence of 1.9% reported among predominantly rural adolescents in Punjab.¹¹ The relatively lower prevalence noted in the present study as compared to urban populations may be due to differences in lifestyle patterns, levels of physical activity, dietary practices and the rural setting of the study population. Differences across studies may also be due to different age groups, socio-economic characteristics and criteria for obesity assessment.

In this study, we found a statistically significant negative correlation between neck circumference and BMI-for-age Z-score ($r=-0.180$, $p=0.001$). ROC curve analysis revealed an acceptable diagnostic performance for obesity detection with an area under the curve (AUC) value of 0.707, sensitivity of 84.6% and specificity of 49.5% at a cut-off value of 29.25 cm. These results are contrasting with those reported in some previous studies. Dongre et al. reported a strong positive correlation between neck circumference and BMI ($r=0.75$) in school children of Nagpur with significantly higher neck circumference values in overweight and obese children.¹² Similarly, Halpara et al showed a strong positive association between neck circumference and BMI in adolescents of Ahmedabad and reported an AUROC of 0.81 for prediction of overweight and obesity.¹³ A study from coastal Karnataka also reported a positive correlation between neck circumference and BMI and observed good diagnostic performance with ROC derived cut off values for obesity screening.¹⁴

In the current study, wrist circumference was negatively correlated with BMI-for-age Z-score ($r=-0.390$, $p<0.001$) and had a good diagnostic performance for obesity with an AUC of 0.832. Of the anthropometric indices evaluated, wrist circumference had a better discriminatory capacity than neck circumference. Contrary to our findings, Halpara et al among adolescents in Ahmedabad reported a strong positive correlation between wrist circumference and BMI, with good predictive ability for overweight and obesity (AUROC=0.811).¹³ The CASPIAN-IV study also reported significant positive

associations between wrist circumference and several obesity indices, including BMI, waist circumference and abdominal obesity with AUC values ranging from 0.81 to 0.85 for generalized obesity.¹⁵ Additionally, a systematic review and meta-analysis by Namazi et al reported higher wrist circumference was associated with increased risk of metabolic syndrome and other cardiometabolic disorders.⁸

The inverse association observed between BMI-for-age Z-score and both neck circumference and wrist circumference in the present study is not consistent with the findings reported in most previous studies. There are several reasons why this may have been observed. The study was conducted among rural adolescents, who may differ from the urban populations generally featured in the literature in terms of nutritional status, growth patterns, physical activity levels and body composition. Anthropometric measurements in adolescence are also influenced by ongoing growth and pubertal development, which may affect the relationship between body measurements and adiposity. Therefore, the differences between the present findings and those reported in previous studies may be partly explained by differences in age distribution, nutritional characteristics and population-specific factors.

The present study's strengths are: it was carried out with adolescents from a rural community, a relatively underrepresented population in studies evaluating the anthropometric indicators of obesity. The study was to assess simple, non-invasive and inexpensive anthropometric measurements that could be easily used in community- and school-based screening programmes. All participants underwent standardized anthropometric measurements, enhancing data reliability. The study also adds to the limited evidence on the utility of neck and wrist circumference as screening tools for obesity among rural Indian adolescents.

The current study has some limitations. First, the cross-sectional design limits the possibility of establishing causal or temporal relationships between anthropometric indicators and obesity. Second, the study was done in a single rural field-practice area and may limit the generalizability of the findings to other populations. Third, the number of obese participants was relatively small, which may have affected the stability of the correlation and diagnostic accuracy estimates. Finally, pubertal status was not assessed. However, growth and pubertal development can influence anthropometric measurements in adolescents. Hence, further multicentric studies with larger sample sizes are required to validate the findings of the present study.

CONCLUSION

To summarize, the prevalence of obesity among rural adolescents aged 11-14 years in the present study was 4.1%. Neck circumference and wrist circumference had a

statistically significant association with BMI-for-age Z-score and were able to identify obesity among adolescents. Wrist circumference had better diagnostic performance than neck circumference and can be used as a simple, non-invasive and inexpensive anthropometric indicator for screening obesity in community and school settings. Future studies should include larger and more diverse adolescent populations to confirm these results and to establish population-specific cut-off values.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee (S.R.T.R.G.M.C./Pharma/IEC/Outward No 98/Date 29/10/2025) held on 19/09/2025

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