Value of Neck Circumference and Waist Circumference Measurement in Assessment of Overweight/Obesity in Adolescent Children

SK Tak1, Anup Paliwal2, Sameer Jagrwal3

ABSTRACT

Background: To measure neck circumference and waist circumference, to compare it between normal and overweight/obese adolescents and to validate these with body mass index.

Methods: A cross-sectional study was conducted in 500 school going children/adolescents. Body mass index, waist circumference and neck circumference were measured. Independent samples t-test and Pearson’s correlation were used as tests of significance to analyze quantitative data.

Results: A positive correlation of neck circumference and waist circumference with body mass index was observed. The neck circumference and waist circumference in overweight/obese adolescents were significantly higher than adolescents with normal body mass index (P<0.001). Area under curve of waist circumference was more than area under curve of neck circumference. Cut off value of neck circumference for screening adolescent obesity in boys and girls were 30.73 cm, and 29.73 cm, respectively, and waist circumference cut off value were 70.73 cm for boys and 69.23 cm for girls at fairly good levels of sensitivity and specificity.

Conclusion: Neck circumference and waist circumference may be used in clinical practice and epidemiological studies as an index of overweight/obesity among school-going adolescents.

Key words: Anthropometry, Body mass index, Neck circumference (NC), Waist circumference (WC), Area under curve (AUC).

INTRODUCTION

Overweight and obesity used to be the problems of developing countries, but recently it is on increasing trends in developing countries too, due to cross cultural interactions, aggressive marketing by food industries and increasing sedentary life style.[1] Central obesity being main predictor of obesity related disorders, body mass index (BMI) may not be the best indicator of functional consequences of obesity.[2] Calculation and interpretation of BMI is difficult & time consuming by field worker sometimes and varying with age. Neck circumference (NC) on contrary may be a good marker to judge subcutaneous fat& obesity, a new concept in the anthropometry. Measuring NC and Waist circumference(WC) by tape is easy and can be taken by health staff and social worker, has not been much explored. Thus present study was conducted to evaluate NC & WC as anthropometric measurement for judging overweight/obesity among adolescent and correlate them with BMI.

METHODS

This school and Hospital based study was conducted in Rajsamand district of Rajasthan. For selection of cases, one school was chosen from low (Government school) and high (Public school) socioeconomic status each and cases
attending hospital OPDs. Total 500 students were selected by random sampling following student list in attendance register. Ethical clearance was obtained from institution’s ethical committee with permission from Principal/ Headmaster of the school prior to study.

Healthy children were included in the study. Children with any condition affecting the measurement of NC such as Goitre, swelling/cyst neck, cranio-vertebral diseases/ anomalies were excluded. The cases with Cushing Syndrome/steroid ingestion (Nephrotic syndrome, Bronchial asthma, Collagen vascular disease), Malnutrition, HIV, Malignancies and chronic illnesses were also excluded.

Weight was taken in light clothes without shoes from digital weighing machine. Height was measured by vertical scale, without shoes. Children were categorised according to their BMI, using BMI percentile of Indian Children from 5-17 years with 3rd, 10th, 25th, 50th, 75th and 95th percentile and at 18 years two more percentiles (23 & 28 kg/m²) were also added.\(^\text{[3]}\) WC was measured by non-stretchable tape at midpoint between costal margin and iliac crest in midaxillary line in standard position at the end of gentle expiration.\(^\text{[4]}\) NC was measured by same tape in standing position with head erect at the level of thyroid cartilage.\(^\text{[5]}\) Anthropometry was performed by trained Paediatric nurse/resident. Data were analysed by using independent t test and Pearson’s correlation. Receiver operating characteristics (ROC) analysis was done to find optimal and maximal sensitivity & specificity for NC/WC against BMI. The cut off value of these were determined by Yonden Index (Sensitivity + Specificity – 1). A p-value of <0.05 was considered to be statistically significant.

**RESULTS**

The age of adolescents recruited in the study (n=500; 55% boys) varied from 10-16 years with a mean SD age 13 (1.4) years. The study sample consisted of 390(78%) with normal BMI, 60(8%) with overweight/obesity and 50(6.66%) with underweight children. The mean (SD) BMI of boys and girls were 18.4(4.5) and 18.6(4.3) kg/m² respectively. The mean (SD) waist circumference (WC) for boys and girls were 68.6(12.4) and 66.3 (9.4) cm respectively. BMI was positively correlated with NC (r=0.644 for boys, 0.613 for girls) and WC(r=0.691 for boys, 0.681 for girls) at significant level (p<0.001). For boys 3rd percentile of NC was 24.9 cm & 97th percentile was 35.95 cm and for girls, 3rd percentile was 24.1 cm and 97th percentile was 34.9 cm.

Table 2 shows values of area under the curve (AUC) and cut off values for WC and NC with their respective sensitivity & specificity levels in identifying children with overweight/obesity.

Table 2 also shows the comparison of NC as a tool for detection of overweight/obesity as compared to WC.

Fig. 1 ROC curve comparing neck circumference and waist circumference with body mass index (BMI) in boys (A), and girls (B).

WC-waist circumference and NC- neck circumference.

### Table 1: Anthropometric Measurements in Adolescents in the study

<table>
<thead>
<tr>
<th></th>
<th>BOYS With (N) BMI</th>
<th>Overweight/ obese</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>151.6 (13.09)</td>
<td>155.2 (13.05)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>38.5 (9.87)</td>
<td>59.78 (14.19)</td>
<td>*</td>
</tr>
<tr>
<td>WC</td>
<td>64.5 (8.58)</td>
<td>80.48 (12.57)</td>
<td>*</td>
</tr>
<tr>
<td>NC</td>
<td>28.9 (2.56)</td>
<td>32.65 (2.68)</td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>GIRLS With (N) BMI</th>
<th>Overweight/ obese</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>147.6(8.3)</td>
<td>148.9(9.3)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>36.89(7.0)</td>
<td>54.29(10.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WC</td>
<td>63.00(7.48)</td>
<td>74.5(8.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NC</td>
<td>28.18(2.2)</td>
<td>31.06(2.4)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

All values in Mean (SD); for (N) BMI, n =215 for boys and n=175 for girls; and for overweight/obese n=33 for boys and n = 27 for girls.

![Table 1: Anthropometric Measurements in Adolescents in the study](image1)

![Table 2: Performance of NC in detecting overweight/obesity](image2)
DISCUSSION
In this study, it is found that a significant difference in WC & NC among normal and overweight/obese children detected by BMI (p=<0.001) in both boys and girls. Also there was a strong positive correlation of NC as well as WC with BMI. Limitations of the present study includes enrolments of adolescents from small geographic area, sample size and lack of validations of these measurements with functional consequences of obesity. It was found that cut off values of NC for screening adolescent obesity in boys and girls was 30.73 cm & 29.73 cm respectively while for WC 70.73 cm. and 69.23 cm. for boys and girls respectively. These results are close to estimates from previous studies. Small differences between cut off could be explained by ethnic variations. Correlation of NC & WC with BMI has also been reported in studies. It was observed that AUC of >80% for both NC & WC in boys and girls including its accuracy to detect adolescents with increased BMI. Further AUC for WC was found to be more as compared to NC in girls (0.849 vs 0.815) and boys (0.885 vs 0.821) indicating WC may be better measure for obesity in adolescents, however several limitations have been documented in the literature either related to its measurements specially among the adolescents owing to body changes they experience during puberty or due to its variations throughout the day according to bowel function or menstrual period. Measurement of NC may be relatively simple, convenient and nonintimidating specially for adolescents. As compared to BMI, Waist to hip ratio, Neck & Waist circumference have been shown to have high accuracy in predicting the risks of atherosclerosis in middle aged adults.

CONCLUSION
Thus, we conclude that both NC & WC are useful screening tools for adolescents with overweight/obesity and have a potential to be used as screening tool for adolescent overweight/obesity.

REFERENCES