IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Neck Circumference: A screening tool to assess obesity among medical undergraduates.

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ABSTRACT

BACKGROUND:

Neck circumference (NC) measurement is one of the simple screening measurements which can be used as an index of obesity. NC is a marker of upper body subcutaneous adipose tissue distribution.

AIM:

To correlate the neck circumference with body mass index and waist circumference and to determine the optimal cutoff value for neck circumference that define overweight/obesity.

METHODS:

Ethical approval has been obtained from Institutional Ethical Committee. The study comprised 100 medical students, aged 18-20 years. Anthropometric markers of obesity were measured, including body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-to-hip ratio (W-H ratio) and compared with neck circumference (NC) of the same subject. Pearson's correlation coefficients were used to evaluate the associations of NC with BMI and WC. The optimal cutoff value for NC to identify overweight/obesity was determined by receiver operating characteristic (ROC) curves.

RESULTS:

The mean BMI (kg/m^2) and WC (cm) were 22.38± 3.94 & 74.88±6.28 in boys and 21.17 ±3.39 & 77.13 ± 7.73 in girls, respectively. Mean NC (cm) in boys and girls were 31.37±1.88 and 31.61 ± 1.88, respectively. There was no significant difference between genders for BMI, WC and NC. NC had a positive correlation with WC (r=0.67; p=0.000) and BMI (r=0.4, p=0.03) in boys as well as in girls (WC: r= 0.60, p=0.000, BMI: r=0.73, p=0.000). At BMI of 25 kg/m^2 (overweight) and 30 kg/m^2(obesity), boys had NC of 34cm & 35cm and WC of 81cm & 86cm compared to girls who had NC of 33cm & 34cm and WC of 84 & 94cm, respectively.

Keywords: Body Mass Index, Neck Circumference, Obesity, Waist Circumference.

BACKGROUND

Overweight and obesity are terms used for people who weigh more than the limits recommended for their age and gender. This leads to several diseases that contribute to increased morbidity and mortality.[1] There is a need to identify some anthropometric parameter that is more feasible and accurate than the existing parameters and relate more closely to the new epidemic called obesity. Practical and easily performed methods for measuring obesity include various anthropometric measures such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), as well as the not-so-easy method of measuring the thickness of subcutaneous fat layer at specific sites for estimating body fat percentage.[2] BMI has been adopted by most health professionals for obesity surveys, as it is easy to perform on a large scale. While BMI is frequently used to assess for overweight and obesity, it does not differentiate between fat and other tissues, such as muscles, and does not account for regional fat distribution. Waist circumference, as an index of central obesity, may be better for predicting obesity-related health risks than BMI. Nevertheless, WC measurements may be inconvenient or difficult to obtain in some situations, such as with severely obese subjects. In addition, WC measurements are affected by fullness of the abdomen after a meal or due to abdominal gases or pregnancy. Moreover, respiratory movement and thick clothing can also affect the accuracy of WC measurements.[3]

Measurement of neck circumference (NC) has recently been used to identify overweight and obesity and is observed to have good correlation with age, weight, waist and hip circumferences, waist-to-hip ratio, and BMI for both genders.[4] Neck circumference measurement is easy to perform, quick, reliable, and inexpensive. In addition, its measurement is convenient and not affected by the aforementioned factors that influence WC measurement. The NC is believed to be a fine predictor of fatness because of the strong correlation between higher NC and central adiposity.[5] Jean Vague, who was the first to describe that different body morphology and types of fat distribution are related to health-related risks. He used a neck skinfold in his index of masculine differentiation to assess upper-body fat distribution.[6] Through subsequent studies, it has been found that upper body obesity and fat distribution are more strongly associated with glucose intolerance, hyperinsulinemia, diabetes mellitus, hyperuricemia, gout, hypertriglyceridemia, uric calculus, etc., than lower body obesity and fat distribution.[7] Neck circumference (NC) is positively associated with obstructive sleep apnea, diabetes, hypertension, metabolic syndrome and cardiometabolic risks in adults.[8] NC has an independent contribution to predict the metabolic abnormalities which is beyond the capabilities of the classical anthropometric indices such as BMI, WC, and waist/hip ratio (WHR), and hence it may be used as an optimal screening method for other obesity-related chronic diseases. The possible role of NC in screening for high BMI in young adults is not well characterized. The aims of this investigation were to examine the correlation of NC with BMI and WC in young adults and to determine the best NC cutoff that identifies those with high BMI.

OBJECTIVES OF THE STUDY

1. To correlate the neck circumference with body mass index and waist circumference.
2. To determine the optimal cutoff value for neck circumference (NC) that define overweight/obesity.

METHODOLOGY

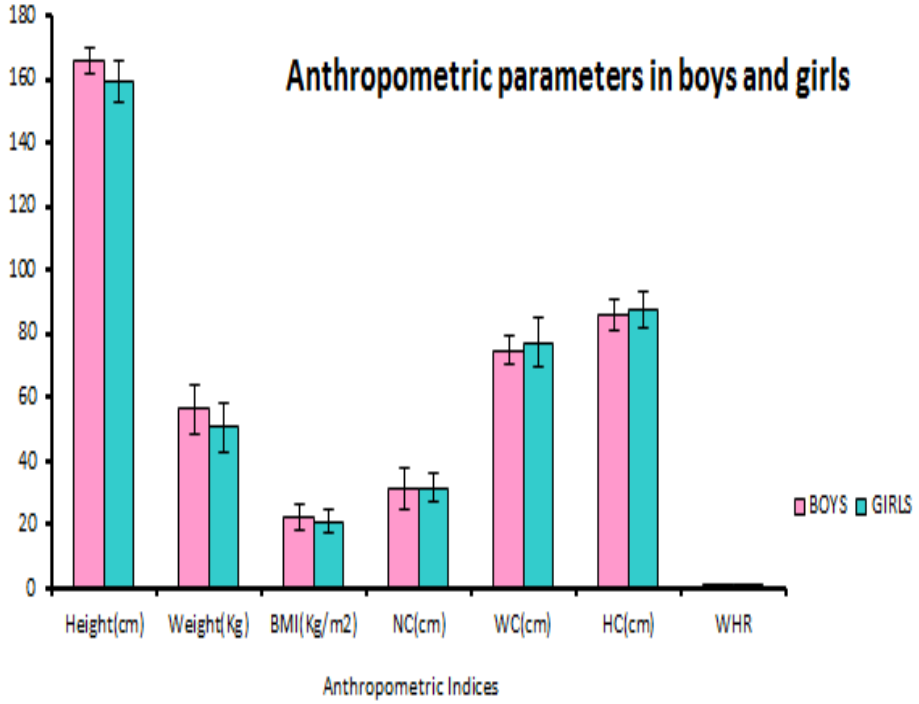
An observational study was carried out in the Department of Physiology, Government Medical College, Pariyaram, Kannur District, Kerala. The study included 100 first year medical undergraduates including 27 boys and 73 girls, aged between 18-20 years. Ethical clearance was obtained from the Institutional Ethical Clearance Committee for the conduct of study. After taking informed consent from the students, anthropometric markers of obesity were measured, including height in meters, weight in kilogram, WC in centimeters, HC in centimeters, NC in centimeters and waist-to-hip ratio (W-H ratio). Height (cm): Standing height was measured in centimeter (cm) using stadiometer. The participant was positioned fully erect, with the head in the Frankfurt plane (with the line connecting the outer canthus of the eyes and the external auditory meatus perpendicular to the long axis of the trunk), the back of the head, thoracic spine, buttocks, and heels touched the vertical axis of the anthropometer, and the heels were together. Height was recorded to the nearest 1 mm. If the reading fell between two values, the lower reading was recorded. Weight (kilogram [kg]): Standard weight measuring device was used that was placed on a hard-flat surface and checked for zero balance before measurement. Each participant was placed in the center of the platform wearing light clothes without shoes, after emptying bladder. Weight was recorded to the nearest 0.5 kg. BMI of participants were calculated by dividing weight in kg with the square of height in meter using formula kg/m ^{2}. BMI was calculated by Quetelet index- weight in kg divided by the square of the height in m (kg/m^2). As per the WHO criteria, BMI< 18.5 kg/m^2 was considered underweight, 18.5–24.9 kg/m^2 as normal weight, 25.0– 29.9 kg/m^2 as pre-obese (overweight), and BMI ≥30 was considered obese. WC was measured while the subject was standing at the end of a normal exhalation at the midpoint between the lower edge of the last rib, and the upper edge of the iliac crest, using a fabric measuring tape. HC was measured in centimeter using a plastic tape measuring, at the horizontal level of greater trochanters, with the legs close together. Average of two readings was used for analysis. WHR: WC was divided by HC to get the WHR. NC was measured in the local situation immediately below the larynx (thyroid cartilage) and perpendicular to the longitudinal axis of the neck (so that the measuring tape in front and back of the neck was at the same height).[9]

Pearson's correlation coefficients were used to evaluate the associations of NC with BMI and WC. The optimal cutoff value for NC to identify overweight/obesity was determined by receiver operating characteristic (ROC) curves.

Statistical Analysis: Descriptive statistics: mean, standard deviation used. Inferential statistics: Pearson correlation and unpaired t-test are used. All statistical analyses were performed using SPSS version 16.

RESULTS

This study involved 100 first year medical students in the age group of 18-20years, among them 58% were normal weight, 18% were underweight, 18% were overweight and 6% were obese. The mean BMI (kg/m^2) and WC (cm) were 22.38± 3.94 & 74.88±6.28 in boys and 21.17 ±3.39 & 77.13 ± 7.73 in girls, respectively. Mean NC (cm) in boys and girls were 31.37±1.88 and 31.61 ± 1.88, respectively (Graph 1). There was no significant difference between genders for BMI, WC and NC.



Graph 1: Anthropometric parameters in boys and girls.

NC had a positive correlation with WC (r=0.67; p=0.000) and BMI (r=0.4, p=0.03) in boys as well as in girls (WC: r= 0.60, p=0.000, BMI: r=0.73, p=0.000) Table 2.

Table 2: Pearson correlation between NC and BMI

Variables	Neck Circumference (cm)			
	Boys		Girls	
	"r" value	"p" value	"r" value	"p" value
BMI (kg/m^2)	0.40	0.03*	0.73	0.000**
WC (cm)	0.67	0.000**	0.60	0.000**

At BMI of 25 kg/m^2 (overweight) and 30 kg/m^2(obesity), boys had NC of 34cm & 35cm and WC of 81cm & 86cm compared to girls who had NC of 33cm & 34cm and WC of 84 & 94cm respectively, using ROC analysis. A NC of ≥34 cm in boys and ≥33 cm in girls are the cutoff values for overweight/obesity. A WC of ≥81 cm in boys and ≥84 cm in girls are the cutoff values for overweight/obesity.

DISCUSSION

NC is considered an index of upper body obesity and is convenient to perform. It has been reported that free fatty acids are released in larger proportion from upper body subcutaneous fat than lower body subcutaneous fat.[10] NC correlates positively with changes in systolic and diastolic blood pressure, blood sugar values, other components of the metabolic syndrome and cardiometabolic risks beyond that of BMI and WC. [7]

In our study the mean BMI (kg/m^2) and WC (cm) were 22.38± 3.94 & 74.88±6.28 in boys and 21.17 ±3.39 & 77.13 ± 7.73 in girls, respectively. Mean NC (cm) in boys and girls were 31.37±1.88 and 31.61 ± 1.88, respectively. There was no significant difference between genders for BMI, WC and NC. NC had a positive correlation with WC (r=0.67; p=0.000) and BMI (r=0.4, p=0.03) in boys as well as in girls (WC: r= 0.60, p=0.000, BMI: r=0.73, p=0.000). At BMI of 25 kg/m^2 (overweight) and 30 kg/m^2(obesity), boys had NC of 34cm & 35cm and WC of 81cm & 86cm compared to girls who had NC of 33cm & 34cm and WC of 84 & 94cm, respectively.

In a cross-sectional study conducted by Qureshi NK et al evaluated NC as a marker of overweight and obesity and suggestive respective cutoff values have been determined. Of 871 studied participants, mean of NC was 33.45 ± 2.22 cm. Male had higher NC than that of female participants (as mean ± SD, in male: 34.16 ± 1.95 cm and in female: 32.50 ± 2.20 cm). NC showed positive and significant correlation with BMI, WC, and HC.[11] In a similar study by Hingorjo MR et al, NC had a strong and positive correlation with BMI and WC. At BMI of 23.0 and 25.0, males had NC 35.7 cm and 37.5 cm while females had it at of 32.2 cm and 33.5 cm, respectively.[1] In another study conducted by Ben-Noun L et al, significant association was found between NC and BMI, WC, HC and WHR. NC ≥37 cm for men and ≥34 cm for women were the best cutoff levels for determining the participants with BMI ≥25.0 kg/m ^{2} using ROC analysis, and NC ≥39.5 cm for men and ≥36.5 cm for women were the best cutoff levels for determining the participants with BMI ≥30 kg/m ^{2}.[4]

To determine the true cutoff points, one needs to expand the study, taking larger number of subjects from a wider age group. This study could involve only a small sample size and NC was not studied in relation to metabolic components as well. Despite the limitations, the study has important implications for prevention of overweight and obesity in young adults as it points towards the practical usage of an easier alternative for obesity measurement. NC can be a practical and an easier alternative tool to other anthropometric parameters.

CONCLUSION:

NC has been shown to independently contribute to the prediction of overweight and obesity and can be used as an initial screening tool, which is an inexpensive test that can be performed with a tape measure. Neck circumference correlated positively with BMI and WC. A NC of ≥34 cm in boys and ≥33 cm in girls can be considered the cutoff point for overweight/obesity. The study concludes that NC is a potentially useful initial screening tool for overweight/obesity.

ACKNOWLEDGEMENT

I acknowledge first year medical undergraduates for volunteering in the study and our former Professor and HOD, Dr. M G Bandelkar for his support in conducting this study.

Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.

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