



NECK CIRCUMFERENCE; INDEPENDENT PREDICTOR FOR OVERWEIGHT AND OBESITY IN COLLEGE STUDENTS: CORRELATION WITH BODY MASS INDEX AND WAIST CIRCUMFERENCE.

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INTRODUCTION

Overweight and obesity are still major public issue around the world. In 1997, the World Health Organisation (WHO) has declared this condition as global epidemic.^[1] According to the International Obesity Task force report, in 2010, the number of overweight and obese people globally was estimated nearly 1.0 billion and 475 million, respectively. Childhood obesity is increasing in the same trend and it has been estimated that near about 200 million school- going children are overweight or obese.^[2] The prevalence of obesity has increased in

Industrialization countries and also in developing country like India. Several studies have confirmed the relationship between overweight and obesity and its marker with a wide range of chronic diseases and even correlation with malignancies that may threatened public health.^[3]

Currently, various methods are used to assess overweight and obesity but commonly used tool is BMI. Despite the simplicity and universal use of BMI, it is not perfect scale to assess the central obesity or visceral fat, which is the main predictors for obesity related disorders.^[4] So, other methods like waist circumference (WC) and hip to waist ratio (WHR) are used to identify central obesity. But waist circumference measurement varies with respiration and with post prandial distention of abdomen^[5] and as well as measuring WC may be time consuming and problematic in terms of cultural and environmental issues. All above given anthropometrics measurement have their own limitation. Therefore, new strategies are required to find a better scale to measure overweight and obesity, particularly focusing on visceral obesity.

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.^[6] Besides, NC is considered an index of upper body obesity and correlates positively with changes in systolic and diastolic blood pressure and other components of the metabolic syndrome.^[7] Increased in NC has been implicated in increased cardiovascular risk of an individual.^[8,9] A study done by Li et al in Chinese adults showed that the NC has significant correlation with visceral adipose tissue as documented by CT scans.^[10] Many researchers have shown the use of neck circumference (NC) as a simple screening method to identify obesity and overweight^[11,12] but not much studies have been done in India. Hence, this study is done to analysis the correlation between Neck circumference with BMI, Waist circumference, and waist hip ratio.

METHODS AND MATERIAL

This was a cross- sectional study conducted in School of physiotherapy, VISTAS, Chennai. After obtaining permission from physiotherapy department, the written informed consent form was given to the subjects. Sample were selected as per the inclusion and exclusion criteria. Simple randomization was carried out in selecting 100 students. This sample consisted of 49 males and 51 females.

❖ Inclusion criteria

1. Students aged between 18-25 years were taken.
2. Both male and female are included.
3. Students who are willing to participate in this study.

❖ Exclusion criteria

1. Students who have established thyroid disease or enlargement and neck abnormality like cystic or mass lesion in the neck.
2. Student having dyslipidemia.
3. Intra or extra abdominal mass lesion and uncooperative subjects.
4. Cervical lymphadenopathy and any anatomical abnormality of waist and hip region.

STUDY TOOLS

Participants were examined regarding height, weight, BMI, WC, WHR and NC.

1. Height(cm)

Stadiometer.

2. Weight (Kg)

Standard weight measuring device

3. **BMI**= weight in kg/square of height in meter.

4. WC, HC and NC

plastic tape.

5. **WHR**= WC/HC

PROCEDURE

Sample were selected as per the inclusion and exclusion criteria. 100 college students were taken for this study. This sample consisted of 49 males and 51 females.

All the measurements were taken in the morning after the overnight fasting. Body weight was measured to the nearest (0.1 kg) wearing the light clothes and without wearing shoes using Standard weight measuring device. Height was taken to the nearest (0.1 cm) using stadiometer. BMI was calculated by dividing weight(kg) by height in meter square.

NC was measured with regular plastic tape to the nearest 0.5 mm. It was taken in a plane as horizontal as possible, at a point just below the larynx (thyroid cartilage) and perpendicular to the long axis of the neck (the tape line in front of the neck at the same height as the tape line in the back of the neck). While taking this reading, the participants was asked to look straight ahead, with shoulder down, but not hunched. Care was taken not to involve the shoulder/neck muscles(trapezium) in the measurement.

WC was measured at the midpoint between the lowest rib and the iliac crest, within 1mm and with the participant standing & at the end of a gentle expiration and HC was measured in CMS using plastic tape measuring, at the horizontal level of greater trochanters, with the legs close together. Average of two reading was used for analysis.

□ STATISTICAL ANALYSIS

Statistical analysis was performed by using Microsoft Excel 2013. All data were analysed and reported by sex. The means and standard deviation (SD) were used to describe the continuous data. For the parametric correlations between independent parameters; Pearson's correlation coefficient was calculated.

OUTCOME MEASURES

✓ BMI

As specified for the Asia-Pacific population by the Western Pacific Regional Office of the WHO, BMI was classified as following.

Category	BMI (kg/ meter in square)
Underweight	<18.50
Normal	18.50-22.99
Overweight	23.00-27.49
Obese	>27.5

✓ WC:

Male: wc>90cm

female: wc>80cm

✓ WHR:

male: >0.9 and female: >0.8

✓ NC:

Male: >or = 35.5cm and Female: > or = 32 cm.

RESULTS

Among 100 studied participants, 49 were males and 51 were females and their anthropometric and metabolic characteristics are shown in Table 1. Mean BMI was 21.60 ± 3.74 and male had higher BMI than female.

Mean neck circumference (CMS) of studied participants was 31.14 ± 2.44 and was higher in male than female (in male: 32.02 ± 2.60 and in female: 30.26 ± 1.92) [Table 1]. The Pearson's correlation between NC and studied parameters showed positive and significant correlation with weight(total participants: $r=0.81$, $P<0.001$; in male: $r= 0.82$, $P<0.001$ and in female: $r=0.79$, $p<0.001$), BMI (total participate: $r=0.62$, $p<0.001$; in male: $r=0.53$, $p<0.001$ and in female: $r= 0.73$, $P<0.001$), WC (total participants: $r=0.79$, $p<0.001$; in male: $r=0.75$, $p<0.001$ and in female: $r=0.81$, $p<0.001$), HC (total participants: $r=0.51$, $p<0.001$; in male: $r=0.58$, $p<0.001$ and in female: $r=0.44$, $p<0.001$) of the studied participants while WHR ratio was also found positive as per this study.

Table 1: Anthropometric and metabolic characteristics of studied participants.

Studied parameters	Total participants (n=100)	Males (n=49)	Females (n=51)
Age	20.07±1.26	20.24± 1.32	19.89± 2.20
Weight	54.5±10.94	57.28 ±10.67	51.71± 10.59
BMI	21.06±3.74	22.28± 3.72	23.92 ±3.67
WC	74.42±9.81	77.20± 9.67	71.65± 9.23
HC	112.46±29.94	93.83± 8.89	131.102± 32.00
WHR	0.79±0.06	0.81± 0.06	0.78± 0.05
height	115.30± 7.6	160.40±8.69	156.20±5.72
NC	31.14± 2.44	32.02± 2.6	30.26± 1.92

BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist hip ratio; NC: neck circumference.

Pearson's correlation between neck circumference and studied obesity parameters

Studied parameters	Total(n=100)		Male(n=49)		Female (n=51)	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Weight	0.81	P<0.001	0.81	P<0.001	0.79	P<0.001
BMI	0.62	P<0.001	0.53	P<0.001	0.73	P<0.001
WC	0.79	P<0.001	0.75	P<0.001	0.81	P<0.001
HC	0.49	P<0.001	0.58	P<0.001	0.44	P<0.001
WHR	0.53	P<0.001	0.42	P<0.001	0.55	P<0.001

N.B: analysis done Pearson's correlation coefficient ($r=0.1$, more value, more correlation); BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist hip ratio; NC: neck circumference.

DISCUSSION

This study showed that there is correlation of neck circumference with height, weight, BMI, WC, HC and WHR. There is strong correlation between NC and WC and moderate correlation between NC and BMI; also, moderate correlation between NC and WHR.

Upper body fat distribution has been considered as risk factor of cardiovascular disease. It has been reported that free fatty acid is released in large proportion from upper subcutaneous fat than lower body fat.^[13,14] Moreover, NC has been used as index for such adverse risk profile.^[15]

For screening to identify metabolic syndrome in post-menopausal woman, NC has an advantage.^[16] The measurement of WC is influenced by post prandial and respiratory abdominal expansion and clothes should be removed for accurate measurement of WC or hip circumference. In contrast, the value of NC is not affected by these physiological and environmental problems. Therefore, the measurement of NC exhibits high reproducibility with a simple procedure and short measurement time, resulting in its suitability for detecting the risk of metabolic disease in large population.

Several studies have examined the association of conventional anthropometric measures of obesity with NC. Onat A et al reported that NC correlated strongly with BMI, WC, homeostatic model- assessed insulin resistance and blood pressure. The association between obstructive sleep apnoea and NC was even greater than WC in case of male.^[16,17] And other studies conducted by Sunil Kumar et al in central India, showed moderate correlation between NC and BMI. This study's correlation coefficient is in concordance with our study.^[18]

It has been hypothesized that fat in the neck, more similar to visceral fat, produces and release substance that cause metabolic abnormalities. More recently it has been described as an ectopic fat depot functioning as a reserve for immediate energy source in a location, not typically associated with adipose tissue storage. This cause increased delivery of free fatty acids to liver causing oxidative stress and ultimately leading to a cardiovascular and metabolic risk.^[8,19] Another likely pathway is that subcutaneous fat in the upper body, particularly in obese individual, is responsible for a much bigger proportion of release of free fatty acid than visceral adipose tissue and higher levels of plasma fatty acid could result in insulin resistance.^[8]

Hence, NC has been showed to independently contribute to prediction of overweight and obesity.

Limitation

1. Studies was conducted in only one collage.
2. Sample size is small.
3. Data was not collected on dietary habits, physical activity, socioeconomic status, blood lipid and genetics.

CONCLUSION

NC measurement as a simple and time saving screening measure could be used to identify overweight and obese population. It is an easy, inexpensive and straightforward tool that can be done in any condition with the help of tape measure.

Measuring NC is socially acceptable, easy to measure, less time consuming and involves less cumbersome procedures when compared to measurement of WC. Hence, for the developing country like India which is facing a double burden of nutritional transition, NC will be feasible method to screen obesity and overweight.

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