Research article

Association of neck circumference with prehypertension and obesity in young paramedical students**Shanmugarajah Mangani Mangalavalli¹, Senthamil Selvi Kaliyaperumal¹, Velusami Deepika², Shivayogappa S. Teli³, Krishnamurthy Soundariya³**¹Assistant Professor, ²Associate Professor, ³Professor, Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital, Kalitheerthalkuppam, Pondicherry, India

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ABSTRACT

Introduction and Aim: Prehypertension and obesity are the important cardio metabolic risk factors for developing metabolic syndrome. Neck circumference (NC) is an effective marker and screening tool for obesity. It gives a quick assessment of the upper body fat distribution. Early detection of obesity and prehypertension can increase the longevity of the individual. Hence, we aimed at evaluating the association of NC with prehypertension and obesity in young adults.

Materials and Methods: A cross sectional study where 150 Paramedical students were screened for prehypertension and fifty students were identified as pre-hypertensives (n=50). Routine anthropometric measurements were taken. NC was measured. The correlation of NC with body mass index (BMI), systolic blood pressure (SBP) and diastolic blood pressure (DBP) was calculated. The prevalence and percentage distribution of obesity using NC in prehypertensive was calculated. The association of NC with obesity and prehypertension was demonstrated.

Results: The prevalence of obesity in prehypertensive students was 58%. The distribution of obesity using NC was 61% in males and 55% in females. Further, the association of NC with BMI ($r=0.53$, $p<0.0001$), SBP ($r=0.52$, $p<0.0001$) and DBP ($r=0.44$, $p<0.0001$) was calculated using Pearson's correlation and was statistically significant.

Conclusion: There was an increased prevalence of obesity among pre-hypertensives with a male predisposition. The study also establishes a statistically significant and strong correlation of NC with BMI, SBP and DBP. NC can be used as an effective screening tool to assess obesity and prehypertension.

Keywords: Body mass index; systolic blood pressure; diastolic blood pressure.

INTRODUCTION

It is a disconcerting revelation that the worldwide prevalence of obesity has actually tripled since 1975. Almost 39% of adults under the age group of 18 and above were found to be overweight in the year, 2016 and almost 13% fell in the category of obesity. It was startling to note that over 38 million children who were under the age of 5 were found to be overweight or obese in the year 2019. It is quiet appalling to note the fact that in India almost 135 million individuals are obese. The prevalence of obesity according to an Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) study done in 2015 was at a range from 11.8% to 31.3% (1). Obesity is said to be a condition of having excess body weight due to fat, causing ill health. In fact, obesity has become a disease of the modern era. In today's world a huge population resides in countries where obesity and overweight cause more mortality than underweight. It is noted that almost 5% of non-communicable diseases in the world are strongly associated with overweight and obesity (2). According to the World health organization (WHO) statistics, nearly 3.2 million deaths are because of

physical inactivity, which ultimately predisposes to obesity and overweight causing an inclination to develop non-communicable diseases like hypertension, cardiovascular disorders (3).

Prehypertension is also identified as an important risk factor for cardiovascular disease and is detrimental to the life expectancy by decreasing it by 5 years, as it is mostly, if not always develops into full blown hypertension, (almost half of the prehypertensive become hypertensive in about 4 years' time) (4). Hence it is quite necessary to monitor even a case of low risk prehypertensive individual annually. The Framingham study showed that if a person with prehypertension was not treated, then these patients more likely develop hypertension in future. Therefore, prehypertension is given a lot more importance both while screening and treating because the sooner it is identified and treated the better is the lifespan of the individual. Early detection of prehypertension by routine screening, keeping the Body mass index (BMI) on check by lifestyle modifications such as regular physical exercises and maintaining a healthy balanced diet, will help us to lead an active, healthy life (5).

Studies showed that the main risk factors for developing prehypertension and eventually hypertension was overweight and obesity (6). Further evidence exists in proving the association of increased body fat to hypertension (7). Traditional techniques used in the assessment of central obesity are Waist circumference (WC), Hip circumference (HC), waist/hip ratio, mid arm circumference and Neck circumference (NC) (8). NC is considered as more accurate than BMI because its association is much stronger with central obesity than the BMI and it is also far more convenient and simple technique (9). NC may be considered as a vital parameter in assessing central adiposity and also visceral adiposity (10). It is also considered as an important independent indicator of risk for the metabolic conditions as per the Framingham heart study (11). It is used mainly to assess the upper body fat distribution and thence the obesity state of an individual (12). For routine screening purposes in health care settings, for research purposes wherein the use of expensive and sophisticated machines is neither easy nor justifiable, NC shall be adopted as a simple yet effective tool for screening. Moreover, in certain special circumstances as screening for obesity in pregnant women, NC might be considered as a meaningful method of assessment (10). Hence, this study was undertaken to use NC as a marker of obesity and to establish its correlation with BMI and prehypertension among prehypertensive young adults.

MATERIALS AND METHODS

The present study was undertaken at Sri Manakula Vinayagar Medical College and Hospital (SMVMCH), Pondicherry. It was a cross sectional study, wherein 150 paramedical students of both sex and of adult age group (18-25 years), belonging to partner institutions were screened for prehypertension based on Joint National Committee (JNC) criteria in which systolic blood pressure (SBP) of range 120-139 mm Hg and a diastolic blood pressure (DBP) of range 80-89 mmHg, were categorized as prehypertensive. After satisfying the inclusion criteria and obtaining their willingness to participate, they were taken up for the study (n=50). Informed consent was obtained from all the participants. The protocol was approved duly by the Human Research Ethics committee. A complete medical history was elicited using a structured questionnaire and physical examination was performed. Participants with SBP $\geq$ 140 mmHg, DBP $\geq$ 90 mmHg, participants with existing thyroid disease or enlargement, any form of neck abnormalities and ill subjects were excluded from the study.

Methodology and data collection

Almost 150 Paramedical students belonging to our partner institutions were screened for elevated blood pressure and the students identified as prehypertensive (n=50) according to JNC 7 criteria and were included in the study. Informed consent was obtained, and then relevant history was collected from the participants. The principal investigator measured the blood pressure. The subjects were made to sit comfortably in the department laboratory for 30 minutes, after which the blood pressure was measured in supine position by mercury sphygmomanometer, between 10 am to 11 am. Three blood pressure readings were measured, and an average value was taken. Pre-hypertensives were diagnosed as per JNC 7 criteria, where the grey area between SBP of 120-139 mmHg and DBP of 80-89 mmHg is defined as “prehypertension.” Routine Anthropometric measurements like height, weight, WC, were measured appropriately and thence the BMI was calculated accordingly. Height was measured to the nearest 0.1 cm asking the subject to stand in erect position with no shoes and feet kept flat on floor on a vertical scale, with the heels touching the wall and the head kept straight. Body weight was measured to the nearest 0.1 Kg making sure that the subject was minimally clothed and without shoes, standing motionless on a weighing scale. Body Mass Index [QUETELET INDEX] BMI was calculated using the formula weight in kilograms divided by square of height in meters (kg/m²). NC was measured using a non-stretchable plastic measuring tape in the midway of the participants neck, (mid-cervical spine and mid anterior neck) while the subject is standing erect. In men, it was measured just below the laryngeal prominence - their Adam's apple to the nearest 0.1cm (13). The standard NC cutoff in males was taken as 36.50cm and in females was taken as 32.50cm in people of Asian Indian origin. This screening test cut off value had a sensitivity of was 84.85% in males and 73.68% in females (14).

Statistical analysis

The data thus obtained was entered simultaneously in Microsoft Excel spreadsheet and subsequently the mean $\pm$ standard deviation was calculated. The frequency distribution of obesity using NC among prehypertensive and the gender predisposition also was calculated using SPSS software version 16. The association of NC with BMI, SBP and DBP was calculated using Pearson's correlation test.

RESULTS

Among the 50 prehypertensive young adults, (n=50), 21 were male and 29 were female (table 1). In the 21 male prehypertensive participants, 8 were having normal standard NC and categorized as normal, non-obese and 13 were found to have increased NC and hence categorized as obese (table 1). Among the 29

female prehypertensive participants, 13 had normal standard NC and were considered normal, non-obese whereas 16 had increased neck circumference and categorized as obese. Out of the net study participants (n=50), 21 participants i.e., 42% (both

male and female) were found to have normal standard NC and categorized as normal and 29 participants i.e., 58% had increased NC and were categorized as obese individuals (fig. 1).

Table 1: Prevalence of obesity (using neck circumference) among prehypertensives

	Male	Female
Normal	8	13
Obese	13	16

Fig. 1: Prevalence of obesity (using neck circumference) among Pre-hypertensives

Hence, the prevalence of obesity (using neck circumference) in prehypertensive young paramedical students was 58%.

Table 2: Distribution of obesity among males and females

	Male	Female
Normal	39%	45%
Obese	61%	55%

Fig. 2: Distribution of obesity among males and females

The distribution of overweight and obesity using NC was found to be 61% in prehypertensive young males and 55% in prehypertensive young females. 39% of prehypertensive males and 45% of prehypertensive females were found to have normal NC and were non obese (fig. 2).

Table 3: The Mean $\pm$ Standard deviation of all the parameters assessed

Parameters	Males	Females
	Non-Obese	Obese
BMI (kg/m ²)	21.4 $\pm$ 2.63	26.5 $\pm$ 1.33
SBP (mmHg)	124.76 $\pm$ 2.38	132.92 $\pm$ 4.21
DBP (mmHg)	82.5 $\pm$ 0.93	85.38 $\pm$ 2.22

p value <0.05 was statistically significant

Table 4: Pearson's correlation of NC with BMI, SBP and DBP

Parameters	Neck Circumference (cms)	
	r value	p value
BMI (kg/m ²)	0.53	<0.0001
SBP (mmHg)	0.52	<0.0001
DBP (mmHg)	0.44	<0.0001

p value <0.05 was statistically significant.

Thus, a strong positive correlation between NC and BMI, SBP and DBP was proved statistically (table 3 & 4).

DISCUSSION

In the present study, it was reported that the prevalence of obesity (using NC) was around 58% in young prehypertensive paramedical students. There was a gender predisposition in which the prevalence of obesity among males was 61% and that in females was 55%, showing a higher prevalence among male prehypertensive adults. There was a statistically strong positive correlation existing between NC and BMI and prehypertension (SBP and DBP). To begin with this study, it was hypothesized that there is a strong association between NC with prehypertension and obesity. This hypothesis was proved to be true by our study. There was a significant association of increased NC with prehypertension indicating that NC can be a reliable marker and screening tool to assess obesity which can predispose to elevated blood pressures in young adults. It is observed that there is a statistically significant strong association of increased NC with prehypertension. Vague *et al.*, were pioneers as early as 1956, in putting forth the concept of upper body fat distribution having a lot of clinical implications (15). Rajagopalan *et al.*, and Yilmazel showed a significant association between high BP with increased NC and increase in BMI. The study also showed that obesity and overweight had a positive correlation with an increase in SBP and DBP (16,17). Guo *et al.*, (18) showed that the early identification of prehypertension can be improved by measuring the NC in normal weight children and also in adolescents more than their BMI. Kurtoglu *et al.*, (19) demonstrated that there was a strong association of NC with blood pressure in a study on obese children in Turkey. Liang *et al.*, demonstrated that increased NC measurements were directly associated with an increased the risk of prehypertension (20). The Framingham heart study had shown a strong association between NC and cardiovascular disease risk factors. Zhou *et al.*, (11) had demonstrated in a cross-sectional study in which they showed that there was significant association of NC with SBP, DBP in both the genders. A lot of experimental studies established that there is increased lipolysis when fat is more likely stored in the upper body (21). This increased lipolysis is related to an increase in release of free fatty acids, more endogenous production of very low density lipoprotein (VLDL) and glucose by the liver and insulin resistance (22). These significant changes ultimately lead to metabolic syndrome which is more obvious due to excess visceral and adipose tissue which is measured with the NC. Fox *et al.*, demonstrated a significant relationship between metabolic risk factors and visceral adipose tissue

(23). Our study findings are further supported by Kuciene *et al.*, where there was a good association of NC with high BP in children and adolescents (24). Hence this study demonstrates a statistically significant strong association of increased NC with prehypertension in young adults. However, there are a few limitations in our study, wherein the participant's lifestyle and diet information were not collected. The sample size was less, as this was a preliminary study which needs further exploration and research in future. Our conclusion of relating the prevalence of obesity, measured using NC with prehypertension may be extended to wider population in future.

CONCLUSION

Our study demonstrated a clear significant increase in the prevalence of obesity measured using NC among prehypertensive young adults. NC can be used as an effective screening tool to assess the upper body fat distribution and thereby assess the prevalence of obesity during screening purposes and demonstrates a statistically strong, positive association between NC with prehypertension, demonstrating the importance of identifying prehypertension, which is a precursor of hypertension, by a simple NC measurement. When obesity, overweight and prehypertension in young adults is picked up at an early stage, then lifestyle modifications, diet changes, routine physical activity can be incorporated for a healthier life, which might in fact help to prevent and/or manage prehypertension and in turn prevent the development of hypertension in future thereby increasing the longevity of the people.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

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