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Neck circumference – A better anthropometric marker for predicting cardiometabolic risk

Cardiology

KEYWORDS: Prevalence, Traditional practices, newborn

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ABSTRACT

Background:
Upper-body subcutaneous adipose tissue, measured by neck circumference (NC), has been positively associated with hypertension (HT). This study was conducted with the objective to correlate and evaluate NC with HT and to define critical cut-off point for screening HT in adult population of central India.

Methods:
This cross sectional study was carried out in the urban filed practice area of Government Medical College Nagpur. All patients attending OPD during study period, aged >30 years after applying exclusion criteria were included in study. The socioeconomic details were assessed using questionnaire. Anthropometric measurements and blood pressure were recorded using standard guidelines. Data was analysed using Epi Info 7 and SPSS. Unpaired t test, Pearson's correlation and finally ROC analysis was done.

Results:
Out of total 206 individuals, 107 were male; majority being aged >50 years. The mean value of NC was 36.43±3.23 cm and 34.84±4.07 cm in hypertensive and non-hypertensives respectively and was seen significantly associated with HT (p=0.02). Positive correlation was seen between SBP and NC in male r=0.27 and in females r=0.26 (p=0.001).On applying ROC, AUC for male and female was 0.652 (p=0.007) and 0.68 (p = 0.002) respectively and the best cut-off for male was 36.5cm and female was 33.5cm with sensitivity of 74% and 72.71% respectively.

Conclusions:
NC is positively correlated with hypertension. NC >36.5cm for males and >33.5cm for females was the best cut-off levels for screening for HT. NC could be a potential, inexpensive, easy screening tool for screening HT.

INTRODUCTION

Hypertension (HT) is one of the major health and development challenges of the 21st century. Globally, nearly one billion people have high blood pressure (hypertension); of these, two-thirds are in developing countries and the problem is growing; an estimated 1.56 billion adults will be living with HT by 2025. (1) Screening for HT is important because it is a silent killer, signs and symptoms are not visible until end organ damage occurs. HT is associated with a greater proportion and abnormal distribution of body fat (2). The upper body distribution of fat, especially with increased visceral adipose tissue, is considered predictive of cardio metabolic conditions (3). Neck circumference (NC) has been proposed as an index for upper-body subcutaneous adipose tissue distribution

METHODS

This Cross sectional study was carried out in the urban filed practice area of Government Medical College Nagpur. The centre was catering to approximately 1 lakh population. The patients attending the general OPD at the UHTC during the study period i.e. January to April 2016 were recruited for the study by simple random sampling method. The patients who were above 30 years of age were recruited for the study after obtaining an informed consent. The individuals who had visible thyroid enlargement or who gave positive history of thyroid disorders, who were severely ill and pregnant ladies were excluded from the study. The sample size for the study was calculated taking the prevalence of hypertension of 21.4% in India as stated by the reports of World Health Organisation with 90% confidence interval and an absolute precision of 5%.The minimum sample to be covered was calculated to be 182. A total of 206 patients were included in the study. The socio demographic information of subjects like age and gender was assessed using a questionnaire. Anthropometric measurements like weight and height were measured according to WHO STEPS guidelines to calculate the body mass index of the subjects. Height was measured to the accuracy of 0.1cm; weight of the study subjects was measured using a digital weighing machine to the accuracy of 0.1kg; and subsequently body mass index (BMI) was calculated. NC was measured at mid-neck height, between mid-cervical spines to midanterior neck, to an accuracy of 0.1 cm, with non-elastic plastic tape. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. Blood pressure (BP) of the subjects was measured to check the presence of hypertension using mercury sphygmomanometer by auscultatory method. Three readings were taken 3 minutes apart and the average of the second & third readings was taken as the final reading. Also history of intake of medications for hypertension was asked. HT was diagnosed as per JNC 8 criteria, systolic blood pressure (SBP) ≥140mmHg and diastolic blood pressure (DBP) ≥ 90mm Hg.

Statistical analysis

Data was analyzed using Epi Info version 7.1 and statistical package for social sciences version 20. Significance level was set at 5%. Descriptive statistics like mean, standard deviation and percentages were calculated. To test the difference between the mean BP of both groups, unpaired t test was applied. The correlation between two variables was done by Pearson's correlation. ROC (Receiver Operating Characteristic) curves were constructed thereafter. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated for each cut-off in the sample.

RESULTS

The age and gender wise distribution of the study subjects are shown in Table 1.

Table 1

Age group (years)	Male (%)	Female (%)
30-40	8 (7.47)	11 (11.11)
40-50	22 (20.56)	21 (21.21)
>50	77 (71.96)	67 (67.67)
Total	107 (100)	99 (100)

Of the 107 males, 77 were more than 50 years, 22 were between 40-50 years and 8 were between 30-40 years of age. Of 99 females, 67 were more than 50 years, 21 were between 40-50 years and 11 were between 30-40 years of age.

Table 2 shows the mean values of the anthropometric parameters along with their standard deviations. The mean height and weight of males were higher than that of females, whereas females had higher mean BMI 24.12±4.71 kg/m2 in comparison to males 21.77±4.25kg/m2. The mean NC of males and females were 37.15±3.59cm and 34.08±3.20cm respectively. The mean systolic and diastolic blood pressure was higher in females; 132.82± 20.95 mmHg and 84.49 ±13.04 mm Hg respectively in males and 135.17±19.83 mm Hg and 86.98±14.36 mmHg respectively in female.

Table 2

Anthropometric Parameter	Male (mean)	Female (mean)
Height	163.15	150.72
Weight	58.01	54.52
Body mass index	21.77	24.12
Neck circumference	37.15	34.08
Systolic blood pressure	132.82	135.17
Diastolic blood pressure	84.49	86.98

The mean value of neck circumference was 36.43±3.23 cm and 34.84±4.07 cm in hypertensive and non - hypertensives respectively. A statistically significant association (p value = 0.02) was seen between NC and HT when unpaired t test was applied.

Table 3 shows the Pearson's correlation coefficient between NC and other parameters like SBP, DBP and BMI for males and females. A weak positive correlation was seen between SBP and NC for both males (r= 0.27, p= 0.001) and females (r =0.26, p= 0.001). No linear association was seen between DBP and NC in both the genders. Moderate correlation was seen between BMI and NC in males (r=0.60) and females(r=0.51).

Table 3

Parameters	Male		Female		Overall	
	r	p-value	r	p-value	r	p-value
Systolic blood pressure	0.274	0.001 HS	0.265	0.001 HS	0.221	0.001 HS
Diastolic blood pressure	0.220	0.02 S	0.156	0.12 NS	0.133	0.056 NS
Body mass index	0.006	0.001 HS	0.511	0.001 HS	0.386	0.001 HS

Table 4 shows the gender-wise cut-off values of NC for screening HT. Using the cut-off based on ROC, 36.5cm for male and 33.5 cm for female, further evaluation was done to find their sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy which are depicted in Table 4.

Table 4

Gender	Neck circumference cut off level	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Diagnostic accuracy
Male	36.5 cm	74	54.39	58.73	70.45	63.55
Female	33.5 cm	73.71	63.41	73.68	61.9	68.69

DISCUSSION

The present study, carried out among adult population of central India, is one of its kind, which was conducted with the hypothesis that neck circumference could be a useful tool to screen for hypertension. This study showed that NC was significantly associated with HT. A weak positive correlation (r=0.274 in males and r= 0.265 in female) was found between NC and SBP in both the genders, whereas no correlation was found between DBP and NC. Also a moderate correlation (r= 0.606 in males and r= 0.511 females) was seen between NC and BMI, a common measure of obesity which is also a proven risk factor for HT.

In a study conducted by Ben- Noun et al in 2004, a significant correlation was found between SBP and NC (men, r = 0.40; women, r = 0.58; each, P = 0.0001) and between DBP and NC (men, r = 0.42; women, r =0.53; P=0.0001).17 Ben- Noun et al also showed a positive correlation between changes in NC and changes in BP (r= 0.54 in males; r = 0.56 in females, each P<0.0001). (17)

The findings of the present study are in concordance with other studies conducted by Joshipura K et al, Alfie J et al and Ben-Noun et al. (4,6,8) Whereas in the study conducted by Liang J et al, NC was associated with SBP and DBP in univariate analysis, but after adjusting for BMI and WC, the association was weak.(18) A case control study conducted by Kuciene R et al amongst adolescents in Lithuania also showed that NC is associated with HTN.(19) The studies conducted by various authors have also shown positive correlation between NC and BMI, which is similar to the finding of the present study.(20,21)

Upper body fat distribution is related to increased cardiovascular disease risk.(22) The association between neck fat and metabolic syndrome and its components may be attributed to an excess release of free fatty acids into plasma from the upper body subcutaneous fat which is found to be larger in size than that from lower-body subcutaneous fat.(12,23) This further strengthens the relevance of measuring upper-body subcutaneous adipose tissue depots, by measuring NC, to identify cardiovascular risk factors like hypertension and obesity.

In the present study, ROC analysis was carried out to evaluate NC as a screening tool for hypertension; AUC was 0.652 (p = 0.007) for male and 0.68 (p = 0.002) for female. The cut of values of neck circumference was derived to be 36.5cm for male and 33.5 cm for female. The sensitivity, specificity and diagnostic accuracy of cut-off value for male was 74%, 54.39% and 63.55% respectively and 72.71%, 63.41 and 68.69%. No studies have estimated the cut-off values of NC for screening HT. various studies have estimated the cut of values of NC for assessing obesity and overweight which is also a risk factor for hypertension. Ben- Noun L et al in his study in Israel found that NC >37 cm for men and >34 cm for women were the best cut-off levels for determining the subjects with BMI >25.0 0 kg/m2 using the ROC analysis where sensitivity, specificity and diagnostic accuracy was 98%, 89% and 94% respectively for men, and 100%, 98% and 99% respectively for women. (7) The cut-offs derived in this study is almost similar to the study by Ben- Noun L et al, but having lower sensitivity, specificity and diagnostic accuracy.(7) Kumar S et al in his ROC analysis showed that AUC for NC and BMI >25 kg/m2 was 0.89 for men and 0.91 for women, respectively; cut off value for NC ≥ 38 cm for men and ≥ 34.7 cm for women were seen to be the best cut-off points for determining subjects with overweight.(20) NC >36cm for males and >32cm for females was the best cut-off levels for determining the overweight/obese subjects in the study conducted by Aswathappa J et al.(21) The slight variations in the cut off could be attributed to the difference in ethnicity and geographic distribution of the study population of the different studies.

The present study has some selection bias as the subjects were randomly selected from the patients attending the OPD of UHTC. Also due to the fact that this was an OPD based study, there are chances that the patients could already have multiple risk factors for

hypertension. So further community based study is indicated to minimize this bias. Though utmost care was taken while collecting data, this study would not be free from instrumental bias and measurement bias occurred during measuring NC and BP.

CONCLUSION

This study has shown correlation between HTN and NC and evaluated the use of NC as a potential anthropometric marker and derived the cut off values that can be used for screening hypertension in the adult population of central India. The correlation seen in this study was of less magnitude, but a larger study with more representative samples from the community will improve the strength of correlation. Measuring neck circumference is less cumbersome, more convenient, more feasible, easy to understand and socially acceptable. Social workers can measure NC to screen masses for hypertension with simple measuring tape with only limited training. Further studies should be conducted in this context in different settings and population and if consistent results are achieved, neck circumference should be included in guidelines and recommended for assessing hypertension in the population.

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