ORIGINAL RESEARCH PAPER

General Medicine

RELATIONSHIP OF NECK CIRCUMFERENCE TO METABOLIC SYNDROME

KEY WORDS: Metabolic Syndrome, Neck circumference, Non communicable diseases

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ABSTRACT

Neck circumference has been investigated as a screening instrument for overweight individuals because it is easy to measure, inexpensive, noninvasive, and unlike waist circumference, it does not vary throughout the day. Moreover, neck circumference correlates with many fat-related anthropometric measurements and cardiovascular risk factors.The study was carried out from September, 2019 to August, 2021 in a total of 367 patients. Metabolic syndrome was present in 71.9% of male and 75% of females. Overall 73.3% of the patients were diagnosed to have Metabolic syndrome which was significant, p=0.063+. NC> 37cmfor males &> 34cm for females was the best cutoff levels for determining the overweight/obese subjects.Correlation of MetS with neck circumference, waist circumference and waist /hip ratio were statistically highly significant, p-value <0.001. Area under ROC curve analysis showed that neck circumference, waist circumference, hip circumference, waist/hip ratio showed significant p value <0.001**. NC with metabolic syndrome with area under the curve was 74.5 % .The cut off for NC was > 35.5cms, sensitivity of 62.8% and specificity of 77.6%.

INTRODUCTION

Cardiovascular diseases, cancers, chronic respiratory diseases, diabetes, and other non communicable diseases (NCDs) are estimated to account for 60% of all deaths in India.1The metabolic syndrome (syndrome X, insulin resistance syndrome) consists of central obesity, hypertriglyceridemia, low levels of high-density lipoprotein (HDL) cholesterol, hyperglycemia, and hypertension that confer increased risk of cardiovascular disease (CVD) and diabetes mellitus (DM).2Insulin resistance, increased circulating fatty acids, leptin resistance, oxidative stress, low adiponectin, increase proinflammatory cytokines have been implicated in the pathogenesis of metabolic syndrome.3Neck circumference has been investigated as a screening instrument for overweight individuals because it is easy to measure, inexpensive, noninvasive, and unlike waist circumference (i.e. lack of a standard measurement technique, variations in certain health conditions), it does not vary throughout the day. Moreover, neck circumference correlates with many fat-related anthropometric measurements and cardiovascular risk factors.4Although obesity results in metabolic abnormalities, upper body obesity is more strongly associated with glucose intolerance, hyperinsulinemia, diabetes, hypertriglyceridemia, gout, and uric calculous disease than lower body obesity.5

AIMS AND OBJECTS

1.To study the relationship of neck circumference to metabolic syndrome.

2.To determine the reliability of neck circumference in comparison to waist circumference as a measure of metabolic syndrome criteria.

MATERIALS AND METHODS

This cross sectional study was carried out in the Department of Medicine, Regional Institute of Medical Sciences (RIMS), Imphal for a period of two years from September, 2019 to August, 2021. Both sexes aged>18 years and patients on drug treatment for hypertension, diabetes mellitus and dyslipidemia were included. Patients with unintentional weight loss due to malignancies, cardiovascular disease, type 1 diabetes mellitus, endocrine disorder and/or previous treatment with hormones or steroids, any neck swelling (example: goitre) or non-ambulatory patients, pregnant and lactating females were excluded. Convenience sampling was used to select the study participants. Neck circumference was measured to within 0.5 mm using a plastic tape which was calibrated weekly with participants asked to stand erect and their head positioned in the Frankfort horizontal plane. The superior border of a plastic tape placed just below the laryngeal prominence and applied perpendicular to the long axis of the neck.

Waist circumference was taken in midpoint between the lower margin of the last palpable rib and the top of the iliac crest with the subject standing and at the end of a gentle expiration with plastic tapes calibrated weekly to within 1 mm. (Normal value of WC for South Asians i.e.,<90 cm for males and <80 cm for females). Hip circumference was measured in midpoint between the lowest rib and the greater trochanter in the mid-axillary line. Height was measured using stadiometer to within 0.1 cm in bare feet. Body mass index (BMI=weight in kilograms / height in meter 2 [kg/m2]) ,WHpR (Waist Circumference divided by Hip Circumference) values were calculated. As per International Diabetes Federation (Global Consensus Definition) guidelines, high bloood pressure is defined as systolic blood pressure >135 mm Hg and/or diastolic blood pressure >85 mm Hg or taking antihypertensive drugs. RANIBOX XIMOLA auto-analyzer was used for measuring triglyceride and HDL cholesterol. International Diabetes Federation (Global Consensus Definition) guidelines was used for diagnosis of

dyslipidemia: Triglycerides: ≥ 150 mg/dL, HDL Cholesterol: Men: < 40 mg/dL and Women: < 50 mg/dL. Fasting glucose: ≥ 100 mg/dL(5.6 mmol/L) or use of medication for hyperglycemia defined high blood sugar according to International Diabetes Federation (Global Consensus Definition).

STATISTICAL ANALYSIS:

Descriptive and inferential statistical analysis had been carried out in the present study. Significance is assessed at 5 % level of significance. Student 't' test (two tailed, independent) to find the significance of study parameters on continuous scale between two groups (Inter group analysis) and Leven1s test for homogeneity of variance had been performed. Pearson correlation was used to find the degree of relationship (co-efficient ranging between -1 to 1).Chi-square/ Fisher Exact test had been used to find the significance of study parameters on categorical scale between two or more groups.ROC curve analysis was performed to find the predictability of study variables for predicting the outcome.The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data .

Approval for conducting the study was obtained from the Research Ethics Board, RIMS. Informed written consent was taken from all patients.

RESULTS AND OBSERVATIONS

Table 1: Neck Circumference distribution of patients studied

Neck Circumference	Gender		Total
	Male	Female	
<30	5(2.5%)	0(0%)	5(1.4%)
30-40	194(97.5%)	158(94%)	352(95.9%)
>40	0(0%)	10(6%)	10(2.7%)
Total	199(100%)	168(100%)	367(100%)

P<0.001**, significant, Chi-Square test

P<0.001**, Significant, Chi-Square Test.

Table 2: Comparison of clinical variables according gender

variables	Gender		Total	P value
	Male	Female		
Age in years	58.66±14.73	58.91±13.66	58.77±14.23	0.866
Neck Circumference	37.04±2.22	34.36±2.00	35.59±2.50	<0.001**
SBP (mm Hg)	139.79±21.14	143.48±22.03	141.48±21.6	0.103
DBP (mm Hg)	85.36±12.63	88.45±15.16	86.77±13.91	0.034*
Height (cm)	162.08±7.36	159.36±6.69	160.83±7.19	<0.001**
Weight (kg)	67.18±10.43	65.51±12.20	66.41±11.29	0.160
Waist Circumference	85.28±11.39	92.52±11.01	88.59±11.78	<0.001**
Hip Circumference	95.56±11.03	100.43±11.12	97.79±11.32	<0.001**
Waist Hip Ratio	0.89±0.06	0.92±0.05	0.91±0.05	<0.001**
BMI (kg/m2)	25.56±3.54	25.81±4.54	25.68±4.02	0.566

Student t test

Mean NC among patients was 35.59± 2.50cms, males had bigger neck circumference with 37.04± 2.22cms, whereas females had 34.36±2.00cms. Mean waist circumference among patients was 88.59±11.78cms, females had bigger waist circumference with 92.52±11.01cms, whereas males had 85.28± 11.39cms. Correlation with neck circumference, height, waist and hip circumference, waist/hip ratio were statistically highly significant , p-value <0.001.

Table 3: Neck circumference in relation to other metabolic risk factors

		Karl Pearson correlation co-efficient r-value	p-value
Neck circumference	BMI	0.483	<0.001**
	Waist circumference	0.422	<0.001**
	Hip circumference	0.006	0.925
	Waist/hip ratio	0.436	<0.001**
	Systolic BP (SBP) (mm hg)	0.213	<0.001**
	Diastolic BP (DBP) (mm Hg)	0.102	0.026*
	FBS-Fasting blood sugar (mg/dl)	0.178	<0.001**
	Total cholesterol (mg/dl)	0.014	0.624
	LDL (mg/dl)	0.343	<0.001**
	HDL (mg/dl)	-0.163	<0.001**
	Triglyceride (mg/dl)	0.278	<0.001**
	Age in year	0.026	0.524

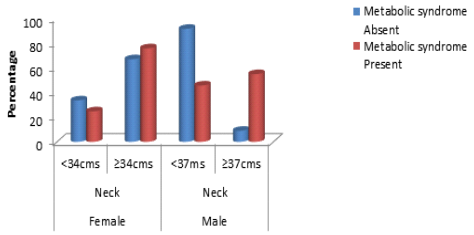
All individual parameter of metabolic syndrome risk factor except hip circumference and total cholesterol were highly significant in patient with abnormal NC when compared with those with normal NC.

Table 4: Distribution of neck circumference in relation to metabolic syndrome

Sex	Neck circumference		Metabolic syndrome		Total	P value
			Absent	Present		
Female	Neck	<34cms	14(33.4%)	31(24.6%)	45(26.7%)	<0.001**
		≥34cms	28(66.6%)	95(75.4%)	123(73.3%)	
	Total		42(100%)	126(100%)	168(100%)	
Male	Neck	<37ms	51(91.1%)	65(45.4%)	116(58.2%)	<0.001**
		≥37cms	5(8.9%)	78(54.6%)	83(41.8%)	
	Total		56(100%)	143(100%)	199(100%)	

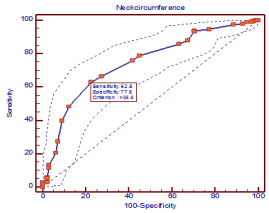
Chi-Square test

Figure 1: Distribution of neck circumference in relation to metabolic syndrome



Among females with NC <34cms, 24.6% had MetS, whereas among females with NC ≥34 cms, 75.4% had MetS. Among males with NC<37cms, 45.4% had MetS, whereas among NC≥ 37cms, 54.6% had MetS. This correlation was highly significant p<0.001**.

Figure 2. Area under ROC curve analysis of NC with metabolic syndrome. Area under the curve is 74.5 %. The cut off for NC was> 35.5cms, sensitivity of 62.8% and specificity of 77.6%.



DISCUSSIONS

The study included a total of 367 patients. Majority of the patients were male which accounted for 54.2 %, and females accounting for 45.8% of the study group. The most common clinical diagnosis was cerebrovascular accident(CVA) which was present in 42.8% of the patients, 14.9% of the patients had acute coronary syndromes and poorly controlled hypertension and diabetes accounting for 15.5% of the patients. We found that neck circumference had positive correlation with systolic and diastolic blood pressure, p-value for systolic and diastolic blood pressure being < 0.001 and 0.027* respectively. Ben Noun et al4 also found that changes in systolic BP and diastolic BP correlated positively with changes in NC and other components of the metabolic syndrome. Mean BMI in our study with metabolic syndrome was 25.81±4.19 kg/m2, mean NC was 36.12± 2.34cms and p-value was <0.001 which was statistically significant. The most widely used index of excess body fat is the BMI. However, recent studies have shown that regional (central) adiposity rather than total body fat is a more serious clinical entity. Unfortunately, BMI is a poor descriptor of central adiposity.6In our study, NC moderately correlated with common indices of obesity such as BMI, WC, W/H ratio(P<0.001) indicating that NC could be a useful screening tool for high BMI in adults. Relationships between obesity and health risks vary between populations. Asians, forexample, are more susceptible and thus BMI risk thresholds are lower than other populations,with an action point for overweight defined at 23 kg/m2.In our study, metabolic syndrome was present in 71.9% of male and 75% of females. Overall 73.3% of the patients were diagnosed to have metabolic syndrome which was significant, p=0.063+. This was almost similar to the Indian study by Nagendran et al7where 63.1% of the study population were found to have MetS.

In our study, MetS was present in 269 participants according to criteria of International Diabetes Federation (Global Consensus Definition).8Among females with NC <34cms, 24.6% had MetS, whereas among females with NC ≥34 cms, 75.4% had MetS. Among males with NC<37cms, 45.4% had MetS, whereas among NC≥ 37cms, 54.6% had MetS. This correlation was highly significant p<0.001**. So NC with MetS correlated more with female than with male. We also observed neck circumference was more strongly associated with adverse risk factor levels in women compared with men. Out of 269 participants with MetS, the mean NC was 36.12±2.34cms, whereas in 98 participants without MetS, the mean NC was 34.12±2.34cms, which yields a t-value of 7.263 and p<0.001** which was highly significant. In our study, there was significant increase in NC in males as compared to females (P<0.001).The difference in free fattyacid storage between men and women may account for thestronger association we found between neck circumferenceand metabolic syndrome risk factors among women. All individual parameter of metabolic syndrome were highly significant in patient with abnormal NC when compared with those with normal.

Correlation of MetS with neck circumference, waist circumference and waist/hip ratio were statistically highly significant, p-value<0.001. Our study confirmed previous findings in adults done by Ben Noun et al9who found that validated group had >37cm for males & 34 cm for females as the cutoff for the BMI of >25kg/m2 that NC strongly correlated with BMI and could indeed be used as an additional and practical screening tool for identifying males & females who are obese.

Area under ROC curve analysis showed that neck circumference, waist circumference, hip circumference, waist/hip ratio showed significant p-value <0.001**. NC with metabolic syndrome with area under the curve was 74.5 %. The cut off for NC was > 35.5cms, sensitivity of 62.8% and specificity of77.6%.

CONCLUSION

Our observations indicate that neck circumference (NC) as an index of upper body fat distribution can be used to identify metabolic syndrome.

NC positively correlated with other indices of obesity in males & females.NC> 37cmfor males &> 34cm for females was the best cutoff levels for determining the overweight/obese subjects.

LIMITATIONS OF THE STUDY

This crosssectional design study limited extension of its interpretationto the causality of associations.Selection bias could not be excluded. Because the survey was completed in a single visit, the inherentvariability in laboratory tests and measurementscould not be taken into account.

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