Original Article

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Neck Circumference as a Marker for Obesity and its Association with Metabolic Syndrome

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Abstract

Background: To Study the relationship of measuring neck circumference as a marker for obesity and to assess the association of neck circumference and metabolic syndrome. **Subjects and Methods:** Patient fulfilling inclusion and exclusion criteria were diagnosed as metabolic syndrome based on criteria. A cut off value of Neck Circumference was calculated and association between increased neck circumference and different parameters of Metabolic Syndrome was evaluated. **Results:** 23.90% Subjects had normal NC whereas 76.10% had high NC. The mean NC among the study subjects was 38.18±2.43.High NC was seen in 62.79% males and 81.03% females. Mean age of subjects having high NC was 52.04 ±9.82 years. Mean weight for subjects was 78.37 ± 9.45 kgs. Mean BMI for subjects was 33.24 ± 5.62 kg/m2. Mean SBP was 135.21 ± 8.42 mmHg and DBP was 86.08 ± 4.98 mmHg Mean FBG was 144.78 ± 41.02 among subjects with high NC. The mean triglycerides were 163.75 ± 42.19, mean HDL was 38.96 ± 9.42, mean LDL was 114.11 ± 34.66, and mean VLDL was 33.67 ± 8.82.The ROC among the scoring system was found to be highly significant. Overall NC cut off ≥38.0cm was found to be effective for evaluation of metabolic syndrome. In the study population, among males the cutoff value was 38.5 cm while the same was found to be 34.5 cm for females The sensitivity, specificity, positive predictive value and negative predictive value of Neck circumference in the prediction of metabolic syndrome is 87%, 100%,100%, 94% respectively. The accuracy rate of Neck circumference was 84.50%. **Conclusion:** Neck Circumference was revealed to be a better, simpler and more reliable independent anthropometric measurement as predictor of metabolic syndrome, adiposity and cardiovascular risk than BMI.

Keywords: Neck circumference, Obesity, Metabolic Syndrome

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Introduction

Obesity is described as an extreme accumulation of bodily adipose tissues, which has numerous health repercussions and leads to a shorter lifespan. Obesity has many health implications, becoming more common in both children and adults, which is alarming healthcare systems around the world.[1] VAT (Visceral adipose tissue) and SAT (Subcutaneous adipose tissue) and are two types of bodily fat stores. Visceral adiposity is more linked to increased Cardiometabolic risk factors. In men, VAT accounts for 10% to 20% of total body fat, while in women, VAT accounts for 5% to 10% of whole body fat. Obesity is well-known for causing metabolic disorders. It's possible that the distribution of excess adipose tissue is more relevant than total fat in determining metabolic and cardiovascular risk.[2–4] Obesity, mainly central obesity, is main contributor to Metabolic Syndrome or Syndrome X. Adiposity is measured using a variety of techniques, including CT, MR, &DEXA. Greater cost and technical limitations, this approach is not suitable for use as an epidemiological tool in the general population.[5] The World Health Organization now recommends using the body mass index, also known as the Quetelet index, to assess overweight &obesity.[6] As a result, the BMI is one of the most extensively used measures for determining adult and child weight status.[7] Despite the benefits of simplicity of measurement and interpretation, BMI has substantial limitations in that it does not accurately reflect body fat distribution.[8,9] Neck circumference (NC), on the other hand, is a very easy, trustable and cheap method of identifying overweight and obese people.[10,11] NC is a reliable quantity for obesity because it is a sign of upper body adiposity deposition. NC measurement is a quick & easy way to determine whether

or whether someone is overweight or obese.[12]

While BMI is widely used to measure obesity, it does not distinguish among fat and additional tissues such as muscles, nor does it count for fat distribution or its dispersion in the body. Measuring the circumference of the neck is simple, rapid, and inexpensive. Females find it difficult to measure their hip, thigh, or waist size due to cultural inhibitions in some areas. The cut-off for the CAI i.e. classic anthropometric indices such as BMI and WC, as well as their prognostic possible for Metabolic Syndrome, vary due to the variation in body size among diverse ethnic populations, and hence cannot always be relied upon.

This research was done to determine the reliability of NC as a marker of elevated metabolic risk factors &to establish a link between (NC & MS) Neck Circumference and metabolic syndrome.

Aim of the Study

To Study the relationship of measuring neck circumference as a marker for obesity and to assess the association of neck circumference and metabolic syndrome.

Material and Methods

Inclusion criteria

Adults 18 years and above presenting to Medicine Department who are diagnosed with metabolic syndrome and who gave consent.

Exclusion Criteria

1. Patients with known thyroid disorders
2. Patients with any neck swellings
3. History of previous neck surgery
4. Any Diseases affecting Neck Circumference
5. Pregnant Females

Procedure

Using a plastic tape measure, the neck circumference (cm) was measured to the nearest 1 mm. It was taken in a horizontal plane as much as feasible, right below the larynx (thyroid cartilage) and perpendicular to the neck's long axis. The shoulder/neck muscles (trapezius) must not be included in the measurement. Males' average height is 37 cm, while ladies' average height is 34 cm.

A cutoff value for Neck Circumference is computed, and a correlation is performed to see if there is a link between increased neck circumference and other Metabolic Syndrome characteristics.

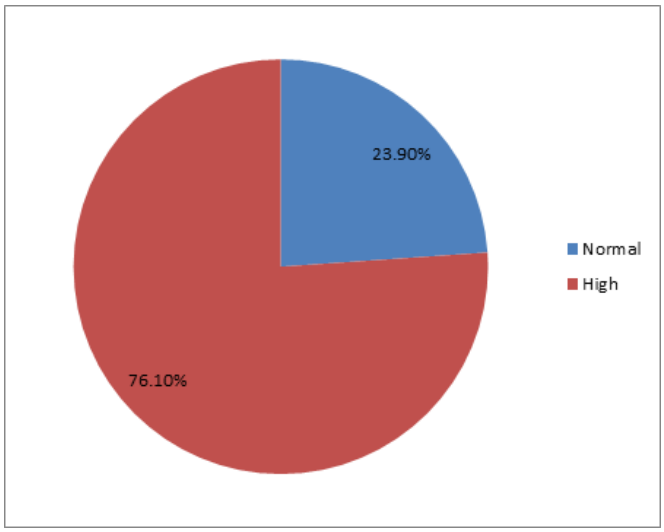

Figure 1: NC among the study subjects

Results

[Table 1 & Figure 1] showed the NC among the study subjects. It was seen that 23.90% had normal NC whereas 76.10% had high NC. The mean NC among the study subjects was 38.18±2.43.

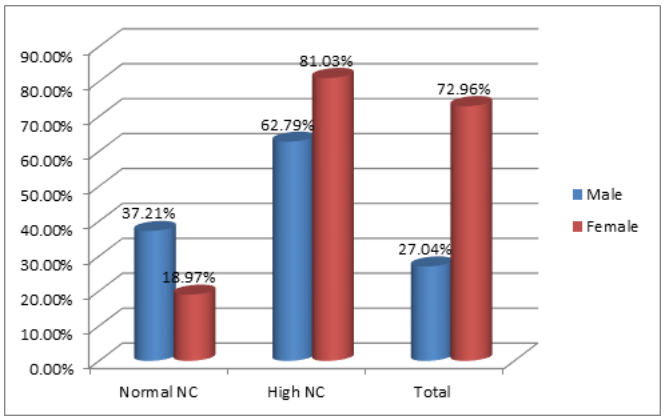

Figure 2: Gender distribution according to neck circumference

[Table 2 & Figure 2] showed the gender distribution according to neck circumference. It was found that normal NC was seen among 37.21% males and 18.97% females while High NC was seen in 62.79% males and 81.03% females. All the findings were not statistically significant.

[Table 3 & Figure 3] demonstrated the age comparison according to neck circumference. The mean age among the study subjects having normal NC was 47.93±10.02 years

Table 1: NC among the study subjects

NC	N=159	%
Normal	38	23.90
High	121	76.10
Mean±SD	38.18±2.43	

Table 2: Gender distribution according to neck circumference

Variables	Normal NC		High NC		Total		p value
	N	%	N	%	N	%	
Male	16	37.21	27	62.79	43	27.04	0.11
Female	22	18.97	94	81.03	116	72.96	
Total	38	23.90	121	76.10	159	100.00	

Table 3: Age comparison according to neck circumference

NC	Age (in years)		p value
	Mean	SD	
Normal	47.93	10.02	0.71
High	52.04	9.82	

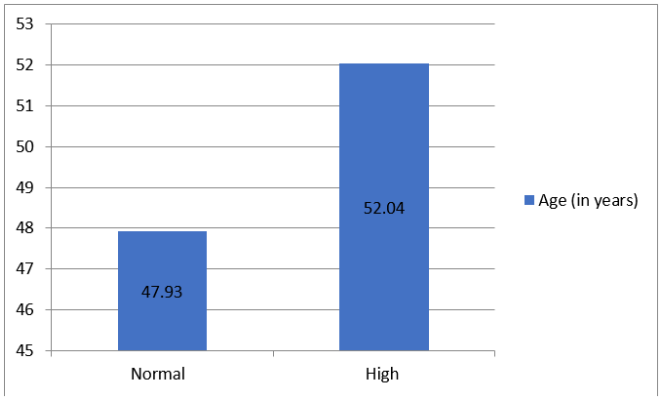

Figure 3: Age comparison according to neck circumference

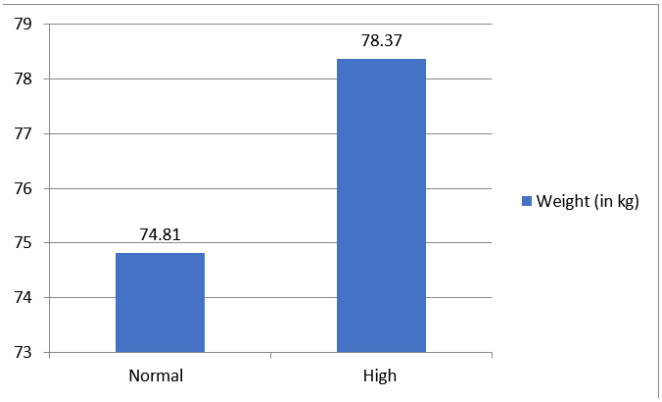

Figure 4: Weight (in kg) comparison according to neck circumference

while for study subjects having high NC was 52.04 ±9.82 years. The findings were not significant.

[Table 4 & Figure 4] illustrated the weight (in kg) comparison according to neck circumference. It was seen that mean weight among subjects with normal NC was 74.81±8.22 kgs while for subjects with high NC was 78.37 ± 9.45 kgs. The results were not significant statistically.

[Table 5 & Figure 5] showed the BMI comparison according to neck circumference. It was seen that mean BMI for subjects with normal NC was 29.72 ± 4.97 kg/m2 while for subjects with high NC was 33.24 ± 5.62 kg/m2. The findings were significant statistically.

[Table 6 & Figure 6] showed the comparison of BP according to neck circumference. The mean SBP was 124.64 ± 7.78 mmHg in subjects with normal NC and 135.21 ± 8.42 mmHg among subjects with high NC. The mean DBP was 76.83 ± 4.14 mmHg in subjects with normal NC and 86.08 ± 4.98 mmHg among subjects with high NC. All the findings were statistically significant.

[Table 7 & Figure 7] showed the FBG comparison according to neck circumference. It was seen that mean FBG was 112.54 ± 17.31 among subjects with normal NC, and 144.78 ± 41.02

Table 4: Weight (in kg) comparison according to neck circumference

NC	Weight (in kg)		p value
	Mean	SD	
Normal	74.81	8.22	0.08
High	78.37	9.45	

Table 5: BMI (kg/m^2) comparison according to neck circumference

NC	BMI (kg/m2)		p value
	Mean	SD	
Normal	29.72	4.97	0.031*
High	33.24	5.62	

*: statistically significant

Table 6: BP comparison according to neck circumference

NC	SBP (mm hg)		DBP (mm hg)	
	Mean	SD	Mean	SD
Normal	124.64	7.78	76.83	4.14
High	135.21	8.42	86.08	4.98
p value	0.005*		0.004*	

*: statistically significant

Table 7: FBG comparison according to neck circumference

NC	FBG		p value
	Mean	SD	
Normal	112.54	17.31	<0.01*
High	144.78	41.02	

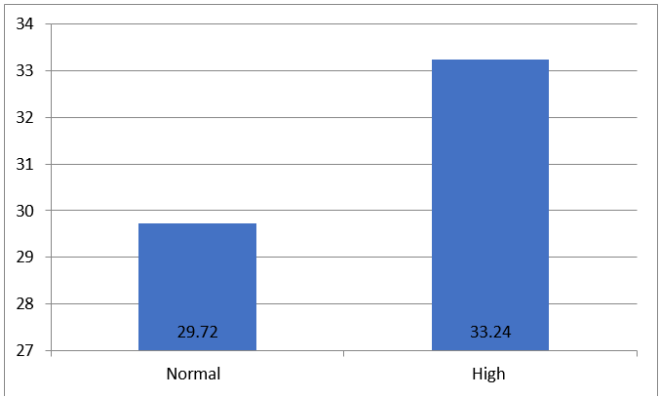

Figure 5: BMI (kg/m2) comparison according to neck circumference

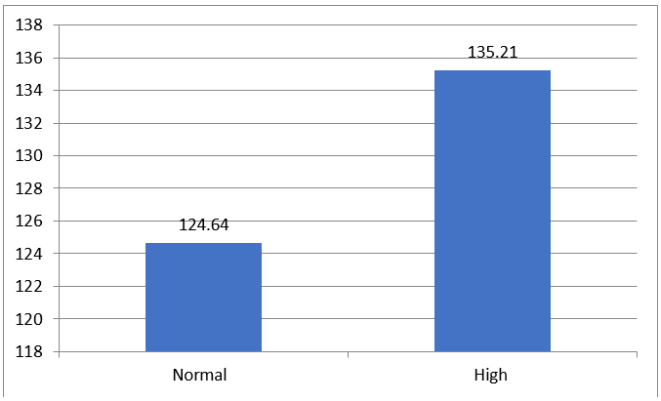

Figure 6: BP comparison according to neck circumference

among subjects with high NC. The results were statistically significant.

The results showed that among normal NC subjects, the mean triglycerides were 97.42 ± 24.56, mean HDL was 54.83 ± 11.27, mean LDL was 122.55 ± 32.69, and mean VLDL

Table 8: Lipid profile according to neck circumference

Variables	Normal NC		High		p value
	Mean	SD	Mean	SD	
Triglyceride	97.42	24.56	163.75	42.19	0.001*
HDL	54.83	11.27	38.96	9.42	0.003*
LDL	122.55	32.69	114.11	34.66	0.09
VLDL	19.04	5.31	33.67	8.82	0.003*

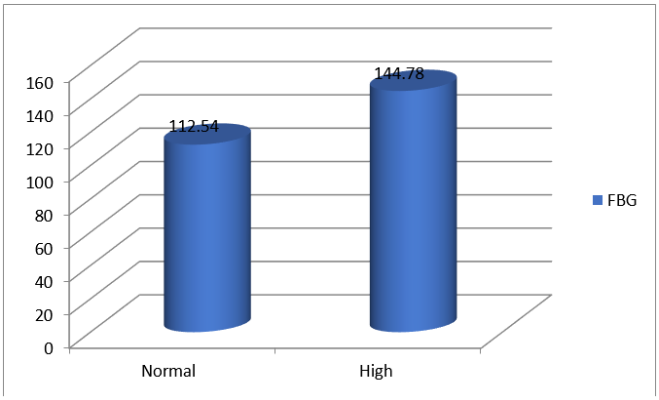

Figure 7: FBG comparison according to neck circumference

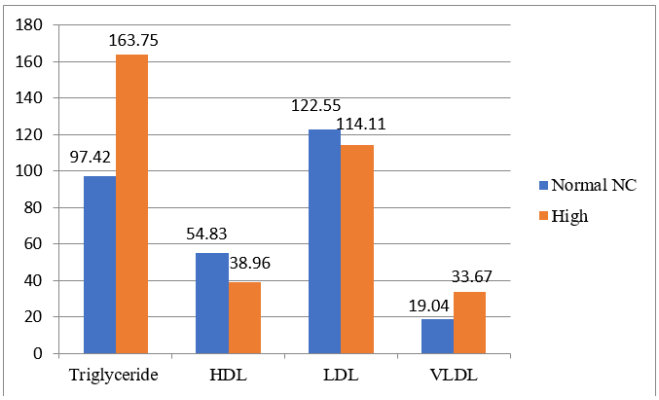

Figure 8: Lipid profile according to neck circumference

was 19.04 ± 5.31. Whilst among high NC subjects, the mean triglycerides were 163.75 ± 42.19, mean HDL was 38.96 ± 9.42, mean LDL was 114.11 ± 34.66, and mean VLDL was 33.67 ± 8.82. All the findings were significant statistically except for LDL.

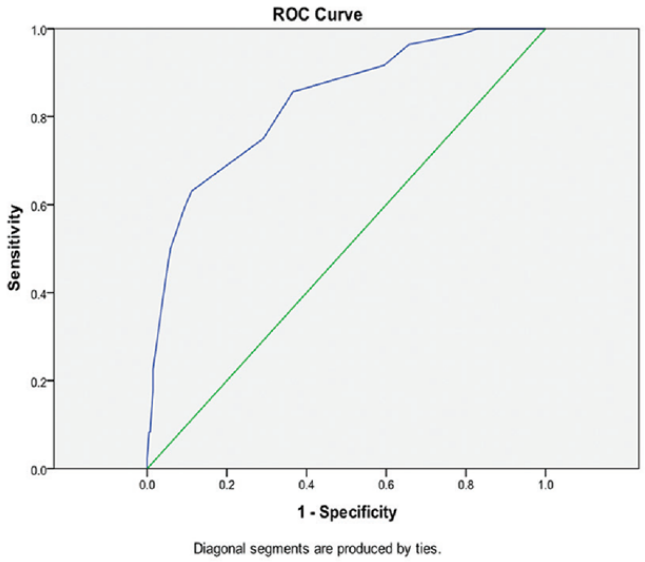

Figure 9: Receiver operating curve analysis of neck circumference with metabolic syndrome. NC cut off ≥38.0cm

Discussion

This study was a Hospital Based Observational Study that was conducted at Teerthanker Mahaveer Medical College & RC, Moradabad among 159 patients assessed.

in the Department of Medicine satisfying the inclusion and exclusion criteria for a period of 12 months. It was seen that 23.90% had normal NC whereas 76.10% had high NC. The mean NC among the study subjects was 38.18±2.43. A study done by Hai AA et al,[13] showed a neck circumference of 38 ± 4.6 cm. A study by Nagendran et al,[14] mean neck circumference was found to be 36.44 ± 2.6 cm.It was found that normal NC was seen among 37.21% males and 18.97% females while High NC was seen in 62.79% males and 81.03% females. All the findings were not statistically significant. A study by Nagendran et al,[14] shwed gender distribution as 82% females and 68% men as having high NC in metabolic syndrome. These findings were similar with

the current findings. The mean age among the study subjects having normal NC was 47.93±10.02 years while for study subjects having high NC was 52.04 ±9.82 years. The findings were not significant. The mean ± SD age of all the patients were 50.5 ± 9.6 years in a study done by Hai AA et al.[13] It was seen that mean weight among subjects with normal NC was 74.81±8.22 kgs while for subjects with high NC was 78.37 ± 9.45 kgs. The results were not significant statistically. The mean weight of 77.3 ± 15.3 kgs was seen among the subjects in a study done by Albassam RS et al.[15] It was seen that mean BMI for subjects with normal NC was 29.72 ± 4.97 kg/m2 while for subjects with high NC was 33.24 ± 5.62 kg/m2. A study done by Albassam RS et al,[15] and Hai AA et al,[13] showed the mean BMI of 32.5 ± 6.2 kg/m2 and 32.8 ± 5.7 kg/m2. The mean SBP was 124.64 ± 7.78 mmHg in subjects with normal NC and 135.21 ± 8.42 mmHg among subjects with high NC. The mean DBP was 76.83 ± 4.14 mmHg in subjects with normal NC and 86.08 ± 4.98 mmHg among subjects with high NC. Hai AA et al,[13] showed the mean SBP was 129.3 ± 16.5 mmHg, and mean DBP was 78.6 ± 10.7 mmHg. These findings were similar to the current study. It was seen that mean FBG was 112.54 ± 17.31 among subjects with normal NC, and 144.78 ± 41.02 among subjects with high NC. The results were statistically significant. In a study conducted by Hai AA et al,[13] the mean FBG was 145.8 ± 6.1. This finding was similar to the current study. Among normal NC subjects, the mean triglycerides were 97.42 ± 24.56, mean HDL was 54.83 ± 11.27, mean LDL was 122.55 ± 32.69, and mean VLDL was 19.04 ± 5.31. Whilst among high NC subjects, the mean triglycerides were 163.75 ± 42.19, mean HDL was 38.96 ± 9.42, mean LDL was 114.11 ± 34.66, and mean VLDL was 33.67 ± 8.82. All the findings were significant statistically except for LDL. The ROC among the scoring system was found to be highly significant. Overall NC cut off ≥38.0cm was found to be effective for evaluation of metabolic syndrome. Among males the cutoff value was 38.5 cm while the same was found to be 34.5 cm for females. The sensitivity, specificity, positive predictive value and negative predictive value of Neck circumference in the prediction of metabolic syndrome is 87%, 100% ,100%, 94% respectively. The accuracy rate of Neck circumference was 84.50%. Nagendran et al,[14] found that individuals with NC >37cm for males and >34cm for women are more likely to develop cardiac metabolic syndrome and require further examination, which is comparable to our findings.

Conclusion

In our research, Neck Circumference was revealed to be a better independent predictor of metabolic and cardiovascular risks than BMI which does not always give an accurate estimation of adiposity. Neck Circumference was discovered to be a simple, yet reliable, anthropometric indicator that can be utilized to improve Metabolic Syndrome and Adiposity screening and diagnosis, which would accelerate commencement of treatment and improve outcomes and patient welfare especially in the context of prevention of cardiovascular complications which have become a major health burden in a developing country like India.

Because of its ease of assessment, it can be used as a first step in screening for metabolic disorders connected to obesity especially in countries like India where there is a paucity of available tests in many regions as well as cultural inhibitions in measurement of other anthropometric methods in many demographics. More studies are needed to confirm the same link in a broader general Indian population as this study is based in a in a specific demographic area.

Limitations

There are some drawbacks to this study. First, because this was a cross-sectional study, the study's findings could not be applied to the entire population due to convenience sampling. After these constraints, we were able to make educated guesses about the utility of NC in the diagnosis of obesity and MS. Secondly, the sample size was insufficient to determine the prevalence of MS with appropriate precision.

Neck Circumference, on the other hand, offers potential as another measure for the metabolic and CV risks associated with central or visceral adiposity, given the strong and consistent relationships found in our research and similar findings from other populations in other studies.

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