Original Research Article

Association between neck circumferences and cardiometabolic risk factors

Mukhtarahmed Bendigeri, Ali Akbar, Dheeraj Kumar Reddy, Prakruthi Jaladhar*

Department of Medicine, Yenepoya Medical College, Mangalore, Karnataka, India

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*Correspondence:
Dr. Prakruthi Jaladhar,
E-mail: prakruthi30@gmail.com

ABSTRACT

Background: Anthropometric measures have been used for screening patients for cardiovascular abnormalities and metabolic syndrome since many years. There are numerous methods to assessing overweight and obesity, such as measurements of weight, height, waist circumference, hip circumference and calculation of waist hip ratio and BMI. Due to cultural inhibitions measurement of hip, thigh or waist circumference is cumbersome in females, neck circumference could be an acceptable option for such patients.

Methods: A cross-sectional study was conducted on patients attending the outpatient department in Yenepoya medical college Hospital between the period of May 2017 to May 2018. Total 201 patients chosen randomly in which 145 males and 56 females, fulfilling criteria of age >20 years were included. Pregnant females, patients with thyroid disorders, history of previous neck surgery were excluded.

Results: Out of the 201 population studied, Cardio metabolic syndrome was present in 94 participants according to criteria of NCEP ATP III. In our study there is a significant correlation between neck circumference and metabolic syndrome (p value <0.001).

Conclusions: Patients with Neck Circumference (NC) >37 cm in males and >34 cm in females are more prone for having cardio metabolic risk factors than patients with NC <37 cm in males and <34 cm in females. NC may be used as a simple and time saving screening measure to identify cardio metabolic risk factors in patients.

Keywords: Cardiovascular events, Cardiometabolic risk factors, Metabolic syndrome, Neck circumference

INTRODUCTION

A global transition in disease pattern has been observed, where the relative impact of infectious diseases is decreasing while chronic diseases like cardiovascular diseases and diabetes are increasing.[1] Epidemiologists in India and international agencies such as World Health Organization (WHO) have been sounding an alarm on rapidly rising burden of Cardiovascular diseases (CVD) for the past 15 years. It is estimated that by 2020, CVD will be the largest cause of disability and death in India, with 2.6 million Indians predicted to die due to CVD.

According to WHO, alarming increases in obesity are being observed in Asian countries, including India.[2]

Metabolic syndrome

The metabolic syndrome consists of a constellation of metabolic abnormalities that confer increased risk of cardiovascular diseases and diabetes mellitus.[3] The major features of metabolic syndrome include central obesity, hypertriglyceridemia, low high-density lipoprotein, hyperglycemia and hypertension. The Criteria for the metabolic syndrome according to National Cholesterol

Education Program, Adult Treatment Panel III: Presence of three or more of the following:

- Elevated waist circumference: Men - greater than 40 inches (102 cm). Women - greater than 35 inches (88 cm).
- Elevated triglycerides: Equal to or greater than 150 mg/dL/specific medication.
- Reduced HDL ("good") cholesterol: Men - Less than 40 mg/dL and Women - Less than 50 mg/dL.
- Elevated blood pressure: Equal to or greater than 130/85 mm Hg or use of medication for hypertension.
- Elevated fasting glucose: Equal to or greater than 100 mg/dL (5.6 mmol/L) or use of medication for hyperglycemia.

Neck circumference and obesity

Obesity is a state of excess adipose tissue mass. There are numerous methods to assessing overweight and obesity, such as measurements of weight, height, waist circumference, hip circumference and calculation of waist hip ratio and BMI. Due to cultural inhibitions measurement of hip, thigh or waist circumference is cumbersome in females. US preventive service task force recommends that all adults must be screened for obesity to prevent morbidity and mortality. And screening must be simple, least cumbersome, noninvasive and easily feasible like measurement of neck circumference. Various studies indicated that neck circumference may be independent correlate of metabolic risk factors beyond BMI and waist circumference.[4] Neck circumference is considered an index of upper body obesity and correlate positively with changes in systolic and diastolic blood pressure and other components of metabolic syndrome.[5] This study aims to establish an association between neck circumference and cardio metabolic risk factors.

METHODS

A cross-sectional study was conducted on patients attending the outpatient department in Yenepoya Medical College hospital between the period of May 2017 to May 2018. After obtaining the Ethical committee approval, informed written consent was obtained for participation in the study and for conduction investigations. Total 201 patients chosen randomly in which 145 males and 56 females, fulfilling criteria of age >20 years were included. Pregnant females, patients with thyroid disorders, history of previous neck surgery were excluded. Detailed history followed by complete physical examination of patients done. All anthropometric measurement was performed among all patients according to WHO guide lines and biochemical parameters to suggest cardio-metabolic risk factors were carried out among all participants.

NC was measured in the midway of the neck, between mid-cervical spine and mid anterior neck, to within 1 mm, using non-stretchable plastic tape with the subjects standing upright. In men with a laryngeal prominence (Adam's apple), it is measured just below the prominence. While taking this reading, the subject is asked to look straight ahead, with shoulders down, but not hunched. Normal values for neck circumference in males was <37 cm and females were <34 cm.[6]

Height was measured to the nearest cm, weight was measured to the nearest 0.5 kg with standard scales, and BMI (in kg/m^2) is calculated.

Waist Circumference (WC) was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of iliac crest.

Fasting lipid profile

LDL <100 mg/dl, HDL >40 mg/dl in men or >50 mg/dl in female, TC <200 mg/dl, TG <150 mg/dl, fasting blood sugar <100 mg/dl were considered normal. Cardio metabolic syndrome was diagnosed based on criteria of NCEP ATP III criteria. Statistical analysis done by using Chi-square test and Karl Pearson correlation coefficient.

RESULTS

In present study population of 201 patient, 145(72.1%) were males and 56 (27.9%) were females. All patients were above 20 years of age, 62% patients were between 41 to 60 years. In this study population, 96 patients had Diabetes mellitus, 73 patients had hypertension and 45 patients had ischemic heart disease. Out of 201 studied, cardio metabolic syndromes was present in 94 participants according to criteria of NCEP ATP III. Out of 94 participants 67 were males and 27 were females. Mean neck circumference with cardiometabolic risk factors is 37.02 cm and without cardiometabolic risk factors is 34.3 cm, which is a highly statistically significant (p value <0.001) correlation (Table 1).

Table 1: Neck circumference in cardiometabolic syndrome.

Metabolic syndrome	N C	Minimum	Maximum	Mean	Std. Deviation	T statistic	df	P value
Positive	94	32.0	41.0	37.021	1.9864	8.492	199	<0.001
Negative	107	28.0	39.0	34.308	2.4750			

Table 2: Neck circumference and cardiometabolic syndrome in males.

Neck Circumference		Metabolic syndrome		Total
		Positive	Negative	
>37 cm	Count	34	9	43
	% within NC	79.1%	20.9%	100.0%
	% within M S	50.7%	11.5%	29.7%
<37 cm	Count	33	69	102
	% within NC	32.4%	67.6%	100.0%
	% within M S	49.3%	88.5%	70.3%
Total	Count	67	78	145
	% within NC	46.2%	53.8%	100.0%
	% within M S	100.0%	100.0%	100.0%

Table 3: Neck circumference and cardiometabolic syndrome in females.

Neck Circumference		Metabolic syndrome		Total
		Positive	Negative	
>34 cm	Count	23	6	29
	% within NC	79.3%	20.7%	100.0%
	% within M S	85.2%	20.7%	51.8%
<34 cm	Count	4	23	27
	% within NC	14.8%	85.2%	100.0%
	% within M S	14.8%	79.3%	48.2%
Total	Count	27	29	56
	% within NC	48.2%	51.8%	100.0%
	% within M S	100.0%	100.0%	100.0%

Table 4: Correlation of neck circumference with various cardiometabolic risk factors.

Total		Age	BMI	SBP	DBP	FBS	Cholesterol	HDL	LDL	TG	Waist	Height	Weight
Neck circum	r-value	.013	.758	.382	.300	.282	.338	-.095	.229	.424	.822	.336	.761
	p-value	.859	.000	.000	.000	.000	.000	.179	.001	.000	.000	.000	.000
	N	201	201	201	201	201	201	201	199	201	201	201	201
Males	r-value	-.128	.662	.111	.054	.256	.445	-.008	.331	.427	.786	.121	.644
	p-value	.126	.000	.183	.521	.002	.000	.920	.000	.000	.000	.147	.000
	N	145	145	145	145	145	145	145	143	145	145	145	145
Females	r-value	.291	.876	.384	.249	.442	.309	-.125	.198	.407	.885	.045	.845
	p-value	.029	.000	.004	.064	.001	.029	.358	.143	.002	.000	.743	.000
	N	56	56	56	56	56	56	56	56	56	56	56	56

In males with neck circumference >37 cm, 79.1% had cardio metabolic syndrome, while in males with neck circumference <37 cm, 32.4% had cardiometabolic syndrome (Table 2). In females with neck circumference >34 cm, 80% had cardio metabolic syndrome, while in females with neck circumference <34 cm, 15% had cardiometabolic syndrome (Table 3). We observe a significant association of metabolic syndrome with neck circumference in both males and females with p value <0.001.

Authors observed a strong correlation between neck circumference and BMI, waist circumference and weight and moderate correlation with other parameters (Table 4).

Among 201 patients studied, 94 were positive for metabolic syndrome and 107 were negative for metabolic syndrome and there observed a significant difference in Age, NC, WC, Weight, BMI, SBP, DBP, FBS, HDL, LDL, cholesterol and triglycerides among them (Table 5).

DISCUSSION

Out of the 201 population studied, cardiometabolic syndrome was present in 94 participants according to criteria of NCEP ATP III.[7]

Among 145 males, 67 had metabolic syndrome.

Table 5: Correlation of metabolic syndrome with various cardiometabolic risk factors.

Metabolic syndrome	Males			
		N	Mean	SD	P value
Age	Positive	67	46.04	10.421	0.363
	Negative	78	44.27	12.656	
Neck circumference	Positive	67	37.366	1.9454	<0.001
	Negative	78	35.212	1.6701	
Waist	Positive	67	94.52	7.585	<0.001
	Negative	78	86.64	5.62	
Height	Positive	67	165.93	3.851	0.174
	Negative	78	166.81	3.905	
Weight	Positive	67	77.12	8.708	<0.001
	Negative	78	69.99	8.512	
BMI	Positive	67	27.721	2.5557	<0.001
	Negative	78	24.869	2.7885	
SBP	Positive	67	138.3	10.738	<0.001
	Negative	78	129.59	10.813	
DBP	Positive	67	86.57	9.111	0.001
	Negative	78	81.79	7.853	
FBS	Positive	67	134.22	53.842	<0.001
	Negative	78	104.83	23.023	
Cholesterol	Positive	67	205.31	36.438	<0.001
	Negative	78	176.04	43.198	
HDL	Positive	67	35.55	8.354	0.001
	Negative	78	41.18	11.258	
LDL	Positive	67	128.53	36.287	0.004
	Negative	78	110.26	37.662	
TG	Positive	67	221	102.868	<0.001
Metabolic syndrome	Females			
Age	Positive	27	49.52	12.122	0.016
	Negative	29	42.17	9.943	
Neck circumference	Positive	27	36.167	1.855	<0.001
	Negative	29	31.879	2.675	
Waist	Positive	27	91.19	7.174	<0.001
	Negative	29	81.28	6.643	
Height	Positive	27	157.85	4.321	0.836
	Negative	29	157.66	2.609	
Weight	Positive	27	69.33	7.338	<0.001
	Negative	29	56.17	8.177	
BMI	Positive	27	27.426	2.8618	<0.001
	Negative	29	22.121	3.1296	
SBP	Positive	27	120.22	14.98	0.013
	Negative	29	111.38	10.598	
DBP	Positive	27	75.19	10.874	0.018
	Negative	29	68.97	8.17	
FBS	Positive	27	136.56	42.523	<0.001
	Negative	29	100.59	10.318	
Cholesterol	Positive	27	202.22	41.949	0.104
	Negative	29	186.28	29.575	
HDL	Positive	27	39.37	9.153	0.184
	Negative	29	43.41	12.863	
LDL	Positive	27	126.37	38.748	0.628
	Negative	29	122	27.834	
TG	Positive	27	182.93	93.041	<0.001

Out of 43 males with neck circumference >37 cm, 34 (79.1%) were positive for metabolic syndrome and 9 (20.9%) were negative for metabolic syndrome, and out of 102 males with neck circumference <37 cm, 33 (32.4%) were positive for metabolic syndrome and 69 (67.6%) were negative for metabolic syndrome which showed a positive correlation of neck circumference with the presence of cardio metabolic syndrome in males.

In present study out of 56 females, 27 had metabolic syndrome. 29 females had neck circumference >34 cm and 27 females had neck circumference <34 cm. Out of 29 females with neck circumference >34 cm 23 (79.3%) were positive for metabolic syndrome and 6 (20.7%) were negative for metabolic syndrome, and out of 27 females with neck circumference <34 cm, 4 (14.8%) were positive for metabolic syndrome and 23 (85.2%) were negative for metabolic syndrome according to NCEP ATP III. So, neck circumference correlates positively with the presence of cardio metabolic syndrome in females also.

This study also showed that NC has positive correlation with body mass index and waist circumference. In a first cross sectional study by Ben noun et al, in 2001 which was done to identify overweight or obese patients solely by measuring the circumference of the neck, it was seen that men with NC >37 cm and women with NC >34 cm are not to be considered overweight.[8] In this study they used a test sample and a second validation sample included 979 subjects (460 men and 519 women), who visited a family medicine clinic in a southern Israeli urban district for any reason. They observed that NC >37 cm for men and >34 cm for women were the best cutoff levels for determining the subjects with BMI >25.0 kg/m2 using the receiver output curve analysis. In the validation unrelated group, the test characteristics were excellent with 98% sensitivity, 89% specificity, and 94% accuracy for men, and 100% sensitivity, 98% specificity, and 99% accuracy for women. In another study by Preis et al, examined an association between NC and cardiometabolic risk factors among participants in Framingham Heart study and found that neck circumference, VAT, and BMI independently contribute to cardiometabolic risk.[9] Kumar S et al, did a prospective cross sectional study, at Wardha hospital, to establish use of neck circumference as a simple screening measure of identifying overweight and obesity in rural Indian population and found that BMI correlated positively with NC, weight and height and finally they concluded NC may be simple and time saving screening measure of overweight and obese patient.[10]

Present study observed that NC has positive correlation with systolic and diastolic blood pressure also. Ben Noun et al, once again in 2004 observed relationship between changes in neck circumference and changes in blood pressure.[11] In this longitudinal cohort study the study group was comprised of 364 subjects (155 men and 209 women) with no known major medical conditions who were not receiving any medication therapy. They found that changes in systolic BP and diastolic BP correlated positively with changes in NC and other components of the metabolic syndrome.

In our study, NC were correlated with various metabolic parameters like LDL, HDL, Total cholesterol, triglycerides and Fasting blood sugar. Similarly, study done by Liubov et al, also found that NC was strongly correlated with SBP, DBP, total cholesterol, LDL-cholesterol, triglycerides, fasting glucose, and uric acid levels and thus the factors of metabolic syndrome.[12]

Among 201 patients, out of 145 males the Odds ratio of having positive metabolic syndrome with NC >37 cm is 0.127 times the odds ratio of having Metabolic syndrome with NC <37 cm. Out of 56 females the Odds ratio of having positive metabolic syndrome with NC >34 cm is 0.045 times the odds ratio of having Metabolic syndrome with NC <34 cm. Present study observations indicate that NC as an index for upper body fat distribution can be used to identify cardio metabolic syndrome. Yan Q et al, in a cross sectional study to explore the relationship of neck circumference to metabolic syndrome (MetS) and obesity in Chinese elders revealed that both waist circumference and neck circumference were independent predictors of Mets, with odds ratios (95% confidence interval) 1.11 (1.08-1.15; p = 0.044) and 1.17 (1.07-1.28; p = 0.000), respectively, in men and 1.08 (1.05-1.10; p = 0.000) and 1.31 (1.21-1.42; p = 0.000), respectively, in women.[13] Hingorjo et al, also concluded that neck circumference strongly correlated with adiposity indices and had a definite cut-off point. It can therefore be used as a useful adjunct for clinical screening of metabolic syndrome.

Strengths and limitations

This study adds to the current literature by showing that neck circumference is a correlate of cardio metabolic risk factors. Since our study was a hospital-based study, results may overestimate the true correlation between NC and cardio metabolic syndrome. Also, NC is a proxy for upper body fat ; we did not have radiographic measure to directly quantify this fat depoition.

The evaluation of the components of the metabolic syndrome was based on the guidelines of the NCEP ATP III. Other variables such as plasma insulin, leptin, C reactive protein and urinary excretion of cortisol and cathecholamines metabolites which can be increased in the metabolic syndrome, were not examined in the present study

CONCLUSION

Patients with NC >37 cm in males and >34 cm in females are more prone for having cardio metabolic risk factors than patients with NC <37 cm in males and <34 cm in females. NC may be used as a simple and time saving

screening measure to identify cardio metabolic risk factors in patients.

REFERENCES

1. Sawant A, Mankeshwar R, Shah S, Raghavan R, Dhongde G, Raje H, et al. Prevalence of Metabolic Syndrome in Urban India. Cholesterol. 2011;2011:1-7.
2. Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome-a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diab Med. 2006;23(5):469-80.
3. Kaur J. A Comprehensive Review on Metabolic Syndrome. Cardiol Res Pract. 2014;2014.
4. Onat A, Hergenç G, Yüksel H, Can G, Ayhan E, Kaya Z, et al. Neck circumference as a measure of central obesity: associations with metabolic syndrome and obstructive sleep apnea syndrome beyond waist circumference. Clin Nutr Edinb Scotl. 2009 Feb;28(1):46-51.
5. Zhou J, Ge H, Zhu M, Wang L, Chen L, Tan Y, et al. Neck circumference as an independent predictive contributor to cardio-metabolic syndrome. Cardiovasc Diabetol. 2013 May 16;12:76.
6. Ben-Noun LL, Laor A. Relationship between changes in neck circumference and cardiovascular risk factors. Exp Clin Cardiol. 2006;11(1):14-20.
7. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol In Adults 2001 Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA. 2011;285:2486-97.
8. Ben-Noun L, Sohar E, Laor A. Neck circumference as a simple screening measure for identifying overweight and obese patients. Obes Res. 2001 Aug; 9(8):470-7.
9. Preis SR, Massaro JM, Hoffmann U, D'Agostino RB, Levy D, Robins SJ, et al. Neck circumference as a novel measure of cardiometabolic risk: the Framingham Heart study. J Clin Endocrinol Metab. 2010 Aug;95(8):3701-10.
10. Kumar S, Gupta A, Jain S. Neck circumference as a predictor of obesity and overweight in rural central India. Int J Med Public Health. 2012;2(1):62-6.
11. Ben-Noun L, Laor A. Relationship between changes in neck circumference and changes in blood pressure. Am J Hypertension. 2004 May 1;17(5):409-14.
12. Ben-Noun L, Laor A. Relationship of neck circumference to cardiovascular risk factors. Obes Res. 2003 Feb;11(2):226-31.
13. Yan Q, Sun D, Li X, Zheng Q, Li L, Gu C, et al. Neck circumference is a valuable tool for identifying metabolic syndrome and obesity in Chinese elder subjects: a community-based study. Diab Metab Res Rev. 2014 Jan; 30(1):69-76.
14. Hingorjo MR, Zehra S, Imran E, Qureshi MA. Neck circumference: A supplemental tool for the diagnosis of metabolic syndrome. J Pak Med Assoc. 2016 Oct;66(10):1221-6.