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Neck height ratio is an important anthropometric predictor in metabolic syndrome

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Abstract

Introduction: *Neck height ratio (NHtR) and NC (neck circumference) have been suggested to measure of upper body adiposity. NHtR has the advantage over NC, as it adjusts for the differences in height. The aim of this study was to evaluate the role of NC and NHtR as an independent predictor of MetS (metabolic syndrome) among Indians*

Materials and Methods: *Present study is a cross sectional observational study, undertaken at Rajarajeshwari Medical College and Hospital, Bangalore, included 50 individuals, 30-80 years age, without comorbidities who gave informed consent underwent clinical, anthropometric and biochemical assessment, presence of MetS was ascertained using (NCEP ATP) 3 criteria.*

Results: *Patients with MetS in both sexes had significantly higher NC, NHtR, glycated HBA1C dyslipidaemia (elevated triglycerides, decreased HDL). The highest tertile of NC had significantly higher BMI, hypertriglyceridemia and MetS . BMI had the largest area under curve (AUC) for predicting MetS in males. NHtR had the highest AUC for predicting MetS in females. A logistic regression analysis, using MetS as the dependent variable, showed that the relationship between NC and MetS after adjusting for sex and age was statistically significant. NC of>32 cm/m and NHtR of >20 cm/m for both the genders were the best values in identifying MetS, it also showed that the relationship between NHtR and MetS was more significant.*

Conclusion: *NC and NHtR are important predictors of metabolic syndrome and neck height ratio has a higher predictive potential than NC.*

Keywords: *neck height ratio, neck circumference, metabolic syndrome, dyslipidaemia, Body mass index.*

Introduction

Body composition and fat distribution are associated with complications such as insulin resistance (IR), dyslipidaemia, diabetes mellitus type 2, and cardiovascular diseases (CVD) in adults [1]

Imaging studies and dual energy X-ray absorptiometry (DEXA) are the gold standard tools for evaluating body adiposity, but they are not applicable in all situations[2].

In clinical practice, anthropometric measurements such as body mass index (BMI), waist circumference (WC), and neck circumference (NC) are valued for being more accessible, making them easier to apply[3]. Studies have shown that upper body obesity was more significantly associated with glucose intolerance hyperinsulinemia hypertriglyceridemia[4].

In previous studies NC as an index of upper body obesity was found to be simple and time saving screening measure that can be used to identify overweight individuals[5]. NC is used as an alternative to WC, as it is not affected by postprandial abdominal distension and respiratory movements, and has shown consistent results for excess subcutaneous fat in the upper body[2][7]. Neck height ratio (NHtR) has also been suggested to be a measure of upper body adiposity like NC. NHtR has the advantage over NC, as it adjusts for the difference in NC attributable to differences in heights[8]

Materials and Methods

Present study is a hospital based cross sectional observational study, undertaken at Rajarajeshwari Medical College and Hospital, Bangalore,

Inclusion Criteria

50 individuals, 30-80 years age, without comorbidities who gave informed consent underwent clinical, anthropometric and biochemical assessment.

Exclusion Criteria

1) Cervical lymph nodes or deformities, neck swellings.
2) Type 1 diabetes, hypothyroidism, and hyperthyroidism
3) Patients on medications that can interfere with body composition and lipids such as anti- depressants, glucocorticoids, and anti- lipid medications
4) Patients not metabolically stable with uncontrolled blood glucose values on glucometer screening, viz. fasting/random blood glucose >300 mg/dl

- The collected blood samples were used for estimation of FBG, glycosylated haemoglobin (HbA1c%) and fasting lipid profile
- The presence of MetS was ascertained using the modified national cholesterol education program adult treatment panel (NCEP ATP) III criteria (ethnic specific cut-offs for WC viz. >90 cm in males and >80 cm in females) with the presence of three or more risk factors were considered diagnostic i.e.

1) Central obesity (waist circumference >90 cm for males and >80 cm for females)
2) Low HDL cholesterol (males<40mg/dl woman<50mg/dl, or under treatment)
3) Triglycerides (>150mg/dl, or under treatment)
4) Increased blood pressure (>130/85 mmHg or under treatment)
5) Fasting blood glucose (>100 mg/dL or under treatment) (1)

- Height was measured in all individuals using a wall mounted stadiometer and body weight measured using an electronic calibrated scale.
- BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m2).
- NC was measured using a calibrated plastic tape, with the head positioned along the Frankfurt plane, at middeck height, between the mid - cervical spine and mid - anterior neck, to within 1 mm. In men with laryngeal prominence, it was measured just below the prominence. A single observer in triplicate made all measurements and the mean of three readings was taken
- WC was measured at the end of a gentle expiration midway between the lower rib margin and iliac crest with the patient standing with feet 23–30 cm apart.
- All participants underwent detailed general physical and systemic examination

Stastical Analysis

Normality of the distribution of variables was checked using the Kolmogorov–Smirnov test. Continuous variables were expressed as mean ± standard deviation. $P < 0.05$ was considered as statistically significant. Chi-squared tests were used for categorical variables.

Pearson's or Spearman's correlation coefficient was calculated for normally and nonnormally distributed variables, respectively.

For categorical data, frequencies, and percentages were estimated.

The associations between metabolic risk factors and anthropometric parameters were assessed using partial correlation analysis. Receiver operating characteristic (ROC) analyses were performed to assess the accuracy of the anthropometric parameters as diagnostic tests for detecting MetS and determine optimal sex-specific NC cut-offs in relation to MetS. The Youden index, defined as (sensitivity + specificity)-1 was used to determine the optimal cut-off points.

SPSS version 16 (Chicago, IL, USA) was used for statistical analysis.

Results

In this study 33 patients were normoglycemic and 17 were diabetic out of which males constituted 20% of the cohort (10/50) and females 14%(7/50)

16 cases were hypertensive and 23 had hypertriglyceridemia.

Males had a higher incidence of diabetes, hypertension, dyslipidaemia and metabolic syndrome they also had a higher NC compared to females.

Patients with MetS in both genders had significantly higher NC, NHtR as compared to those without Mets. A NC of >32 cm/m (sensitivity 77.8% and specificity 80%) for men and >32 cm/m (sensitivity 90% and specificity 81.8%) for women were the best values in identifying MetS

Table 1 Baseline characteristics of the study population with regards to sex distribution and occurrence of metabolic syndrome (n=50)

Parameter	Males			Females			p-value (males vs. females)
	All (n=29)	With MetS (n=20)	Without MetS (n=9)	All (n=21)	With MetS (n=11)	Without MetS (n= 10)	
Age	57.00±12.510	55.60±11.789	58.50±13.518	50.48±14.236	51.38±13.711	47.60±17.170	0.092
HTN	10(34.5%)	4(26.7%)	6(42.9%)	6(28.6%)	4(25%)	2(40.)%)	0.169
SBP	135.72±10.885	136.93±10.053	134.43±11.953	135.52±19.421	135.63±22.202	135.20±6.099	0.035
DBP	84.21±8.946	84.93±9.059	83.43±9.095	80.48±7.891	85.06±8.209	70.00±5.0	0.095
Pre DM/T2DM	10(34.5%)	5(33.3%)	5(35.7%)	7(33.3%)	5(31.3%)	2(40.0%)	0.001*
BMI	25.686±4.154	25.973±4.8	25.379±3.486	24.49±3.847	25.084±3.261	24.304±4.092	0.001
Neck circumference	33.00±5.210	33.13±5.370	32.86±5.231	30.10±5.957	31.20±7.463	29.75±5.651	0.001*
NHt(cm/m)	20.398±2.756	20.768±2.671	20.0028±2.890	20.08±3.248	31.20±7.463	21575±3.496	0.117
FBS	129.83±47.385	115.53±37.828	145.14±52.979	132.62±61.839	166.40±67.759	122.06±58.096	0.857
HBA1c	8.145±10.8411	9.673±15.05	6.507±1.8248	6.133±0.8132	6.044±0.8809	6.420±0.5119	0.402
total chol	170.59±47.593	163.20±28.927	178.50±62.026	158.95±51.225	163.69±56.493	143.80±27.851	0.413
HDL	36.66±14.403	34.07±9.043	39.43±18.513	39.33±10.061	33.40±8.735	41.19±9.961	0.468
triglycerides	189.90±115.39	205.73±142.25	172.93±79.304	153.33±67.101	161.20±79.829	150.88±65.398	0.200
MetS	20(69.0%)			11(52.4%)			0.001

Table 2 Anthropometric and biochemical characteristics of the study studies as per the distribution of neck circumference

Parameters	Males(n=29)				Females(n=21)			
	Neck circumference			p-value	Neck circumference			p-value
	<25 th (<34cm) (n=12)	25-75 th (34-37.5) (n=13)	>75 th (>37.5) (n=4)		<25 th (<34cm) (n=17)	25-75 th (34-37.5) (n=4)	>75 th (>37.5) (n=0)	
Age	62.08±11.39	52.92±12.41	55±13.68	0.18	49.53±15.701	54.5±3.109	-	0.544
BMI								
Normal(<23Kg)	7(58.3%)	0	0	0.001	7(41.2%)	0(0.0%)	-	0.001
Overweight(23-27.5Kg)	3(25.0%)	5(38.5%)	2(50%)	0.001	8(47.1%)	3(75%)	-	0.001
Obesity(>27.5kg)	2(16.7%)	8(61.5%)	2(50%)	0.001	2(11.8%)	1(25.0%)	-	0.001
Pre DM/T2DM	4(33.3%)	3(23.1%)	3(75%)	0.16	4(23.5%)	3(75.0%)	-	0.08
MetS	5(41.7%)	11(84.6%)	4(100.0%)	<0.001	7(41.2%)	4(100.0%)	-	<0.001
hypertriglyceridemia	3(25.0%)	9(69.2%)	3(75%)	0.001	7(41.2%)	1(25.0%)	-	0.001

Individuals were divided into subgroups based on NC tertile Individuals with higher NC had greater central obesity significantly more BMI, dysglycemia and males had higher triglyceride and significantly more incidence of METs

Similar observations were noted in studies by ben-noun et al which showed that NC had positive correlation with traditional anthropometric indices like WC and BMI.

Neck circumference had a positive correlation with cardio metabolic risk factors hypertension dysglycemia dyslipidemia in both males and females and negative with HDL-C

These correlations grew stronger with NHtR and dysglycemia, TC and LDL-C, HDL-C in females and total cholesterol and HDL-C in males

Table 3 Correlation between anthrometric indices and cardio metabolic risk factors after adjusting of age

Parameters	SBP	DBP	FBS	PPBS	HBA1c	Total cholestrol	HDL	LDL-C	VLDL
Males(n=29)									
SBP	1	0.696**	0.042	0.144	-0.123	0.121	0.120	-0.002	-0.124
DBP	0.696**	1	0.037	0.152	-0.297	0.108	-0.003	0.110	0.493
FBS	0.042	0.037	1	0.745**	-0.095	0.336	-0.124	0.426*	0.832
PPBS	0.144	0.152	0.745**	1	0.122	0.386*	-0.005	0.425*	-0.521
HBA1c	-0.123	-0.297	-0.095	0.122	1	0.009	0.183	0.037	-0.492
total chol	0.121	0.108	0.336	0.386*	0.009	1	0.477**	0.916**	-0.593
HDL	0.120	-0.003	-0.124	-0.005	0.183	0.477**	1	0.213	-0.800
LDL-C	-0.002	0.110	0.426*	0.425*	0.037	0.916**	0.213	1	0.220
VLDL	-0.124	0.493	0.832	-0.521	-0.492	-0.593	-0.800	0.220	1
Females(n=21)									
SBP	1	0.334	0.062	-0.073	-0.152	0.025	-0.180	0.012	0.357
DBP	0.334	1	0.536*	0.604**	0.301	0.013	-0.226	0.240	-0.072
FBS	0.062	0.536*	1	0.836**	0.765**	-0.243	-0.599**	-0.098	0.757
PPBS	-0.073	0.604**	0.836**	1	0.790**	-0.261	-0.539*	-0.031	0.648
HBA1c	-0.152	0.301	0.765**	0.790**	1	-0.296	-0.327	-0.128	0.329
total chol	0.025	0.013	-0.243	-0.261	-0.296	1	0.311	0.642**	-0.270
HDL	-0.180	-0.226	-0.599**	-0.539*	-0.327	0.311	1	0.338	-0.666
LDL-C	0.012	0.240	-0.098	-0.031	-0.128	0.642**	0.338	1	-0.428
VLDL	0.357	-0.072	0.757	0.648	0.329	-0.270	-0.666	-0.428	1

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 4 Area under the ROC by different anthropometric indices as pre diabetics of metabolic syndrome and cardio metabolic risk factors(n=50**)**

Parameters	NC		WC		NHtR		BMI	
	AUC(95%CI)	P value	AUC(95%CI)	P value	AUC(95%CI)	P value	AUC(95%CI)	P value
Males(n=29)								
MetS	0.471(0.257-0.685)	<0.001	.414(0.203-0.626)	0.001	0.364(0.156-0.57)	0.001	0.483(0.267-0.699)	<0.001
Pre DM/T2DM	.387(0.153-0.62)	0.024	.539(0.313-0.76)	0.65	.424(0.202-0.646)	0.075	.518(0.296-0.74)	0.00 2
HTN	.521(0.287-0.755)	0.554	.582(0.338-0.825)	0.650	.574(0.348-0.8)	.521	.550(0.328-0.772)	0.663
Hypertriglyceridemia	.205(0.039-0.37)	<0.001	.231(0.051-0.411)	0.014	.138(0.005-0.271)	.001	.333(0.122-0.544)	0.127
Females(n=21)								
MetS	0.675(0.364-0.986)	<0.001	0.562(0.24-0.885)	<0.001	0.713(0.472-0.953)	0.160	0.587(0.288-0.887)	0.001
Pre DM/T2DM	.291(0.027-0.55)	0.026	.362(0.115-0.61)	0.314	.230(0.0-0.478)	.048	.265(0.039-0.491)	.086
HTN	.433(0.154-0.713)	0.540	.339(0.105-0.573)	<0.001	.450(0.170-0.73)	.726	.256(0.045-0.466)	.087
Hypertriglyceridemia	.255(0.065-0.471)	0.025	.274(0.051-0.497)	0.069	.293(0.069-0.518)	.119	.144(0.0-0.313)	.007

The area under curve was constructed(AUC) to evaluate the predictive values of anthropometric indices for MetS and its components
•The AUC for NHtR predicting MetS in males and females was 0.364 and 0.713 respectively.
•BMI had the highest AUC for predicting MetS in males and NHtR had the highest AUC for females
•3 out of 20 males and one out of 11 females with MetS had normal WC but a higher NC and NHtR.

Discussion

Visceral fat and abdominal subcutaneous fat has been traditionally measured using WC and WC is used as the standard index to identify patients with Metabolic syndrome in studies done by Cornier et al[10]. Studies by Aswathappa et al have shown that WC fails to identify a significant proportion of patients with cardiovascular diseases. Studies have shown that upper body subcutaneous fat is responsible for a much larger proportion of systemic free fatty acid release and then visceral fat as it is lipolytically more active than lower body adipose tissue[11] hence it may have a significant correlation to insulin resistance and dyslipidemia. Studies by Yang GR et al and Dutta et have used NC as an index of upper body subcutaneous fat and has been correlated with various cardiovascular risk factors[12][13]. Preis et al followed up participants from the Framingham heart study and noted NC correlated with development of multiple cardiovascular risk factors, it was found that NC was associated with CVD risk factors even after adjustment for VAT and BMI thus suggesting upper body fat may be a unique pathogenic fat depot[14]

In this study patients with metabolic syndrome had significantly higher NC, it had a positive correlation with cardio metabolic risk factors like hypertension dysglycemia and dyslipidemia which was in line with the studies by Grundy Scott et al[8][15]. NHtR ratio was better correlated with the above cardiovascular risk factors, this observation was in accordance with previous studies by Selvan et al[8]. BMI had the highest area under the curve for predicting MetS in males and NHtR had the highest AUC for females. NC and NHtR had a higher sensitivity in predicting patients with metabolic syndrome

A NC of >32 cm/m (sensitivity 77.8% and specificity 80%) for men and >32 cm/m (sensitivity 90% and specificity 81.8%) for women were the best values in identifying MetS similar results were found in previous studies by Ben noun et al and De Silva et al[6][2].

A logistic regression analysis, using MetS as the dependent variable, showed that the relationship between NC and MetS after adjusting for sex and age was statistically significant (odds ratio 1.561 [95% confidence interval [CI]: 0.83–1.112]; P =0.001).

Similarly, a NHtR of >20 cm/m (sensitivity 66.7% and specificity 95%) for men and >20 cm/m (sensitivity 80% and specificity 75.3%) for women were the best values of combined sensitivity and specificity in identifying MetS.

A logistic regression analysis, using MetS as the dependent variable, showed that the relationship between NHtR and MetS after adjusting for sex and age was statistically significant (odds ratio 1.951[95% CI: 0.772–1.336]; p=0.001)

NC and NHtR are good predictors of MetS and cardiovascular risk factors in Asian Indians. NHtR is more reliable and a better parameter than NC

NC and NHtR are convenient to measure as there is no need of any privacy for the patient as compared to WC and waist height ratio which may be socially less acceptable during community screening and certain circumstances

Conclusion

NC and NHtR are good predictors of MetS and cardiovascular risk factors in Asian Indians. NHtR is more reliable and a better parameter than NC

NC and NHtR are convenient to measure as there is no need of any privacy for the patient as compared to WC and waist height ratio which may be socially less acceptable during community screening and certain circumstances

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