Central obesity and coronary risk factors

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***Full title:** Relationship of waist circumference and waist-hip ratio with metabolic risk factors of coronary heart disease among Bengalee Hindu men of Kolkata, India*

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Key words

Bengalees; central obesity; metabolic variables

Abstract

A cross-sectional study of 130 Bengalee Hindu men (mean age=50.3 years; SD=10.5 years) was undertaken to investigate the relationship of body mass index (BMI), waist circumference (WC) and waist-hip ratio (WHR) with total cholesterol (TC), high density (HDL-C), low density (LDL-C) and very low-density (VLDL-C) lipoprotein cholesterol, fasting plasma glucose (FPG) and triglycerides (FTG). Correlation studies revealed that WHR was significantly correlated ($r=0.245$, $p<0.01$) with TC. WC and WHR had significant correlations with VLDL-C, FPG and FTG. All subjects were further divided into two groups based on WHR≤0.95 (centrally non-obese, CNO) and WHR>0.95 (centrally obese, CO) following the US Joint National Committee (JNC) guidelines. Students' t-test revealed that CO subjects (n=83) had a significantly higher mean TC ($p<0.05$), VLDL ($p<0.05$), FPG ($p<0.01$) and FTG ($p<0.05$) compared with CNO individuals (n=47). Results of analysis of variance (ANOVA) of central obesity status (CNO=no, CO=yes) and BMI (BMI tertiles used as a categorical variable) with these metabolic variables revealed that CO status had a significant effect ($p<0.05$) on TC, VLDL-C, FPG and FTG. BMI tertiles did not a have significant effect on any of these metabolic variables. There was no significant BMI tertile-central obesity status interaction. It can therefore be concluded that the JNC guidelines of WHR>0.95 to define central obesity can be used, irrespective of BMI, among this population, to identify individuals who have enhanced metabolic risk factors of coronary heart disease (CHD). Furthermore, it can be routinely used for health promotion purposes among Bengalee men.

INTRODUCTION

Obesity is now so common within the world's population that it is beginning to replace undernutrition and infectious diseases as the most significant contributor to ill health. In particular, obesity is associated with type 2 diabetes, coronary heart disease (CHD) and other associated disorders.[1] Vague[2] first suggested that body fat around the abdomen was related to diabetes and atherosclerosis in both men and women. However, there is no universally agreed way of measuring adiposity, nor is it known which measure is the best predictor of cardiovascular disease.

Several researchers have favoured waist to hip ratio (WHR) arguing that it is a simple, useful and better indicator of risk factors and a better predictor of CHD[3-6] than other used measures of adiposity such as body mass index (BMI) and waist to height ratio. In some recent studies[7] waist circumference (WC) has also been utilised to measure central adiposity. The relationship of WHR with risk factors of CHD has been investigated in different ethnic groups: native Americans,[8,9] Mexican-Americans,[7,10] African-Americans,[11] Melanesians,[12] and Central Asians.[13] These studies show that the association of central adiposity with metabolic risk factors is not the same at all levels of adiposity in all ethnic groups. A recent report of the Joint National Committee (JNC)[14] has suggested that a WHR>0.95 in males is associated with a higher coronary risk.

Asian Indians, both in India as well as migrants elsewhere, have unusually high rates of CHD.[15,16] Studies have investigated the relationship of BMI[17] and WHR[18-20] with risk factors of CHD among migrant South Asians. Although recent studies from India have investigated the association of WHR with hypertension[21] and other risk factors for CHD,[22,23] none of these studies have used the JNC cut-off point of WHR>0.95 to classify individuals as centrally obese. Although Dasgupta and Hazra[24] utilised the JNC cut-off point of WHR>0.95 to determine the prevalence of central obesity among Bengalee men and women, they did not study the relation of central obesity with metabolic risk factors of CHD. Therefore, no information is available on the relationship of WC and WHR with metabolic risk factors of CHD among Bengalees. The present study on Bengalee Hindu men had two

objectives: firstly, to investigate the relationship of BMI, WC and WHR with some metabolic risk factors of CHD; and secondly, to investigate the relationship of central obesity, at different levels of BMI, on metabolic risk of CHD.

METHODS

Study population

The present study was conducted during December 1999-July 2000 at the Outpatients Department of BR Singh Hospital, Eastern Railways, Calcutta, as part of a collaborative research programme between the Department of Anthropology, University of Calcutta and the Department of Pathology, BR Singh Hospital. Prior to the commencement of the study, written information regarding the aims, objectives and the criteria for eligibility were sent to all employees of the Eastern Railways at Kolkata. Any employee who belonged to the Hindu caste population and was more than 30 years of age was eligible to participate in this health check-up programme. The study sample was therefore representative of the general Bengalee Hindu male population.

Anthropometric and lipid profile measurements were made after the subjects had completed a questionnaire which requested information on their age, occupation, medical history, exercise undertaken and alcohol consumption. Only two subjects were receiving treatment either for high cholesterol or diabetes and they were excluded from the analyses. A total of 14 men had undiagnosed diabetes and they were included in the study since they formed a representative part of the population. Their inclusion did not bias the results when the data were re-analysed without them. The sample size of this study was 130.

Anthropometric measurements

Height, weight, waist and hip circumference measurements were made using standard techniques of Lohman *et al*[25] by a trained investigator (AG). Height and weight were measured to the nearest 0.1 cm and 0.5 kg, respectively. Waist and hip circumferences were measured with a tape to the nearest 0.2 cm. BMI and WHR were computed using the standard formulae:

WHR=waist circumference (cm)/hip circumference (cm)

BMI=weight (kg)/height^2 (m^2)

The JNC[14] criterion of WHR>0.95 was utilised as a cut-off point to define central obesity as suggested by several researchers.[24, 26] It is now widely accepted[26] that a WHR>0.95 in men is associated with lipid abnormalities and confers the highest risk of CHD. The JNC guidelines classify men into two groups: centrally non-obese (CNO) and centrally obese (CO). The cut-off points used were: CNO=WHR≤0.95; CO=WHR>0.95. There were 47 and 83 subjects, respectively, in these two groups.

Metabolic variables

A fasting blood sample was collected from each subject for the determination of metabolic variables. All subjects maintained an overnight fast (at least 12 hours duration) prior to blood collection. Plasma was separated by centrifugation at 1,000 x g for 20 min at room temperature within two hours of collection. Estimation of total cholesterol (TC), fasting plasma glucose (FPG) and fasting triglyceride (FTG) were carried out on separated plasma using a Technicon RA-XT autoanalyzer (Technicon Instruments Corporation, NY, USA). High-density lipoprotein cholesterol (HDL-C) was measured after an overnight stand of plasma in a refrigerator and then precipitation of non-high-density lipoproteins (LDL, VLDL, chylomicrons) with manganese-heparin substrate.[27]

Values of low-density lipoprotein cholesterol (LDL-C) and very low-density lipoprotein cholesterol (VLDL-C) were

Table 1

Anthropometric and metabolic characteristics of the study population

Variable	Mean	SD
Age (years)	50.3	10.5
Anthropometric		
Height (cm)	164.3	7.12
Weight (kg)	64.3	9.17
BMI (kg/m^2)	23.8	2.80
WC (cm)	86.0	7.00
HC (cm)	89.7	5.14
WHR	0.959	0.046
Metabolic		
TC (mmol/l)	5.5	0.92
HDL-C (mmol/l)	1.2	0.09
LDL-C (mmol/l)	3.3	0.74
VLDL-C (mmol/l)*	0.3	0.22
HDL/LDL ratio	0.4	0.09
FPG (mmol/l)	6.2	1.10
FTG (mmol/l)*	1.9	0.22

*Geometric means are presented

SD = standard deviation
HC = hip circumference
TC = total cholesterol
FPG = fasting blood glucose
WC = waist circumference
VLDL-C = very low density lipoprotein cholesterol
HDL-C = high density lipoprotein cholesterol
LDL-C = low density lipoprotein cholesterol
WHR = waist-hip ratio
FTG = fasting triglyceride

estimated using the following formulae[28]:

LDL-C=TC - (HDL-C + FTG/5)

VLDL-C=FTG/5

All biochemical analyses were carried out at the Biochemistry Unit of the Department of Pathology, BR Singh Hospital, Kolkata. All metabolic variables were measured in mg/dl and then converted into mmol/l by using the following standard conversion formula:

For TC, HDL-C, LDL-C and VLDL-C: value in mg/dl x 0.02586

For FTG: value in mg/dl x 0.01129

For FPG: value in mg/dl x 0.05551

Statistical analyses

The distributions of all variables and indices were checked for normality. The distributions of VLDL-C and FTG were significantly skewed. Log(10) transformations were undertaken to normalise their distributions. All statistical analyses of these two variables were performed on log(10) transformed values. Correlation studies were undertaken to investigate the associations of BMI, WC, WHR and the metabolic variables. Metabolic differences between CNO and CO were studied using Student's t-test. Finally, analysis of variance (ANOVA) was utilised to test the impact of BMI (BMI tertiles were used, first tertile=22.7 kg/m^2, second tertile=24.8 kg/m^2) and central obesity status (categorical variable: CNO=no; CO=yes) on metabolic variables. All statistical analyses were performed using the SPSS (Statistical Package for Social Sciences) Version 5 Package. Statistical significance was set at $p<0.05$.

RESULTS

The mean age of the subjects was 50.3 years (SD=10.5 years). The majority of the subjects (96%) had a sedentary lifestyle. None of them consumed alcohol. There was no significant relationship between age and the anthropometric variables and indices. Table 1 presents the means and standard deviations of the anthropometric and metabolic variables and indices of the subjects. Geometric means of VLDL-C and FTG are presented.

The associations of BMI, WC, WHR and the metabolic variables were studied utilising correlation analyses. Results (Table 2) revealed that WHR was significantly associated with TC (r=0.245), VLDL-C (r=0.230), FPG (r=0.177) and FTG (r=0.198). WC was significantly associated with VLDL-C (r=0.174), FPG (r=0.177) and FTG (r=0.175). BMI did not have significant association with any of the metabolic variables.

Since it was observed that WHR had significant relationship with various metabolic variables (Table 2), subjects were divided into two groups (CNO, n=47 and CO, n=83) following the JNC[14] criterion to compare their metabolic profiles. The mean age of both groups was similar (CNO=50.5 years, SD=9.6; CO=50.2 years, SD=11.1). Students' t-test revealed that CO subjects had significantly higher mean TC ($p<0.05$), VLDL-C ($p<0.05$), FPG ($p<0.01$) and FTG ($p<0.05$) compared with CNO individuals.

Since there were significant differences between CNO and CO subjects in TC, VLDL, FPG and FTG, ANOVA was undertaken to study the effect of BMI (BMI tertiles used as a categorical variable) and central obesity status (CNO=no; CO=yes) on these metabolic variables. Results (Table 3) revealed that CO status had significant effect ($p<0.05$) on TC (F=4.270), VLDL (F=5.488), FPG (F=5.826) and FTG (F=5.488). BMI did not have significant effect on any of these variables. Furthermore, there was no significant BMI-central obesity interaction for any of these metabolic variables. Moreover, CO subjects had greater mean TC, VLDL-C, FPG and FTG compared to the overall means. In each case, CNO individuals had lower means compared to the overall means.

DISCUSSION

Obesity causes or exacerbates many health problems, both independently and in association with other diseases.[29] Obese individuals with excess intra-abdominal fat are at particular risk of negative health consequences, with certain ethnic populations like migrant Indians carrying different levels of risk.[18] Total body fat appears to be a less important indicator of metabolic complications than the fat distribution pattern.

Although there is no universally agreed way of measuring central adiposity, WHR

Table 2

Pearson correlation coefficients (r) of BMI, WC and WHR with metabolic variables

	BMI		WC		WHR	
	r	p	r	p	r	p
TC	0.005	0.954	0.117	0.185	0.245	0.005
HDL-C	−0.075	0.398	−0.001	0.995	0.115	0.193
LDL-C	0.008	0.926	0.010	0.909	0.137	0.119
VLDL-C	0.051	0.565	0.174	0.048	0.230	0.020
FPG	0.149	0.091	0.177	0.042	0.177	0.042
FTG	0.047	0.599	0.175	0.046	0.198	0.024

BMI = body mass index
WC = waist circumference
WHR = waist-hip ratio
TC = total cholesterol
HDL-C = high density lipoprotein cholesterol
LDL-C = low density lipoprotein cholesterol
VLDL-C = very low density lipoprotein cholesterol
FPG = fasting blood glucose
FTG = fasting triglyceride

has been found to be the best predictor of cardiovascular disease.[5, 6, 26] A recent report[14] has suggested that a WHR>0.95 in males and WHR>0.85 in females is associated with higher coronary risk. However, the association of central adiposity with metabolic variables is not the same at all levels of adiposity in all ethnic groups.

This study indicated that there is a significant positive association of WC and WHR with TC, VLDL-C, FPG and FTG among Bengalee men. This implied that among Bengalee men, WC and WHR are associated with an enhanced CHD risk factor profile. Bose and Mascie-Taylor[20] in a study conducted in Peterborough, UK, also found that WHR was significantly related to TC among European and migrant Pakistani men. Similar results have been reported from other ethnic groups like African Americans[11] and native British.[30]

Moreover, based on the results of correlation analyses and ANOVA, the present study provided clear evidence that the BMI does not have a significant association with various metabolic risk factors of CHD. Bose and Mascie-Taylor[17] had also reported that the BMI was not significantly associated with TC and FPG among migrant Indians in Britain. It therefore appears that among Indians, both migrants[17] as well as residents in India (present study), central adiposity is more strongly associated with metabolic risk factors of CHD than BMI.

The presence of a significant positive relationship between WHR and CHD risk factors has limited epidemiological applications unless a specific cut-off point of WHR is used. A specific WHR cut-off point allows direct inter-individual as well as inter-population comparisons. In one study, Dasgupta and Hazra[24] have utilised the JNC cut-off point of WHR>0.95 to define central obesity among the Bengalee population.

The present study found that CO men had significantly greater means compared with CNO subjects for several metabolic risk factors for CHD. Results of ANOVA using central obesity status (CNO=no, CO=yes) and BMI (BMI tertiles) as categorical variables further demonstrated the significant effect of central obesity, and not of BMI, on these metabolic risk factors. Central obesity status had significant impact on these metabolic variables irrespective of the level of BMI. Moreover, there was no significant BMI tertile-central obesity status interaction. These results therefore provide evidence that the JNC cut-off point of WHR>0.95 can be utilised to identify individuals who are at greater risk of developing CHD among Bengalee men.

The only previous study from India[22] that compared metabolic risk factor profiles of CHD between CNO and CO subjects did not report any significant difference between the two groups. However, they had used a cut-off point of WHR=0.88 (median WHR) to define CNO and CO individuals; this is not an established cut-off point. Moreover, it may not be appropriate to use WHR=0.88 for use among adult Bengalee men since Gupta and Majumdar's study was not undertaken on Bengalees.[22] A further reason for recommending a cut-off point of WHR>0.95 among Bengalee men is that it would enable the comparison of prevalence rates of central obesity as well as lipid abnormalities associated with it in this population with data available from other ethnic groups.

Since there is vast ethnic heterogeneity in India, future studies should determine whether this cut-off point of 0.95 is 'ethnic-specific' to Bengalees or is applicable to others resident in India. Furthermore, similar studies on Indian women are needed to test the validity of the JNC[14] recommendations for this gender (WHR>0.85). The Indian Diaspora should be studied to determine whether the JNC guidelines can also be applied to them. The Indian Diaspora offers a unique opportunity to study the 'gene-environment' interaction involved in the aetiology of CHD. Although investigations from Britain[18, 20] have studied the relationship of

Table 3

ANOVA of central obesity status (CNO=no, CO=yes) and BMI tertiles with metabolic variables

Dependent variable		F	P
TC			
	BMI tertile	2.072	0.130
	Central obesity status	4.270	0.041
	BMI tertile-central obesity status interaction	0.007	0.993
VLDL			
	BMI tertile	0.180	0.836
	Central obesity status	5.488	0.021
	BMI tertile-central obesity status interaction	0.186	0.831
FPG			
	BMI tertile	0.193	0.825
	Central obesity status	5.826	0.017
	BMI tertile-central obesity status interaction	0.275	0.760
FTG			
	BMI tertile	0.180	0.836
	Central obesity status	5.488	0.021
	BMI tertile-central obesity status interaction	0.186	0.831

BMI = body mass index
TC = total cholesterol
VLDL-C = very low density lipoprotein cholesterol
FPG = fasting blood glucose
FTG = fasting triglyceride

WHR with CHD risk factors among migrant South Asians, no study has been undertaken on migrant Indians specifically using the JNC guidelines[14] for WHR as a marker for central obesity. Such studies when done in comparison with the native populations should yield valuable information on the ethnic susceptibility to central obesity and its relationship to CHD. Most importantly, prospective studies should be undertaken to obtain the optimum cut-off point to define central obesity among various Indian populations.

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