Original Article

Association of food patterns, central obesity measures and metabolic risk factors for coronary heart disease (CHD) in middle aged Bengalee Hindu men, Calcutta, India

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The association of central obesity measures and food patterns with metabolic risk factors for coronary heart disease (CHD) were studied among middle aged (≥ 30 years) Bengalee Hindu men of Calcutta, India. CHD risk factors included total cholesterol (TC), fasting triglyceride (FTG), fasting plasma glucose (FPG), high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol (VLDL-c). The total sample size in the study was 212 male individuals. Anthropometric measurements, metabolic and food pattern variables were collected from each participant. The relative role of central obesity measures and food pattern variables in explaining metabolic risk factors of CHD were also made in this study. The results revealed that body mass index (BMI) had no significant relation with any of the metabolic risk factors of CHD. Whereas almost all-central obesity measures, namely waist circumference (WC), waist-hip ratio (WHR), and conicity index (CI) were significantly and positively related with TC, FTG, FPG and VLDL-c. Of the food pattern variables, only the frequency of egg, fried snacks and Bengalee sweets consumption were positively and significantly related with all central obesity measures. In contrast, frequency of chicken and fish consumption was negatively associated with central obesity measures. Conicity index (CI) was found to be the most consistent in explaining metabolic variables of CHD. Percent of variance explained by central obesity measures and food patterns were TC (10%), FPG (16%), FTG (6.6%) and VLDL-c (6.7%). Significant negative association of chicken and fish consumption with central obesity measures indicates the beneficial effect of both these items in this population.

Key Words: central obesity, metabolic complication, waist-hp ratio, conicity index, waist circumference, food pattern, Bengalee Hindu, coronary heart disease, egg, fried snacks, sweets, fish, chicken, India.

Introduction

The prevalence of coronary heart disease (CHD) is known to be very high among Indians both in India and abroad. Moreover, CHD among Asian Indians occurs at least a decade or two earlier than that seen in Europeans.[1-3] The precise aetiology and mechanisms leading to the development of CHD catastrophe among Indians (both in India and migrants else where) remain incompletely understood. Yet it is quite clear that some risk factors of atherosclerosis (considered to be the leading cause of CHD) are particularly prevalent among the Asian Indian population namely, insulin resistance, glucose intolerance, central or abdominal obesity, hypertriglyceridaemia, and increased level of low density lipoprotein cholesterol (LDL-c).[1-4] Factors such as genetic predisposition (which appears to be mediated by elevated levels of lipoprotein (a) or Lp(a) and apolipoprotein (E) or Apo (E)) as well as changing lifestyle (including physical inactivity) may also increase the coronary risk profile among Indians both in India and abroad.[3,31]

It has been clear in the past few years that in addition to the amount of fat in the human body, its pattern of distribution is also important. A number of studies have shown that fat distribution pattern is a powerful predictor of coronary risk factors.[2,12,13,17,18] Obesity, as measured by body mass index (BMI), measures general obesity and does not take into account the detrimental effect of abdominal and intra-abdominal fat.[5,7,15,20] Central obesity measures, namely waist circumference (WC), waist-hip ratio (WHR) and conicity index (CI), are sufficient enough to measure abdominal obesity and are considered as indirect measures of intra-abdominal visceral fat deposition.[11,20] The intra-abdominal visceral deposition of adipose tissue, which characterizes upper body obesity, is a major contributor to the development of 'Syndrome X'. This includes cardiovascular disease and its risk factors such as dyslipidemia, hyper-tension, glucose intolerance and hyperinsulinemia.[15,16] Decreased physical activity and increased consumption of calories and saturated fat contribute to abdominal obesity,

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insulin resistance and atherogenic dyslipidaemia.[3] In contrast, smoking, can precipitate coronary attack and sudden death, particularly in those with other risk factors.[14] In spite of that, only a few studies have explored the association between smoking, alcohol consumption and body fat distribution on the one hand and metabolic risk factors for CHD on the other hand.[7-10]

As far as India is concerned, there have been limited studies investigating the role of abdominal obesity measures and food pattern variables simultaneously in explaining metabolic risk factors for CHD. In view of the above consideration, the present study was undertaken among the middle aged Bengalee Hindu men of Calcutta with the following objectives:

I. To study the relationship of central obesity measures with food pattern variables.
II. To study the relationship of central obesity measures with metabolic risk factors, namely total cholesterol (TC), fasting triglyceride (FTG), fasting plasma glucose (FPG), high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol (VLDL-c), of CHD.
III. To study the role of central obesity and food pattern variables in explaining metabolic risk factors for CHD.

Subjects and methods

Study population

The sample comprised 212 male railway employees of Eastern Railway, Government of India. They belonged to the Bengalee Hindu population and were aged 30 years and above. All 212 subjects were residents of Calcutta and its suburbs. The present study was conducted during the period of December 1999 to January 2001 at the out patient department (OPD) of B.R.Singh Hospital, Eastern Railway, Calcutta, India. The subjects of the present study were part of a health examination programme conducted during this period as part of collaboration between the Department of Anthropology, University of Calcutta and the Department of Pathology, B.R.Singh Hospital, Eastern Railway, Calcutta. Prior to the commencement of the programme, written information regarding the aims and objectives of the health examination programme were made available to different official departments of Eastern Railway, situated in Calcutta. The written information also outlined the criteria of selection of an individual to this health examination programme. In response, 230 Bengalee Hindu males, aged 30 years and above, contacted the OPD during the study period. However, a total of 220 male individuals ultimately participated in the programme. Of these, a total of 8 male individuals were excluded later because of missing data. Written consents about their willingness to participate in the programme were obtained from all 212 male individuals prior to the actual commence-ment of the study. The subjects were interviewed by the recorder (AG) in the OPD of the Hospital. All 212 individuals were engaged in non-manual work. Because of that they generally lead sedentary lives. Besides athro-pometric and metabolic variables, an open-ended schedule was used to collect food pattern variables from each participant. The responses to the open-ended schedule were free and spontaneous and respondents were not limited in their replies to a particular question posed to them. The sole purpose of using open-ended questionnaire in the study was to collect quantitative cross-sectional data on food patterns.

Anthropometric Measurements

Height, weight, circumferences of waist (WC) and hip were made using a standard technique[29] by one researcher (AG). Height and weight were measured to the nearest 0.1cm and 0.5kg respectively. Waist and hip circumferences were measured with an inelastic tape to the nearest 0.2cm. Body mass index (BMI) and waist-hip ratio (WHR) were computed using the standard formulae:

$$\text{BMI} = \text{Weight (kg)}/\text{Height}^2\ (\text{m}^2)$$

$$\text{WHR} = \text{Waist circumference (cm)}/\text{Hip circumference (cm)}$$

Conicity index (CI) was derived using the following equation:[5]

$$\text{CI} = \text{Waist circumference (m)}/(0.109) \times \sqrt{[\text{weight (kg)}/\text{Height (m)}]}$$

Metabolic Variables

A fasting blood sample was collected from each subject for the determination of metabolic variables. All subjects maintained an over night fast (≥12 hour) prior to blood collection. Plasma was separated by centrifugation at 1000xg for 20 minutes at room temperature within 2 hours of collection. Estimation of total cholesterol (TC), fasting triglyceride (FTG), fasting plasma glucose (FPG) was carried out on separated plasma using a Technicon RA-XT auto-analyser (Technicon Instrument Corporation, NY., USA). High density lipoprotein cholesterol (HDL-c) was measured after an overnight stand of plasma in a refrigerator. Non-high density lipoprotein, namely low density lipoprotein chole-sterol (LDL-c), very low density lipoprotein cholesterol (VLDL-c), and chylomicrons were precipitated with manganese-heparin substrate.[27] Values of LDL-c and VLDL-c were estimated using the following formulae:[26]

$$\text{LDL-c} = \text{TC} - (\text{HDL-c} + \text{FTG}/5)$$

$$\text{VLDL-c} = \text{FTG}/5$$

All biochemical analyses were done at the Biochemistry Unit of the Department of Pathology, B.R. Singh Hospital, Calcutta. All metabolic variables were measured in mg/dl and then converted into mmol/l by using the following standard conversion formulae:

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

Food pattern variables

Frequency of consumption (average consumption) of mutton, chicken, fish, egg, fried snacks and Bengalee sweets in a week were collected using an open-ended schedule. Other food stuffs such as vegetables, fruits, milk butter etc were also collected using the same schedule, but not incorporated in the analysis because of low average consumption of these items by the study population.

Statistical Analyses

The distribution of all anthropometric and metabolic variables and indices were checked for normality. The distribution of WC, hip circumference as well as WHR and CI were significantly skewed. The distribution of all the metabolic variables was significantly skewed except LDL-c. Log (10) transformation was under taken to normalize their distribution. Mean and 95% confidence interval of each of the anthropometric, metabolic and food pattern variables were computed. Spearman's correlation was performed to show the relationship between food pattern variables and central obesity measures. Pearson's correlation was performed to find out the relationship between central obesity measures and metabolic variables on log transformed values. Finally stepwise multiple regression analyses were undertaken in three steps. In step 1, food pattern variables were included in the model as independent variables against each of the metabolic variables (as dependent variables). In step 2, central obesity measures were included in the model as independent variables against each of the metabolic variables. Independent variables, which were significant against each of the metabolic variables in step 1 and 2, were put in step 3. In step 3, metabolic variables were programmed as dependent variables. All statistical analyses were done using the SPSS (Statistical Package for Social Sciences, PC+ Version 10) package. A P value of <0.05 was considered as statistically significant.

Results

The mean age of the participants was 50.78 years. The majority of subjects (96%) had a sedentary lifestyle. None of them consumed alcohol. Out of total participants, 145 individuals (68.4%) were smokers. All past smoker was classified ad non-smoker. Average frequency (number of days in a week) of egg, fried snacks, and Bengalee sweets consumption were 5.93, 5.72, and 5.58 respectively (Table 2).

To find out the relationship of central obesity measures namely WC, WHR, and CI with food pattern variables, Spearman's correlation was undertaken (results not shown). Results revealed that frequency of egg, fried snacks and Bengalee sweets consumption were positively and significantly associated with all central obesity measures. Pearson's correlation was undertaken between central obesity measures and metabolic variables, namely TC, FTG, FPG, HDL-c, LDL-c, and VLDL-c (Table 3). It revealed that all central obesity measures were significantly and positively associated with TC, FTG, FPG, and VLDL-c, except WC with TC. None of the central obesity measures were significantly associated with HDL-c and LDL-c. Similarly, no significant associations were seen between BMI and the metabolic variables (Table 3). Finally, stepwise multiple regression analyses were undertaken to find out the relative role of central obesity measures and food intake in explaining metabolic risk factors of CHD. Results (only significant ones) are shown in Table 4. The percent of variance explained by these variables were: TC 10%, FPG 16%, FTG 6.6% and VLDL-c 6.7%.

Table 1. Anthropometric characteristic, central obesity measures and metabolic variables of the study population (N = 212)

Variable	Mean	95% Confidence Interval	
		Lower bound	Upper bound
Anthropometric variables			
Age (in years)	50.78	49.40	52.16
Height (in cm)	164.88	164.06	165.71
Weight (in kg)	64.83	63.59	66.07
Body mass index (BMI Kg/m^2)	23.87	23.49	24.25
Waist circumference (WC)	87.25	86.33	88.13
Hip circumference	90.25	89.59	90.92
Waist-hip ratio (WHR)	0.96	0.960	0.971
Conicity index (CI)	1.27	1.27	1.28
Metabolic variables (mmol/l)			
Total Cholesterol (TC)	5.520	5.38	5.63
Fasting Triglyceride (FTG)	2.29	2.12	2.45
Fasting Plasma Glucose (FPG)	6.26	6.12	6.41
High Density Lipoprotein Cholesterol (HDL-c)	1.24	1.22	14.25
Low Density Lipoprotein Cholesterol (LDL-c)	3.27	3.18	3.37
Very Low Density Lipoprotein Cholesterol (VLDL-c)	1.05	0.977	1.12

Table 2. Mean and 95% confidence interval of mean of diet pattern variables in the study population (N= 212)

Variable	Mean	95% Confidence interval	
Frequency per week (in days)		Lower bound	Upper bound
Mutton consumption	1.86	1.49	2.14
Chicken consumption	4.40	3.87	4.93
Fish consumption	5.75	5.44	6.05
Egg consumption	5.93	5.48	6.38
Fried snacks consumption	5.72	4.34	5.09
Bengalee sweets consumption	5.58	4.71	5.97

Table 3. Pearson correlation coefficient (r) between central obesity measures

Variable	TC†	FTG†	FPG†	HDL-c†	LDL-c	VLDL-c†
BMI	0.030	0.060	0.091	-0.036	0.032	0.062
WC†	0.119	0.169**	0.202**	0.017	0.031	0.169**
WHR†	0.169**	0.163**	0.241**	0.039	0.029	0.163*
CI†	0.157*	0.198**	0.244**	0.095	0.047	0.189**

Significant at *P<0.05 **P<0.01; † = Log (10) transformed values were used.

Discussion

Obesity causes or exacerbates many health problems, both independently and in association with other deseases.[15] Obese individuals with excess intra-abdominal fat are at particular risk of negative health consequences with certain ethnic population like Indians (both in India and abroad) carrying different levels of risk.[2] Total body fat appears to be a less important indicator of metabolic complications than the fat distribution pattern.[11,19] The central body fat distribution, as measured by WC, WHR and CI, is considered to be the main determinant of Syndrome X. In turn, Syndrome X can pre-dispose an individual to CHD. On the other hand, central as well as intra-abdominal visceral fat accumulation are largely influenced by smoking, physical activity or inactivity, alcohol consumption, and food intake.[7,8] There have limited studies undertaken in India to investigate the relationship between central obesity measures and food intake or their relative role in explaining metabolic risk factors for CHD. In view of the above consideration, the present study was undertaken on middle-aged Bengalee Hindu men of Calcutta, India.

Significant (P<0.01) negative associations of chicken and fish consumption with central obesity measures indicated that they may have a beneficial effect in this population. On the other hand, the significant positive associations of egg, fried snacks and Bengalee sweets consumption with central obesity measures suggested that these foods may have an adverse effect. It is noteworthy to mention here that both fish and Bengalee sweet consumption was very high among Bengalee population. *Trans* fatty acids in the Indian diets are mostly derived from Vanaspati, [21] (hydrogenated vegetable oil) a type of cooking medium frequently used to prepare snacks and sweets. With widespread and increasing use of *Vanaspati*, intake of *trans* fatty acid is likely to increase further in the Asian Indian population[20] *Trans* fatty acids elevate the level of Lp (a), an independent risk factor for CHD.[22,29] This fact is critically important in Asian Indians where one of the highest levels of Lp (a) has been recorded and correlated to CHD.[23]

Significant associations between BMI and metabolic variables has not been reported in other studies concerning Indians.[24,25] However, neither of these studies examined in detail the relationship of central obesity measures with lipid profile. Here lies the uniqueness of the present study. This study and other studies fortify the fact that Indians (both in India and abroad) are at higher risk of the metabolic complication leading to CHD, even at lower BMIs. Significant positive associations of almost all central obesity measures with metabolic variables (TC, FTG, FBG, VLDL-c) indicate that among middle aged Bengalee Hindu men, central body fat distribution was more atherogenic than over-all adiposity. This result is in accordance with the finding that health risks associated with obesity occur in people with lower BMI in the Asia-Pacific region[30] - in particular, South Asians (Indians) have more centralized obesity for a given level of BMI compared to Caucasians.[2] Furthermore, percent of variance explained by central obesity measures, food pattern and metabolic variables were much greater for TC (R^2=0.100) and FPG (R^2=0.157). Of all the central obesity measures, CI was found to be most consistent in explaining metabolic risk factors of CHD.

Age, the only non-modifiable factor in the present study, had significant negative impact on FTG and VLDL-c. In our early study we found a significant negative association of age with CI among Bengalee Hindu men of Calcutta.[27] Furthermore, the atherogenic dyslipidaemia (concentration of HDL-c <0.9mmol/l), which is frequently considered to be a coronary risk factor for Indian populations, was absent in the study (mean HDL-c = 1.24 mmol/l or 47.95 mg/dl). This may have been due to frequent consumption n-3 PUFA by means of fish eating. The n-3 fatty acid found in fish oil lowers blood triacylglycerol concentration significantly and reduces CHD risk as well, in part, independently of their influence on lipoprotein concentration.[29] The major limitations accounted

Table 4. Stepwise multiple regression analyses of central obesity measures, life style pattern variables and diets with metabolic variables in the study population (N = 212)

	Dependent Variable = Total Cholesterol (TC)				
Independent variables	B	SEB	Beta	T	R^2Change
Frequency of Bengalee Sweets consumption per week	0.075	0.022	0.232	3.429***	0.031
Frequency of fried Snacks consumption per week	0.066	0.023	0.200	2.961**	0.034
Fonicity index	3.036	1.076	0.186	2.821**	0.034
			R^2=0.100		
	Dependent Variable = Fasting Triglyceride (FTG)				
Independent variables	B	SEB	Beta	T	R^2Change
Conicity index (CI)	4.481	1.428	0.211	3.138**	0.037
Age	-0.020	0.008	-0.170	-2.529*	0.029
			R^2=0.066		
	Dependent Variable = Fasting Plasma Glucose (FPG)				
Independent variables	B	SEB	Beta	T	R^2Change
Frequency of Bengalee Sweet consumption Per week	0.083	0.025	0.220	3.381***	0.068
Conicity index(CI)	3.350	1.276	0.177	2.626**	0.054
Waist-hip ratio (WHR)	4.081	1.833	0.149	2.227*	0.017
			R^2=0.157		
	Dependent Variable = Very low density lipoprotein Cholesterol (VLDL)				
Independent variables	B	SEB	Beta	T	R^2Change
Conicity index	2.066	0.654	0.213	3.161**	0.037
Age	-0.009	0.004	-0.172	-2.551*	0.029
			R^2= 0.067		

Significant at * *P*<0.05; ** *P*<0.01; *** *P*<0.001

for in the present study are cross-sectional nature of sleuth, the small sample size and only male participants. Since there is vast ethnic and cultural heterogeneity in India, future investigation should be undertaken on other Indian population to determine the relative role of central obesity measures, and food pattern variables in explaining metabolic risk factors of CHD. Longitudinal studies investigating the interaction between central obesity measures, metabolic and food pattern variables are needed to further our understanding of the aetiology of CHD. More studies on Indian migrant populations elsewhere are also needed. Such studies, when done in comparison with the native population, should yield valuable information about the ‘gene-environment’ interaction involved in the aetiology of CHD. Furthermore, vast cultural heterogeneity results in differences in food consumption among different Indian communities across the Indian diaspora. This difference in food consumption, no doubt, is a potential risk factor for CHD among Indians. In this respect an enlightened public health policy, including dietary guidelines, is necessary to retard the growing incidence of CHD among the Indian population. At present, no such policy exists in India.

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