International Journal of Biomedical Research
ISSN: 0976-9633 (Online); 2455-0566 (Print)
Journal DOI: 10.7439/ijbr
CODEN: IJBRFA

Original Research Article

Cardiometabolic Risk Factors by Fasting Blood Glucose Tertiles in a Rural Community of Asian Indian Origin

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Abstract

Background: This study was aimed to investigate cardiometabolic risk factors by fasting blood glucose (FBG) tertiles in a rural community of Asian Indian origin.
Methods: This cross-sectional study was carried out among 1007 participants (645 males and 362 females) aged 20 to 80 years in a rural community in West Bengal, India. Anthropometric measures were collected using standard techniques. Blood pressure was recorded according to standard protocol. Metabolic profiles were measured using an auto-analyzer.
Results: Significant ($p<0.05$) group (tertile) differences were observed for waist circumference, waist-hip ratio, waist-height ratio, percentage of body fat, total cholesterol, triglycerides, low and very low density lipoprotein cholesterol, total cholesterol (TC)**:** high density lipoprotein cholesterol (HDL) and blood pressure. Significant differences ($p<0.0001$) between dyslipidaemic and non-dyslipidaemic individuals by FBG tertiles were also evident. Higher prevalence of high total cholesterol, high triglycerides, high TC: HDL and low HDL was found with increasing FBG tertiles.
Conclusions: It may be argued that increased level of fasting blood glucose might be responsible for clustering of cardiometabolic risk factors and in turn CVD occurrence.
Keywords: metabolic syndrome, CVD, diabetes, obesity, Asian Indian.

1. Introduction

Cardiovascular disease (CVD) is the number one cause of death globally [1]. By the year 2020, there will be an increase by almost 75% in global CVD prevalence, and almost all of these increases will occur in developing countries [2]. It has been predicted that by 2030, almost 23.6 million people will die from CVD, mainly from heart disease and stroke [3]. It has been 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 [4-5]. By 2020 there will be a 111 % increase in cardiovascular deaths in India. It has also been predicted that India will be the heart disease capital in the world by 2020 [6]. From a survey conducted in 45 rural villages in India, it was seen 32 per cent of all deaths were due to CVD. On the other hand, infectious diseases were responsible for 13 per cent. It proves that the epidemic has reached its advanced stage even in rural India [7].

The metabolic syndrome (MS), as a principal cause for diabetes and CVD, is considered as a major challenge to public health throughout the world. The MS is associated with a doubling of the risk of CVD [8]. Individuals with MS have a 30%–40% probability of developing diabetes and/or CVD within 20 years, depending on the number of components present [9].

It has been estimated that diabetes prevalence by 2030 will include 439 million adults worldwide [10]. It was reported that the rising incidence of diabetes was, as expected, accompanied with significant increase of CVD [11]. South East Asian countries bear the highest burden of diabetes, including India which may have up to 33 million cases [12]. Though the burden of diabetes and dyslipidemia in India is mainly contributed by urban population, the increasing trend of diabetes and even dyslipidemia is observed in rural population too. According to Wild *et al* the prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030 with a maximum increase in India [13].

Dyslipidemia has been closely linked to the pathophysiology of CVD and is a key independent modifiable risk factor for CVD [14-15]. Not only the prevalence of dyslipidemia is high among Indians, it has been increasing steadily over the past few decades. In fact, as shown in the INTERHEART study, dyslipidemia appears to be the strongest contributor of acute myocardial infarction (MI) in

South-Asians [16]. In earlier studies dyslipidaemia was considered as a silent killer which increased the risk to develop coronary heart disease (CHD) prematurely [16-18]. The prevalence of dyslipidaemia and/or type 2 diabetes mellitus (T2DM) were found high for Asian Indians both in India [19-22] and abroad [16,18,23-25].

Emphasis should be given to identify individuals who are at greater risk from dyslipidaemia and/or T2DM for the effective management of the disease.

The term 'cardiometabolic risk' evolved from an enhanced understanding of established and emerging risk factors associated with a predisposition to cardiovascular and metabolic diseases. Cardiometabolic risk is defined as a cluster of modifiable risk factors and markers that identify individuals at increased risk for CVD and T2DM [26]. The lifestyle changes and urbanization is mainly responsible for the prevalence of cardiometabolic changes in rural areas [27-28]. But very little information is available in this regard from rural area. Therefore, it may be argued that as per prevalence of cardiometabolic abnormalities and MS there is definitely alarming situation in rural population. The early identification of cardio metabolic risk factors can help to prevent or delay MS, T2DM and CVD.

It is noteworthy to mention that various cut-offs are used for assessment of CVD risk factors. For example, MS are assessed by cut-offs such as World Health Organization (WHO), National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III), International Diabetes Federation (IDF), South Asian Specific (SAS). To identify the population who is prevalent to diabetes but not diagnosed, cut-offs such as Indian Diabetes Risk Score (IDRS), Framingham Risk Score (FRS) are used. IDRS not only predicts diabetes but also MS and other CVD risk factors [28]. It is also a very useful tool for predicting dyslipidaemia [29]. But which cut-off is accurate it is under debate. No universal cut-off is available. Therefore, in the present study, natural cut-off such as Fasting Blood Glucose tertiles (FBG tertiles) is used to identify the individuals with high risk of cardiometabolic risk factors.

However, to the best of the authors' knowledge, virtually no study has been undertaken to find out the association of cardiometabolic risk factors with FBG tertiles in a rural community of Asian Indian origin. In view of the above consideration, the present cross-sectional study was undertaken with the following objectives:

- To compare anthropometric measures, body composition, lipid profiles and blood pressure by FBG tertiles
- To study the prevalence of dyslipidaemia in accordance to FBG tertiles
- To study the prevalence of cardiometabolic risk factors by FBG tertiles

2. Materials and Methods

2.1 Study population

The present community-based cross-sectional study was conducted among 1007 rural Asian Indian aged 20 to 80 years (645 males and 362 females) living in and around Santiniketan-Bolpur area [about 160 km from Kolkata (erstwhile Calcutta)], West Bengal, India. The study was carried out in between July 2012 and February 2014. The participants were categorized in according to FBG tertiles as: 1st tertile (33.33%), n = 388; 2nd tertile (66.66%), n = 289; 3rd tertile (99.99%), n = 330. Written consent was obtained from all participants before actual commencement of the study. The study was approved by the institutional ethics committee of the 'Human Genetic Engineering Research Centre' (HGERC), Kolkata, India.

2.2 Socioeconomic characteristics

A schedule was used as data collection tool. This pre-designed questionnaire contained questions relating to socio-demographic information of the participants. The name, age, sex, marital status, etc as well as socioeconomic characteristics, such as, monthly family income and expenditure, occupation and education, etc., were obtained from participants using the open ended schedule. Health-related behaviors, such as, drinking status, smoking status, family history, physical activity, etc. were also recorded.

2.3 Anthropometric measures

Anthropometric measures, namely, height, weight, minimum waist circumference (MWC), maximum hip circumference (MHC) and skinfold thickness at biceps, triceps, subscapular, suprailiac were obtained using standard techniques [30]. Age was obtained from participants using the schedule and it was ascertained from the local voters' registration list. Height and weight of lightly clothed subjects were measured to the nearest 0.1 cm and 0.5 kg, respectively. Circumferences were measured with the help of a non-elastic tape to the nearest 0.1 cm. Waist–hip ratio (WHR) and Waist–height ratio (WHtR) were calculated accordingly. Skinfolds thicknesses were measured using a Holtain skinfold calliper (Holtain Corporation, UK). Sum of four skinfold thickness ($\sum SF_4$) i.e. biceps + triceps + subscapular + suprailiac were computed subsequently. Percentage of body fat (% BF) and body mass index (BMI) were obtained using an Omron body fat analyzer (Omron Corporation, Tokyo, Japan).

2.4 Blood pressure

Left arm systolic (SBP) and diastolic (DBP) blood pressure were taken twice from each participant in a sitting position using a stethoscope and standard mercury sphygmomanometer according to a standard protocol and were averaged for analyses. A third measurement was taken only when the difference between the two measurements was $\geq$ 5 mmHg and a subsequent mean was calculated. A five minute relaxation period between measurements was maintained throughout the study. Mean Arterial Pressure (MAP) was calculated subsequently using the standard formula: MAP = DBP + 1/3(SBP-DBP).

2.5 Metabolic profiles

A fasting blood sample (~7 ml) was collected from each participant for the determination of metabolic profiles.

All participants maintained an overnight fast of 10 to 12 hours prior to blood collection. The serum was separated by centrifugation at 1000 rpm for 20 min at room temperature within 2 hours of collection. Total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL) cholesterol and fasting blood glucose (FBG) were estimated on separated serum using semi auto-analyzer (Mindray BA 88A, China). Low density lipoprotein (LDL) cholesterol and very low density lipoprotein (VLDL) cholesterol were then calculated by using the standard formula [31]: VLDL = TG/5 and LDL = TC – (HDL + VLDL). All metabolic variables were measured in mg/dl (mg %) unit.

2.6 Definition of Dyslipidaemic

Individuals with one or more of the following conditions were defined as dyslipidaemic: TG ≥ 2.3 mmol/l, TC ≥ 6.2 mmol/l, or TC/HDL ≥ 4.4 [23-24]. The remaining individuals were considered as non-dyslipidaemic. Metabolic variables such as TC, TG and HDL measured in mg/dl unit then converted into mmol/l unit using the following standard conversion factors:

For TC, HDL: value in mg/dl x 0.02586.

For TG: value in mg/dl x 0.01129.

2.7 Statistical analyses

Comparison of variables, such as, anthropometric measures, body composition, lipid profiles and blood pressure was studied by FBG tertiles and ANOVA was executed to study the significant group differences of variables. To find out the prevalence (%) of dyslipidaemia in respect of FBG tertiles, Chi-square test was performed. The prevalence of cardiometabolic risk factors was compared in according to FBG tertiles. Percentiles distribution of cardiometabolic risk factors was also compared by FBG tertiles

All statistical analyses were carried out using the SPSS Inc., Chicago, IL, USA (PC+ version 14.0). A p value of < 0.05 was considered as significant.

3. Results

It was found (results were not shown) that ~38% participants had monthly family income between Rupees 20,001/- and 40,000/- (1 US$ ~ 62 Indian Rupees) and 93.64% participants were found non-vegetarian. Moreover, 75.27% and 88.88% participants did not have the habit of smoking and consumption of alcohol, respectively. Physical activity (mainly brisk walking) of ≤ 15 minutes per day was recorded in 62.16% of participants.

Comparison of anthropometric measures, body compositions, lipid profiles and blood pressure according to FBG tertiles is presented in Table 1. Significant ($p<0.05$) group (tertiles) differences were evident for MWC, WHR, WHtR, %BF, TC, TG, LDL, VLDL, TC/HDL, SBP and MAP by FBG tertiles. In contrast, no significant group differences were observed for height, weight, MHC, BMI, $\sum SF_4$, HDL, HDL/LDL and DBP.

The prevalence of dyslipidaemia in accordance to FBG tertiles is presented in Table 2. Significant ($p<0.0001$) differences for dyslipidaemic and non-dyslipidaemic individuals by FBG tertiles was evident.

Prevalence of cardiometabolic risk factors in respect of FBG tertiles is presented in Table 3. The higher prevalence of high TC, high TG, high TC/HDL and higher prevalence of low HDL were found with increasing FBG tertiles.

Percentiles (25^{th}, 50^{th}, 85^{th} and 95^{th}) distribution of cardiometabolic risk factors namely WHR, ΣSF4, TG and SBP according to FBG tertiles is shown in Figure 1. Stiff increase of values from 50^{th} to 95^{th} percentile was observed for WHR, ΣSF4, TG and SBP.

Table 1: Comparison of anthropometric measures, body composition, lipid profiles and blood pressure by FBG tertiles (n = 1007)

Variables	FBG tertiles			ANOVA
	1^{st} tertile (Mean±SD) (n = 388)	2^{nd} tertile (Mean±SD) (n = 289)	3^{rd} tertile (Mean±SD) (n = 330)	(p)
Height (cm)	160.32±8.97	159.53±9.18	160.51±8.74	0.358
Weight (kg)	63.57±12.09	64.05±11.21	65.58±12.38	0.070
MWC (cm)	79.98±9.01	81.55±7.91	83.42±8.18	<0.001
MHC (cm)	92.26±8.02	92.85±7.36	93.05±8.02	0.368
WHR	0.86±.05	0.87±.05	0.89±.05	<0.001
WHtR	0.49±.05	0.51±.05	0.52±.05	<0.001
BMI (kg/m^2)	24.70±4.12	25.13±3.67	25.40±4.02	0.058
%BF	30.01±6.79	31.18±6.82	31.65±6.70	0.004
$\sum SF_4$ (mm)	53.57±20.39	55.33±18.87	55.83±20.28	0.279
TC (mg%)	158.45±24.13	167.65±29.90	168.01±32.65	<0.001
TG (mg%)	138.26±45.50	154.36±62.00	167.11±67.77	<0.001
HDL (mg%)	46.27±7.29	47.06±6.98	47.17±7.61	0.196
LDL (mg%)	84.53±19.89	90.03±25.91	87.61±26.57	0.012
VLDL (mg%)	27.65±9.10	30.56±10.47	33.22±12.30	<0.001
TC/HDL	3.48±0.63	3.62±0.77	3.63±0.79	0.012
HDL/LDL	0.57±0.16	0.56±0.19	0.58±0.21	0.378
SBP (mmHg)	125.05±17.70	125.48±18.22	131.35±18.41	<0.001
DBP (mmHg)	81.03±8.71	81.14±8.79	81.92±8.42	0.344
MAP (mmHg)	95.69±10.71	95.91±10.94	98.39±10.59	<0.001

MWC, minimum waist circumference; MHC, maximum hip circumference; WHR, waist- hip ratio; WHtR, waist-height ratio; BMI, body mass index; %BF, percentage of body fat; $\sum SF_4$, sum of four skinfolds; TC, total cholesterol; TG, triglyceride; HDL, high density lipoprotein; LDL, low density lipoprotein; VLDL, very low density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure.

Table 2: Prevalence of dyslipidaemia by FBG tertiles

	FBG tertiles		
	1st tertile	**2nd tertile**	**3rd tertile**
Dyslipidaemic	58 (14.95%)	72 (24.91%)	90 (27.27%)
Non-dyslipidaemic	330 (85.05%)	217 (75.09%)	240 (72.73%)

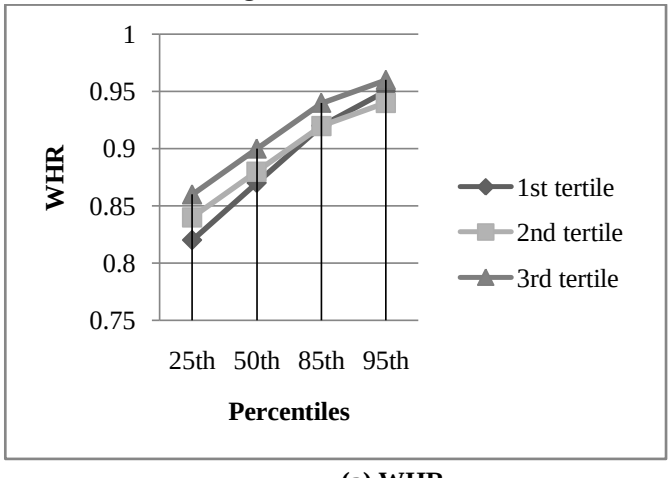
$\chi^2_{(2)} = 18.08$; $p < 0.0001$

Table 3: Prevalence of cardiometabolic risk factors by FBG tertiles

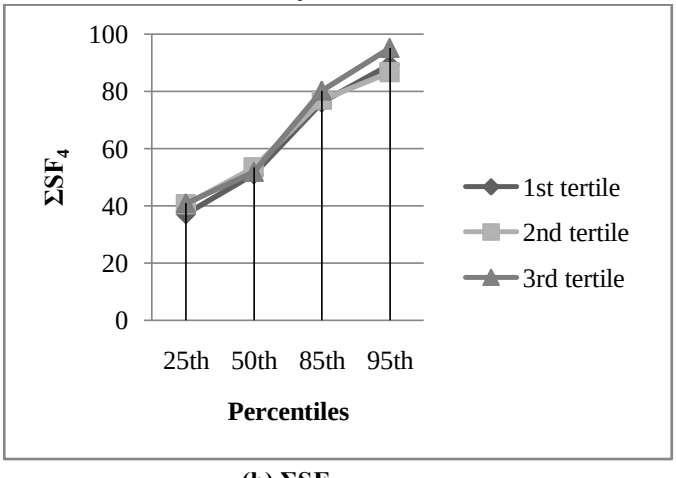
Prevalence of cardiometabolic risk factors	**FBG tertiles**			**Total (n = 1007)**
	1st tertile (n = 388)	**2nd tertile (n = 289)**	**3rd tertile (n = 330)**	
High TC	17 (4.38%)	41 (14.19%)	55 (16.67%)	113 (11.22%)
High TG	137 (35.31%)	141 (48.79%)	181 (54.85%)	459 (45.58%)
High BP	195 (50.26%)	138 (47.75%)	196 (59.39%)	529 (52.53%)
Low HDL	49 (12.63%)	35 (12.11%)	33 (10.00%)	117 (11.62%)
High TC/HDL	36 (9.28%)	40 (13.84%)	51 (15.45%)	127 (12.61%)

[High TC when TC ≥ 200 mg %; high TG when TG ≥ 150 mg %; high BP when SBP ≥ 130 or DBP ≥ 85 mmHg; low HDL when HDL ≤ 35 in male and ≤ 40 in female; high TC/HDL when TC/HDL ≥ 4.4]

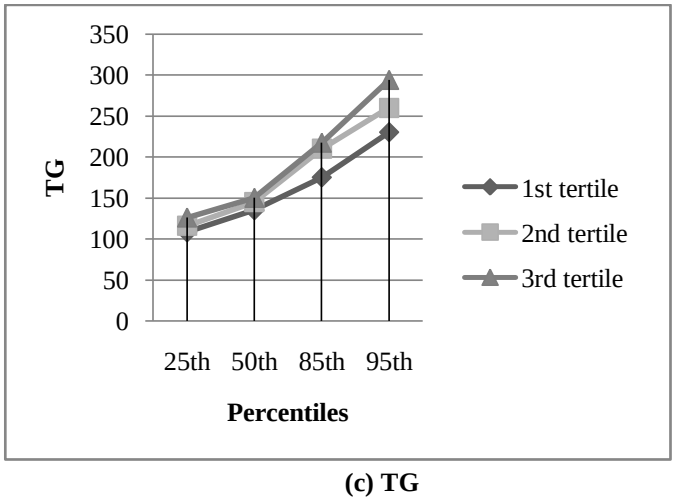
Figure 1: Percentiles distribution of cardiometabolic risk factors by FBG tertiles



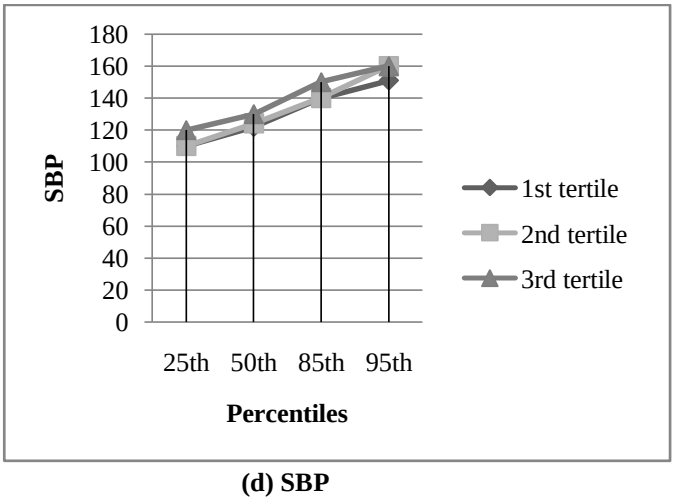
(a) WHR



(b) ΣSF_4



(c) TG



(d) SBP

4. Discussion

The present investigation was aimed to find out the association of cardiometabolic risk factors with FBG tertiles in a rural community of Asian Indian origin. FBG tertiles were used to identify the rural population of Asian Indian origin with high risk of cardiometabolic risk factors.

In the present study, the higher anthropometric measures, body compositions, lipid profiles and blood pressure were found with increasing FBG tertiles. In earlier studies, various cut-offs were used for the determination of adverse CVD risk factors. For example, increased TV watching duration was found associated with adverse CVD risk factors, which was evident from previous studies [32-37]. Earlier study further showed that the prevalence of adverse CVD risk factors was evident in according to age [38]. From the present study, it may, therefore, be concluded that adverse CVD risk factors may also be identified by FBG tertiles.

Individuals with significant increasing dyslipidaemia were found in the study population with the increase of FBG tertiles. In our study significant ($p<0.0001$) differences between dyslipidaemic and non-dyslipidaemic individuals were found in respect of increasing FBG tertiles. In an earlier study, IDRS was found as a very useful tool for predicting dyslipidaemia [29]. Another study showed that common significant risk factors for dyslipidemia included obesity, diabetes, and dysglycemia [39]. Hence, it may be argued that FBG tertiles may also be used for the determination of dyslipidaemia.

The prevalence of cardiometabolic risk factors was found evident in according to FBG tertiles in the study population. The increasing cardiometabolic risk factors further vindicate that individuals with higher FBG tertiles are more vulnerable to their CVD health. Anthropometric cut points were previously used for the determination of risk of cardiometabolic risk factors in an urban Asian Indian population [40]. In another study the prevalence of MS was identified with the help of IDRS cut-off [28]. Therefore, it is reasonable to argue that cardiometabolic risk factors may also be identified by natural cut-off such as FBG tertiles.

It was also observed in the study that the percentile distribution of cardiometabolic risk factors among the rural Asian Indian was evident by FBG tertiles. Therefore, it is noteworthy to mention that individuals will more be susceptible to CVD risk with increasing FBG tertiles.

From the above observations we may conclude that FBG tertiles can be used for identifying the individuals with increased risk of cardiometabolic risk factors. However, similar other criteria may be developed for the study of cardiometabolic risk factors considering ethnic and cultural variations of the study area. The early identification of cardiometabolic risk factors can help with an attempt to prevent or delay the appearance of CVD. Based on the study results, it is clear that proper management and strategy are the need of the hour to arrest cardiometabolic risk factors and ultimately increasing burden of CVD in the rural community.

However, some limitations are associated with the present study. Though the sample size was sufficient enough, yet, it is not representative of the entire Asian Indian population. Owing to considerable ethnic and cultural heterogeneity in Asian Indian population, it is imperative to study other ethnic groups to see if the trends observed also exist among them. Another limitation is that it is a cross-sectional study and further prospective studies are required in other parts of urban as well as rural population of India to find out the association of cardiometabolic risk factors with FBG tertiles.

Acknowledgements

Authors are thankful to all the participants for their sincere cooperation during data collection. No funding received.

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