

# Obesity measures, metabolic profiles, blood pressure and intake of dietary fatty acids in rural women of Asian Indian origin: Santiniketan women study

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## ABSTRACT

**Objectives:** The present cross-sectional study was aimed to investigate obesity measures, metabolic profiles, blood pressure, and intake of dietary fatty acids in rural women of Asian Indian origin. **Materials and Methods:** A total of 280 healthy rural women aged 25–65 years took part in the study. A random sampling procedure using a local voters' registration list was followed to select the participants. All participants belonged to the Bengalee population and were inhabitants of the Bolpur-Santiniketan area, West Bengal, India. Anthropometric measures, namely, height, weight, circumferences of waist and hip, skinfolds at biceps, triceps, subscapular, and suprailiac regions, etc., were collected using standard techniques. Body mass index (BMI), percentages of body fat (PBFs), basal metabolic rate (BMR), and intra-abdominal visceral fat (IVF) were measured using an Omron body fat analyzer (Omron Corporation, Tokyo, Japan). Fat mass (FM), fat free mass (FFM), waist-hip ratio (WHR), and sum of four skinfolds (SF4) were also taken into consideration. Blood pressure and metabolic and hormonal profiles were measured using standard techniques. The weekly consumption (frequency) of food stuffs was collected using an already validated food frequency schedule. **Results:** The result showed that the mean age was  $41.52 \pm 10.95$ , BMI  $23.07 \pm 4.34$ , PBF  $31.76 \pm 7.06$ , BMR  $1162.34 \pm 139.59$ , WHR  $0.83 \pm 0.06$ , systolic blood pressure  $118.84 \pm 20.35$ , diastolic blood pressure  $77.77 \pm 12.12$ , total cholesterol  $185.61 \pm 25.19$ , triglyceride level  $135.82 \pm 30.39$ , high-density lipoprotein  $48.13 \pm 6.13$ , low-density lipoprotein  $109.90 \pm 22.53$ , fasting blood glucose  $90.91 \pm 7.98$ , and insulin  $11.98 \pm 3.42$ . The result also shows the mean intake of total protein to be  $177.01 \pm 47.79$ , total energy  $8321.60 \pm 1354.86$ , total fat  $210.36 \pm 53.57$ , total PUFA  $82.02 \pm 49.73$ , and total MUFA  $94.01 \pm 16.38$ . The percentile distribution of the dietary fat intake revealed that the 10th and 95th percentile values of the total protein intake were 125.3 and 261.5, total energy intake were 7491.6 and 10470.2, total fat intake were 178.8 and 273.5, total PUFA intake were 55.5 and 191.7, and of the total MUFA intake were 86.0 and 126.9, respectively. **Conclusion:** It seems reasonable to argue that dietary management including dietary guidelines across India is essential to retard the growing incidence of cardiovascular diseases in coming years.

**Key words:** Obesity, lipids, dietary fatty acids, cardiovascular diseases, Asian Indians

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DOI:

10.4103/0975-3583.78599

## INTRODUCTION

India, being a country in developmental transition, faces the dual burden of pretransition diseases like undernutrition and infectious diseases as well as posttransition, lifestyle-related degenerative diseases such as obesity, diabetes, hypertension, cardiovascular diseases and

cancers.<sup>[1]</sup> Cardiovascular disease (CVD) accounts for a large proportion of all deaths and disability worldwide. The Global Burden of Diseases (GBD) study reported that in 1990, there were 5.2 million deaths from CVD in economically developed countries and 9.1 million deaths from the same cause in developing countries.<sup>[2]</sup> It has been predicted that by year 2020, there will be an increase by almost 75% in the global CVD and almost all of this increase will occur in developing countries.<sup>[3]</sup> It was reported<sup>[4]</sup> that the mortality from CVD was projected to decline in developed countries from 1970 to 2015 while it was projected to almost double in the developing countries.

Epidemiologic evidence from the INTERHEART study has identified nine risk factors that account for approximately 94% of the risk of a first occurrence of acute myocardial infarction in women.<sup>[5]</sup> This study strengthened the known associations between risk factors and modifiable lifestyle choices. Eight of the nine factors were noted to be strongly influenced and modified by diet and demonstrated that the prevention of coronary heart disease (CHD) through changes in diet and lifestyle for this population is certainly attainable. The conclusions of the Coronary Risk Factors for Atherosclerosis in Women (CORA) study<sup>[6]</sup> clearly state that the impact of dietary habits on CHD risk in women is independent of, and additive to, conventional risk factors. The CORA study was designed to demonstrate the effect of nutrition on the manifestation of CHD and to provide a basis for improved preventive measures.

Recent research has established that an inappropriate lifestyle, including poor nutrition, can be a major contributor to the development of atherosclerosis.<sup>[7]</sup> This suggests then that CHD might be preventable if an appropriate lifestyle were adapted. The impact of CHD in women has been underestimated in clinical practice with recent research showing a disparity in not only risk factors but the utilization of medical and nutritional therapy as well.<sup>[8]</sup>

A recent study by the US Centers for Disease Control and Prevention (CDC) showed that clinicians are less likely to counsel women than men about the management of risk factors such as nutrition, exercise, and weight reduction.<sup>[7]</sup> A national survey on gender differences documented that women were significantly less likely to be enrolled in cardiac rehabilitation after bypass surgery or myocardial infarction.<sup>[9]</sup> This demonstrates the imbalance of care given to women regarding CHD risk management and prevention despite the published recommendations for primary prevention being applicable to women as well as men.<sup>[10]</sup>

It is also important to note that first cardiovascular events in women, while occurring later in life, have a higher mortality.<sup>[11]</sup> Therefore, careful consideration should be given to individual risk factor management and preventative strategies that are critical to improving the quality of life of women in later years.<sup>[12]</sup> Keeping this view in mind, the present study was aimed to examine the obesity measures, blood pressure, metabolic profile, and intake of dietary fatty acids in rural women of Asian Indian origin.

## MATERIALS AND METHODS

### Study population

The present cross-sectional study was conducted between April 2009 and March 2010. A total of 280 healthy women aged 25–65 years took part in the study. All subjects belong to the Bengalee population and were inhabitants of the Bolpur-Santiniketan area (lies between 23°40' north latitude and 87°43' east longitude), West Bengal, India. Prior to the actual commencement of the study, 400 individuals were selected randomly using local voters' registration, and written information was communicated to them for an appointment at their respective houses. Only one individual was selected from each household to avoid intrahousehold clustering of CVD risk factors. In doing so, 350 individuals were first attended positively. After attending all the respondents, only 300 individuals were found to be suitable for the study. The rest 50 individuals were excluded purposively as they were suffering either from prolonged chronic illness like polycystic ovarian syndrome (POCS), type 2 diabetes mellitus (T2DM), or coronary heart disease (CHD) or were on hormone therapy (HT). It is noteworthy to mention that out of these 300 individuals, it was only possible to study 280 individuals who ultimately participated in the study and the rest (20 individuals) were excluded due to their unavailability during the actual study. The institutional ethics committee (IEC) of the Human Genetic Engineering Research Center (HGERC), Kolkata, India has had approved the study. Written consent from participants was also obtained prior to the actual commencement of the study.

### Anthropometric measures

Anthropometric measures, namely, height, weight, circumferences at the mid-upper arm (MUAC), minimum waist (MWC), maximum hip (MHC), skinfolds at biceps (BSF), triceps (TSF), subscapular (SUSF), suprailliac (SUSF) regions, etc., were collected using standard techniques.<sup>[13]</sup> Percentages of body fat (PBF), intra-abdominal visceral fat (IVF), body mass index (BMI), and basal metabolic rate

(BMR) were measured using an Omron body fat analyzer (Omron Corporation, Tokyo, Japan). The waist–hip ratio (WHR) and sum of four (biceps + triceps + subscapular + suprailliac) skinfolds ( $SF_4$ ) were then calculated subsequently. Fat mass (FM) and fat free mass (FFM) were then calculated using the following equations:<sup>[12]</sup>

$$FM \text{ (kg)} = (\%BF/100) \times \text{weight (kg)}$$

$$FFM \text{ (kg)} = \text{Weight (kg)} - FM \text{ (kg)}$$

### Blood pressure

Left arm systolic (SBP) and diastolic (DBP) blood pressure was taken from each participant with the help of an Omron MI digital electronic blood/pulse monitor (Omron Corporation). Two blood pressure measurements were taken and averaged for analysis. A third measurement was taken when the difference between the two measurements was  $\geq 5$  mmHg and subsequently the mean was calculated. A 5-min relaxation period between measurements was maintained throughout the study.

### Metabolic profiles

A fasting blood sample (7 ml) was collected from 131 subjects for the determination of metabolic profiles. All subjects were maintained an overnight fast of 12 hours prior to blood collection. Plasma was separated by centrifugation at  $1000 \times g$  for 20 min at room temperature within 2 h of collection. The estimation of total cholesterol (TC), triglycerides (TGs), and fasting plasma glucose (FPG) was carried out on separated plasma using an autoanalyzer. High-density lipoprotein cholesterol (HDL) was measured after an overnight stand of plasma in a refrigerator and then precipitation of non-high-density lipoproteins, namely, low-density lipoprotein (LDL), very low density lipoprotein (VLDL), and chylomicrons with the manganese-heparin substrate.<sup>[16]</sup> LDL was then estimated using the following formula:<sup>[17]</sup>  $LDL = TC - (HDL + TG/5)$ . All metabolic variables were measured in mg/dl ( $mg\%$ ). The reproducibility of the instruments was checked periodically using a control solution.

### Hormonal profile

17 $\beta$ -Estradiol was measured with the help of the Estradiol ELISA kit (DRG Instruments GmbH, Germany). Insulin was measured by the Accubind ELISA Microwells kit (Monobind Inc., USA). Testosterone was measured by the Testosterone 48 kit (Equipar Diagnostici, Italy). The estimation of 17 $\beta$ -estradiol, insulin, and testosterone was carried out using an ERBA Microscan Microplate ELISA Reader (Trans Asia Biomedicals Ltd., Mumbai,

Maharashtra, India) and the absorbance was measured at 450 nm.

### Dietary profile

The dietary intake was recorded using the 24-h recall methods for seven consecutive days using a food frequency schedule prepared in the local language which is already validated in the Asian Indian population.<sup>[14]</sup> Total protein, total energy, total fat, total polyunsaturated fat (PUFA) and monounsaturated fat (MUFA) contents of various foods were obtained using the standard guidelines.<sup>[15]</sup> The standardization to convert foodstuffs into fatty acids has been mentioned elsewhere.<sup>[16]</sup>

### Statistical analyses

Descriptive statistics such as mean, standard deviation (SD), and range (maximum–minimum) were undertaken. Percentile distribution (10th, 25th, 50th, 85th, and 95th) for the consumption of dietary fats and fatty acids was also undertaken. All statistical analyses were performed using the SPSS PC+ version 10.

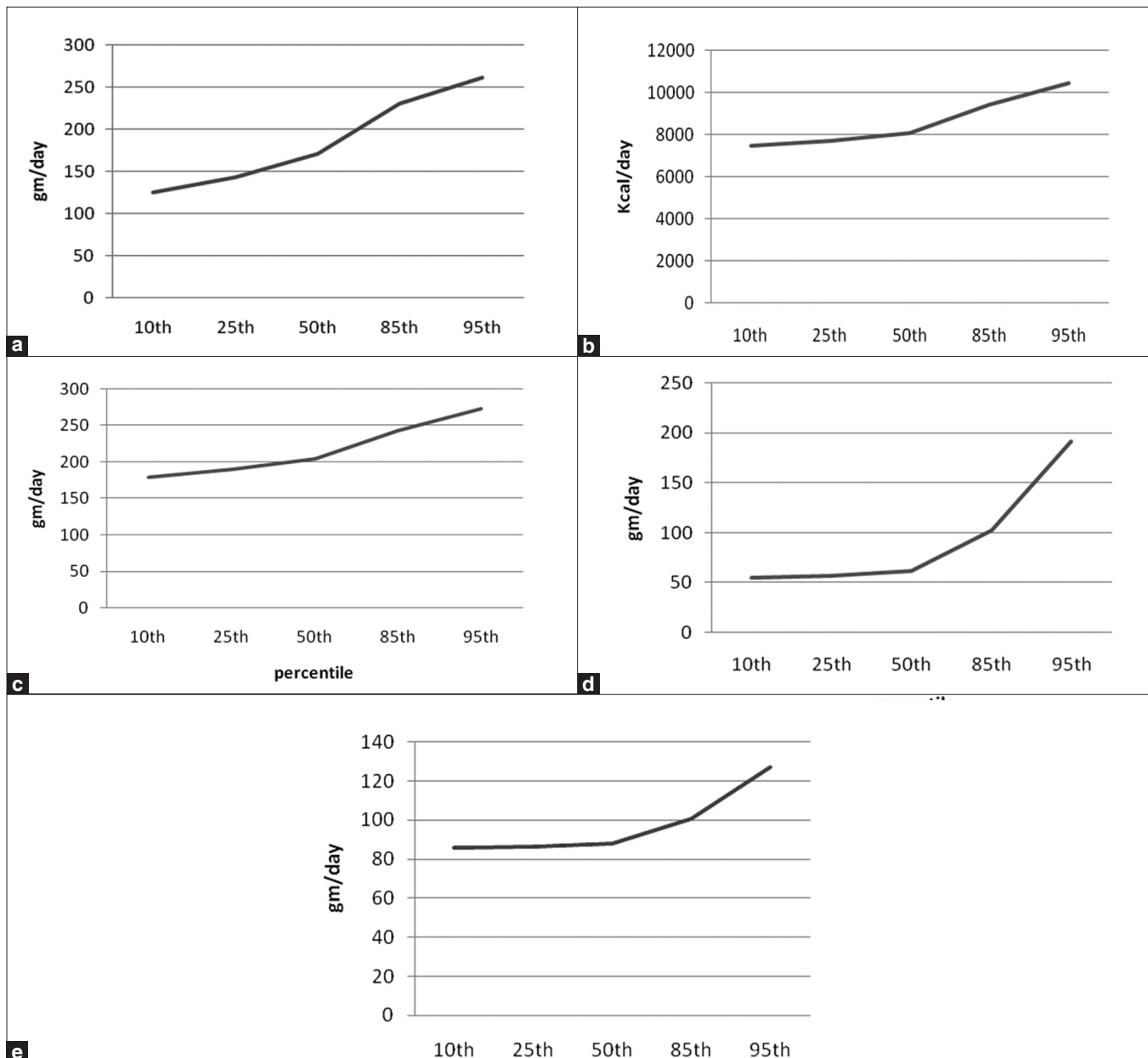
## RESULTS

The socioeconomic characteristics of the study population are presented in Table 1. It was observed that about 60% participants had an average monthly expenditure of Indian rupees 5000 or less. Moreover, more than 44% participants had education up to class 10th (secondary education).

The mean, SD, and range of obesity measures and blood pressure are presented in Table 2. The result shows that the mean age was  $41.52 \pm 10.95$ , basal metabolic rate  $23.07 \pm 4.34$ , sum of four skinfolds  $60.15 \pm 21.35$ , percentage of body fat  $31.76 \pm 7.06$ , basal metabolic rate  $1162.34 \pm 139.59$ , fat mass  $17.33 \pm 6.48$ , fat free mass  $35.78 \pm 6.08$ , waist–hip ratio  $0.83 \pm 0.06$ , systolic blood pressure  $118.84 \pm 20.35$ , diastolic blood pressure  $77.77 \pm 12.12$ , and pulse rate  $81.35 \pm 10.14$ .

The mean, SD, and range of metabolic and hormonal profiles are presented in Table 3. The result shows that mean TC was  $185.61 \pm 25.19$ , TG level was  $135.82 \pm 30.39$ , very low density lipoprotein  $27.50 \pm 7.33$ , high-density lipoprotein  $48.13 \pm 6.13$ , low-density lipoprotein  $109.90 \pm 22.53$ , fasting blood glucose  $90.91 \pm 7.98$ , insulin  $11.98 \pm 3.42$ , testosterone  $0.34 \pm 0.17$ , and estradiol  $97.85 \pm 62.36$ .

The mean, SD, and range of the intake of dietary fatty acids are presented in Table 4. The result shows that the mean



**Figure 1:** Percentile distribution of (a) total protein, (b) energy, (c) fat, (d) PUFA, and (e) MUFA intake in the study

intake of total protein was  $177.01 \pm 47.79$ , total energy  $8321.60 \pm 1354.86$ , total fat  $210.36 \pm 53.57$ , total PUFA  $82.02 \pm 49.73$ , and total MUFA  $94.01 \pm 16.38$ .

The percentile distribution of the dietary fat intake is presented in Figure 1. The 10th and 95th percentile value of the total protein intake was 125.3 and 261.5, of the total energy intake was 7491.6 and 10470.2, of the total fat intake was 178.8 and 273.5, of the total PUFA intake was 55.5 and 191.7, and of the total MUFA intake was 86.0 and 126.9, respectively.

## DISCUSSION

In the present investigation, an attempt was made to examine the obesity measures, metabolic profile, blood pressure, and intake of dietary fatty acids in rural women of Asian Indian origin.

In our study, the mean intake of total protein was  $177.01 \pm 47.79$  g/day, total energy was  $8321.60 \pm 1354.86$  kcal/day, total fat was  $210.36 \pm 53.57$  g/day, total PUFA was  $82.02 \pm 49.73$  g/day, and total MUFA was  $94.01 \pm 16.38$  g/day. A study on lean and obese postmenopausal

diabetic women revealed a significantly higher intake of carbohydrates, proteins, fats, trans fatty acids (TFA) in obese postmenopausal diabetic women.<sup>[16]</sup> In another study, it was observed that males with metabolic syndrome had a significantly higher consumption of MUFA than females with metabolic syndrome. The study also hinted that the intake of saturated fat may be a major risk factor for the onset of metabolic syndrome in adult Asian Indians.<sup>[14]</sup>

In a study, the average visible fat intake by women was 21 ± 0.73 and 23 ± 0.89 g in the semiurban and urban areas, respectively, with a contribution of 47.7% and 52.5% to the total fat.<sup>[17]</sup> The National Nutrition Monitoring Bureau (NNMB) led dietary survey in the 10 states of India over

the 20 years revealed that the visible fat intake was only in a range of 9–13 g where the state of Punjab was not included.<sup>[18]</sup> Sodhi<sup>[19]</sup> reported the visible fat intake of 25.3 and 23 g by the urban and rural Punjabi females, respectively, and the values are close to the intake of the present study. The invisible fat intake was 23 ± 0.21 g and 21.8 ± 0.2 g with the percent contribution of 52.3% and 47.5% to the total fat by semiurban and urban females, respectively.

According to WHO,<sup>[20]</sup> diets should provide an adequate intake of PUFA, i.e., in the range 6–10% of the daily energy intake. There should also be an optimal balance between the intake of n-6 PUFA and n-3 PUFA, i.e., 5–8% and 1–2% of the daily energy intake, respectively. The intake of oleic acid, monounsaturated fatty acid, should make up the rest of the daily energy intake from fats, to give a daily total fat intake ranging from 15% up to 30% of daily energy intake.

Prospective studies indicate that the increased intake of fat in the form of ω-3 fatty acids from either plant sources (α-linolenic) or fish oils (eicosahexanoic acid and docosahexanoic acid) will reduce cardiovascular risk up to 32–50%.<sup>[21]</sup> Recently, for the first time, the American Heart Association recommended that a nutrient, ω-3 fatty acids, be consumed as a supplement if the diet contained an insufficient amount of this fat.<sup>[22]</sup> Monounsaturated fats reduce cardiovascular risk, especially when substituted for easily digestible starches and sugars. Studies suggest that replacing saturated fat with monounsaturated fat would result in a 30% reduction in risk, or three times the risk reduction achieved by replacing saturated fat with carbohydrates.<sup>[23]</sup>

The average consumption of the dietary fat intake in different parts of India is summarized in Table 5. Studies on adult urban males from Ghaziabad, Goa, and Kolkata

**Table 1: Socioeconomic characteristics of the study population (n = 280)**

Variables	Percentage (%)
Family size	
Up to 4 members	70.4
5–10 members	29.6
Number of children	
Up to 2	70.0
3–5	27.1
>5	02.9
Monthly family expenditure (in rupees)	
≤5000.00	60.4
>5000.00	39.6
Occupation	
Housewife	82.1
Others	17.9
Education	
Primary	13.6
Secondary	44.6
Higher secondary	11.1
Graduate	09.3

1 US\$ = 48 Indian rupees.

**Table 2: Obesity and blood pressure measures in the study (n = 280)**

Variables	Mean	SD	Minimum	Maximum
Age (years)	41.52	10.95	25.00	65.00
Age at menarche (years)	13.48	01.39	09.00	18.00
Body mass index (kg/m <sup>2</sup> )	23.07	04.34	13.60	37.10
Waist-hip ratio (WHR)	00.83	00.06	00.64	01.03
Sum of four skinfolds (mm)	60.15	21.35	14.80	120.00
Percentage of body fat	31.76	07.06	05.70	44.00
Basal metabolic rate (kcal)	1162.34	139.59	857.00	1851.00
Fat mass (kg)	17.33	06.48	02.66	38.41
Fat free mass (FFM, kg)	35.78	06.08	20.42	59.70
Systolic blood pressure (mmHg)	118.84	20.35	80.00	190.50
Diastolic blood pressure (mmHg)	77.77	12.12	48.00	116.33
Pulse rate	81.35	10.14	53.67	111.67

**Table 3: Metabolic and hormonal profiles+ in the study**

Variables	Mean	SD	Minimum	Maximum
Total cholesterol (mg%)	185.61	25.19	138.00	320.00
Triglyceride (mg%)	135.82	30.39	86.00	270.00
High-density lipoprotein (mg%)	48.13	06.13	38.00	66.00
Low-density lipoprotein (mg%)	109.90	22.53	55.00	206.00
Very low density lipoprotein (mg%)	27.50	07.33	17.20	74.00
Fasting blood glucose (mg%)	90.91	07.98	70.00	120.00
Insulin ( $\mu$ g/ml)	11.98	03.42	02.30	19.10
Testosterone (ng/ml)	00.34	00.17	00.20	01.00
Estradiol (pg/ml)	97.85	62.36	28.70	241.15

\*Lipid profile, n = 131; Hormonal profile, n = 45)

**Table 4: Intake of nutritional and dietary fatty acids in the study population**

Variables	Mean	SD	Minimum	Maximum
Total protein (g/day)	177.01	47.79	66.90	374.39
Total energy (kcal/day)	8321.60	1354.86	4123.40	20242.50
Total fat (g/day)	210.36	53.57	34.43	714.62
Total polyunsaturated fatty acids (g/day)	82.02	49.73	40.93	294.51
Total monounsaturated fatty acids (g/day)	94.01	16.38	49.16	176.96

**Table 5: Brief review of the dietary fat intake in the Indian population**

Author	Year	Nature of the study	Population	Major findings
Goyal <i>et al.</i> <sup>17</sup>	2005	Cross-sectional	Urban and semiurban women of Punjab	Visible fat intake by women was $21 \pm 0.73$ and $23 \pm 0.89$ g in the semiurban and urban areas, respectively, with a contribution of 47.7% and 52.5% to the total fat.
Udipi <i>et al.</i> <sup>24</sup>	2006	Cross-sectional	Male adults from three regions of India	Total fat intakes ranged from 26.9 g/day to 163.2 g/day. Percentage of subjects having intakes above the desirable level was 72% in Kolkata, 36% in Ghaziabad, UP, and only 10% in Goa. SFA intakes were higher and MUFA lower than desirable levels
Ghosh <sup>16</sup>	2009	Cross-sectional	Asian Indian women (Eastern India)	Significantly higher intake of carbohydrate, protein, fat, trans fatty acids in obese postmenopausal diabetic women
Das <i>et al.</i> <sup>14</sup>	2010	Cross-sectional	Asian Indian origin (Eastern India)	It was observed that males with metabolic syndrome had significantly higher consumption of MUFA than females with metabolic syndrome. The study also hinted that intake of saturated fat may be a major risk factor for the onset of metabolic syndrome in adult Asian Indians.

revealed that total fat intakes ranged from 26.9 g/day to 163.2 g/day. Percentage of subjects having intakes above the desirable level was 72% in Kolkata, 36% in Ghaziabad, UP, and only 10% in Goa. In all three areas, SFA intakes were higher and MUFA lower than desirable levels. The ratios of saturated versus unsaturated fatty acids varied widely and the percentage of subjects with intakes close to the desirable ratios was 12% in Goa, 23% in Ghaziabad, and 40% in Kolkata. The data highlight the need for limiting fat intakes and modifying diets to provide fatty acids in desirable ratios.<sup>[24]</sup>

However, some shortcomings are associated with the present study including small sample size and therefore are not representative of the Asian Indian population.

Moreover, the dietary fatty acids were obtained through the retrospective method (recall methods) and not directly from isolated plasma. Further prospective studies are required to see the rural–urban differences in dietary fatty acid consumption and in turn to better compare the *gene–diet* interaction in the growing menace of CVD in this part of the world.

## ACKNOWLEDGMENTS

AG received financial support (Ref. No. 5/9/48/2006-RHN vide RFC No. RHN/Adhoc/1/2009-10) from the Indian Council of Medical Research (ICMR), Government of India, New Delhi. Authors are thankful to Dr. Susil Pal of the Human Genetic Engineering Research Centre (HGERC), Kolkata, for providing logistic support to conduct this work. Authors are also indebted

to all the subjects who participated in the study.

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**Source of Support:** Indian Council of Medical Research, Government of India, New Delhi.,  
**Conflict of Interest:** None declared.

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