Original Paper

Low Fat Intake and Coronary Artery Disease in a Population with Higher Prevalence of Coronary Artery Disease: The Indian Paradox

Ram B. Singh, MD, FACN, Mohammad A. Niaz, PhD, Saraswati Ghosh, PhD, Raheena Beegom, PhD, Poonam Agarwal, PhD, Swarna Nangia, PhD, M. Moshiri, MD, and Edward D. Janus, MD

Heart Research Laboratory and Nutrition Center, Medical Hospital and Research Center, Moradabad, INDIA; Rajaie Cardiovascular Research Center, Tehran, IRAN; and Royal Children's Hospital, Parkville, AUSTRALIA

Key words: saturated fat, serum cholesterol, coronary artery disease, body mass index

Objective: To determine the association between saturated fat intake and prevalence of coronary artery disease (CAD) and coronary risk factors.

Design and Setting: Total community cross sectional survey of 20 urban streets out of 196 streets, in the city of Moradabad in north India.

Subjects and Methods: Adult population between 25 to 64 years inclusive comprised of 1806 subjects (904 men, 902 women) were divided into three groups according to level of saturated fat intake as assessed by 7-day dietary intake records (very low <7%, low 7 to 10%, high >10% energy (en) per day).

Results: We examined the relationship between CAD risk and levels of % en from fat intake. Low (7 to 10% en/day) and high (>10% en/day) saturated fat were positively and significantly associated with higher prevalence of CAD. The prevalence of coronary risk factors (hypertension, hypercholesterolemia, obesity and sedentary lifestyle) were significantly higher among subjects with low and high saturated fat intake compared to subjects with very low (<7%) saturated fat intake. Logistic regression analysis with adjustment for age showed that hypercholesterolemia (OR: men 0.89, women 0.68), hypertension (men 0.92, women 0.56), physical activity (men 0.80, women 0.36), obesity (men 0.82, women 0.88) and smoking (0.70 men) were significant risk factors of CAD. Low and high saturated fat intake were associated with more prestigious occupations, higher and middle income status and better educational levels compared to very low saturated fat intake.

Conclusions: The prevalence of CAD and coronary risk factors was higher in urban Indians with low and high saturated fat intake than those with lower saturated fat intake. These findings suggest that the saturated fat intake should be <7% en/day for prevention of CAD in Indians.

INTRODUCTION

There is convincing epidemiological evidence that in populations with very low serum cholesterol and saturated fat intake such as rural Indians and Chinese, the relation of saturated fat intake to serum cholesterol and of serum cholesterol to coronary artery disease (CAD) still holds [1–6]. In most developing countries [2], the total fat (<30% kcal/day) and saturated fat intakes and serum cholesterol levels in their urban populations are lower or within desirable range, however there is rapid emergence of CAD in these countries [3]. The Seven Countries Study [6] showed that populations with an average saturated fat intake between 3% and 10% of energy intake were characterized by a serum cholesterol level below 200 mg/dl (5.17 mmol/L) and by low mortality rates from CAD. However this study did not include any other population group from developing countries with serum cholesterol levels around 200 mg/dl (5.17 mmol/L) which may have shown relatively higher prevalence such as in Indian and Chinese urbans [4–8]. Studies in Indian rural and urban subjects [4] showed lower saturated fat consumption (4.9% and 9.2%) and low serum cholesterol levels [167 mg/dl (4.3 mmol/L) and 203 mg/dl (5.2 mmol/L)], respectively which were associated with a significantly increased prevalence of CAD in urban (8 to 13%) compared to

Address reprint requests to: Ram B. Singh, MD, Heart Research Lab, Med Hosp Res Cen, Civil Lines, Moradabad-10 (U.P.) 244 001 INDIA.

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rural (3%) populations [8–10]. These studies indicate the possibility of an Indian paradox, and that the concept of normal saturated fat intake and normal cholesterol level may have little meaning among Indians. On a population basis, the risk of CAD rises progressively with increases in saturated fat intake >5% kcal/day and in serum cholesterol level >150 mg/dl (3.89 mmol/L) [4–8]. However there is some controversy regarding the role of dietary fat intake and serum cholesterol level in the etiology of CAD in Indians [9–12]. It is possible that developing populations are in a better situation to demonstrate the relation of rapid changes in diet and lifestyle and increased prevalence of CAD and coronary risk factors because dietary changes among them are of more recent origin and there are wide differences between rural and urban and between poor and rich classes. In the present study, we examine the relation of CAD with saturated fat consumption in an Indian urban population.

SUBJECTS AND METHODS

The study was conducted in the city of Moradabad and the sampling frame consisted of the total population which is 0.43 million according to the 1991 census of India. Details of survey methods have been reported elsewhere [4]. The city has 40 wards which are subdivided into 196 streets or Mohallas. After excluding 16 suburban streets, 20 out of 180 streets were randomly selected by the persons unconnected with the study by blindly selecting 20 cards each enclosed in a sealed envelope from the stack containing cards marked 1 to 180 numbers sealed in 180 envelopes.

Sample Selection

Assuming from other studies that the prevalence of CAD is at least 5% in the community [4], we would need a sample of at least 1500 to estimate with 90% confidence to detect at 5% significance a relative risk of 1.54 for prevalent CAD in Indians [13]. This calculation is based on the assumption that the sampling is done by a simple random method. Since our sample was a cluster sample and we wanted to study a larger population for greater precision, the sample size was increased to approximately 2000 subjects. With a sample of 2000 persons we would be able to estimate the prevalence within 2% error on either side which was deemed satisfactory as a first estimate.

Study Design

Each street contained 6 to 12 blocks or clusters. Of 20 streets randomly selected, two blocks or clusters were randomly selected from each street. The addresses for the correspondence were obtained from the electoral list and house tax registers of corporation of Moradabad city. We were successful in contacting 1991 persons aged 25 to 64 years of which 185 (9.3%) subjects refused to give blood for examination. The remaining 1806 subjects, (904 males and 902 females) were invited for this study.

Detailed interviews were performed with a pretested and validated questionnaire [4] (prepared according to guidelines of the World Health Organization, [13]) by the nutritionist and a physician to collect detailed information on dietary intakes, age, sex, education, occupation, socioeconomic status, physical activity, alcohol intake and smoking and past and family history of hypertension, diabetes and CAD (Rose Questionnaire). Subjects without any education were placed in the no education group. Highest class achieved in school or college was used to calculate the number of years of education. Those who had up to 5 years of education were included in primary education group and those whose education extended beyond 5 years were classified as beyond primary education. The socioeconomic status of the family was classified as high, middle and low based on housing condition, occupational income of all the family members and number of dependents. Per capita income was calculated by dividing the total income of the family by the total number of family members.

Dietary intakes were obtained by weekly diet diaries of all adults in the household by using food measures, food models, and food portion estimates. Since a large majority of subjects had no education, educated neighbors and dietitians helped them in filling the diet diaries. A cross check questionnaire was completed based on weekly diet diaries by asking probing questions to assess the exact intake of foods mentioned in the diaries. All subjects were asked to fill every food item taken at meals and between meals around the time of eating. Fruit, vegetable and legume intakes were weighed by all the subjects before recording to find out more accurate information. Indian food composition tables [14] were used to calculate 24 hour nutrient intakes by computation based on questionnaires, weekly diet diaries and the weight of fruit, vegetable and legume intake. Saturated fat consumption was subdivided into very low (<7% en/day), low (7 to 10% en/day) and high (>10% en/day) and all subjects were classified according to saturated fat intake.

Physical examination included measurements of height, weight and blood pressure. Blood pressure (systolic and diastolic phase V of Korotkoff) was measured in right arm after 5 minute rest in sitting position by a single standard mercury manometer and by the same physician in all subjects. In those subjects suspected with hypertension (>140/90 mmHg), blood pressure was also recorded after a 5-minute rest lying comfortably in the supine position to confirm the presence of hypertension. A 12-lead electrocardiogram was recorded on all subjects. A fasting blood sample after a overnight fast was obtained from all the subjects. Total cholesterol and triglyceride levels were estimated by an enzymatic method. The concentration of high-density lipoprotein cholesterol was obtained after precipitation of non- high-density lipoprotein cholesterol with manganese-heparin substrate. The concentration of low-density lipoprotein cholesterol was derived by using Friedwald's formula: low-density lipoprotein=total cholesterol−high-density lipoprotein- (triglyceride/5).

Criteria

Body mass index was calculated and obesity defined [11] as a body mass index ≥27 kg/m^2. Hypertension was diagnosed when systolic blood pressure was ≥140 mmHg and diastolic blood pressure was ≥90 mmHg, as per guidelines of the Joint National Committee [15]. Figures for WHO criteria [13] for the diagnosis of hypertension (>160/95 mmHg) were also calculated. Hypercholesterolemia was diagnosed in presence of serum cholesterol >5.18 mmol/L (>200 mg/dl) and hypertriglyceridemia in presence of serum triglyceride >2.08 mmol/L (>185 mg/dl). Those persons who smoked ≥ cigarette, beedi (tobacco rolled in leaf) or hukka (pipe) were considered smokers. Those smoking <15 cigarettes/day were classified as mild smoker and those >15 cigarettes/day as heavy smokers. Smoking of >1 cigarettes/day was considered in our analysis, non-smokers were excluded from the analysis. Physical activity was assessed by determining both occupational [14] and spare time activities [16]. Household activities for women were considered occupational. According to Paffenberger et al [16], a person who walks less than 14.5 km a week, climbs fewer than 20 flights of stairs a week, or performs no moderately vigorous physical activity on 5 days a week is considered sedentary. Subjects were classified into sedentary vs. moderately active categories.

The diagnosis of CAD was based on World Health Organization Criteria [13]: a) a documented history of angina or infarcation and previously diagnosed CAD, b) affirmative response to the Rose Questionnaire, and c) electrocardiographic changes namely Minnesota codes 1-1, 1-2, 4-1, 5-1 or 9-2. We also regarded the diagnosis as confirmed when there were only ST-T and Q wave changes or Q wave changes in the electrocardiogram. Proper response to Rose Questionnaire varies in different cultures and may influence the diagnosis of CAD.

Statistical Analysis

Mean values were expressed with 1 SD and prevalence given as percentages. P values were two tailed and significance was taken as $p<0.05$. To determine the significance of trends in the prevalence of CAD and risk factors in various groups (divided according to status of saturated fat intake), the X^2 test was used. The Mantel-Haenzel statistic which tests for linear association was determined with statistical package (SPSS, Inc, Chicago). Spearmans coefficient of rank correlation (r) was calculated for status of saturated fat intake with various physical parameters such as age, body mass index and systolic and diastolic blood pressure and lipoprotein lipid levels. Systolic and diastolic blood pressure and lipid levels were determined at various levels of saturated fat intake and the significance of trends checked with Kendall's test. Multivariate analysis to obtain the overall relation of saturated fat intake with CAD and risk factors was performed by logistic regression. The dependent variables were: presence or absence of CAD, hypertension, smoking physical activity, obesity (BMI>27 kg/m^2), and hypercholesterolemia. Independent variables were saturated fat intake (>7% en/day), level of education, socioeconomic status, age and physical measurements. A relation was initially determined between the risk factor and the level of saturated fat consumption. Age, which is the major factor, was then added to the equation and odds ratios determined and tabulated. After adding body mass index (>27 kg/m^2) blood pressure, (>140/90 mmHg), total cholesterol, (>200 mg/dl), smoking (>1 cigarettes or beedies/day) and physical activity to the equation, odds ratios were calculated. In India, saturated fat intake may be associated with higher social class and physical activity and smoking with lower social classes [4,8].

RESULTS

Total energy (mean±SD) (9936±715 vs. 8612±665 KJ/day), total fat (25.7±4.8 vs. 26.1±5.2% kcal/day) saturated fat (10.0±1.4 vs. 9.8±1.2% kcal/day), dietary cholesterol (156±12 vs. 150±90 mg/day) and fruit, vegetable and legume intake (198±22 vs. 180±15 g/day) were comparable in men and women, respectively. The consumption of saturated fat as percentage energy in different age groups in both sexes was also comparable (data not shown).

The level of saturated fat intake among men (n=904) and women (n=902) in the total study population of 1806 adults is shown in Table 1. The amount of saturated fat intake varied with occupation. Low and higher saturated fat intake were more common among professionals, business men, shop keepers, executives, clerks and skilled workers compared to unskilled workers or laborers. A greater proportion of subjects with primary education and beyond and those in the middle and high socioeconomic status groups consumed low and high saturated fat than those with no education and those in low socioeconomic status groups respectively (Table 1).

The total prevalence of CAD was 9.0% (n=163) with a prevalence of 11.0% (n=100) in men and 6.9% (n=63) in women. The prevalence was lowest in the age group of 25 to 34 years in both sexes. The prevalence of CAD between 45 to 64 years of age was also higher in men compared to women (Table 2). The prevalence of CAD in relation to saturated fat intake is shown in Table 3. An overall decline in the prevalence of CAD with lowering in saturated fat intake was apparent in both sexes and the trend was significant for total prevalences both for men ($X^2=17.2$, $p<0.001$) as well as for women ($X^2=12.6$, $p<0.004$). With respect to change in the electrocardiogram, both ST-T and Q wave changes were significantly more common among subjects in the high and low saturated fat groups compared to very low saturated fat group in both sexes. Q wave

Table 1. Characteristics of Subjects According to Saturated Fat Intake by Sex

	Men (n=904) Saturated fat intake (% kcal/day)			Women (n=902) Saturated fat intake (% kcal/day)		
	Very low (<7%)	Low (7–10%)	High (>10%)	Very low (<7%)	Low (7–10%)	High (>10%)
Occupation						
Professional	38 (18)	223 (46)	97 (47)	10 (5)	27 (6)	10 (5)
Business, clerical and artisan	52 (25)	220 (45)	80 (39)	16 (8)	70 (14)	08 (4)
Household	—	—	—	160 (77)	335 (69)	162 (76)
Worker	120 (57)	46 (9)	28 (13)	22 (10)	50 (10)	32 (15)
Total	210 (100)	489 (100)	205 (100)	208 (100)	482 (100)	212 (100)
Educational level						
Beyond primary (>5 years)	30 (14)	265 (54)	110 (53)	17 (8)	252 (52)	114 (54)
Primary (1–5 years)	75 (36)	203 (41)	81 (39)	60 (29)	198 (41)	70 (33)
No education	105 (50)	21 (4)	14 (7)	131 (63)	32 (6)	28 (13)
Total	210 (100)	489 (100)	205 (100)	208 (100)	482 (100)	212 (100)
Socioeconomic status (rupies per month)						
>600	37 (17)	170 (35)	85 (41)	32 (16)	175 (36)	91 (43)
300–600	63 (30)	205 (42)	105 (51)	60 (21)	200 (41)	80 (38)
<300	110 (52)	114 (23)	15 (7)	116 (56)	107 (22)	41 (19)
Total	210 (100)	489 (100)	205 (100)	208 (100)	482 (100)	212 (100)

Numbers in parentheses represent percent of subjects.

Table 2. Prevalence of Coronary Artery Disease by Age and Sex

Age groups	Men		Women		Total	
	No. of subjects	Coronary artery disease	No. of subjects	Coronary artery disease	No. of subjects	Coronary artery disease
25 to 34	304	25 (8.2)*	354	15 (4.2)	658	40 (6.0)
35 to 44	290	36 (12.4)*	254	15 (5.9)	544	51 (9.3)
45 to 54	182	23 (12.6)*	171	18 (10.5)	353	41 (11.6)
55 to 64	128	16 (12.5)	123	15 (12.1)	251	31 (12.3)
Total	904	100 (11.0)*	902	63 (6.98)	1806	163 (9.0)
Total between 45 to 64 years	310	39 (12.5)*	294	33 (11.2)	604	72 (11.9)

* =$p<0.01$, p value obtained by X^2. Test by comparison of males and females.
Numbers in parentheses represent percent of subjects.

changes alone were also associated with low and high saturated fat intakes (Table 3).

Table 4 shows the prevalence of risk factors in men and women. Higher body mass index was more common in women but physical activity, diabetes, and hypertension were less common and smoking was rare. Hypercholesterolemia was comparable in both sexes. Prevalence of major risk factors for CAD according to level of saturated fat intake revealed that a decreasing level of saturated fat in the diet was associated with a significant downward trend in the prevalence of hypertension (men, $X^2=30.71$, $p<0.001$, women; $X^2=17.8$, $p<0.001$), hypercholesterolemia (men, $X^2=60.6$, $p<0.001$, women, $X^2=62.4$, $p<0.001$) obesity and sedentary lifestyle as shown in Table 5. There was no association with smoking but physical activity was greater with lower saturated fat consumption.

Table 6 shows the lipoprotein levels and blood pressure at various levels of saturated fat intake. Mean levels of total cholesterol, body mass index as well as systolic and diastolic blood pressure showed a downward trend with decreasing level of saturated fat intake. This trend was nonsignificant with high- and low-density lipoprotein cholesterol and triglyceride in both sexes. There was a significant positive rank correlation of the saturated fat intake with weight and body mass index in men and inverse correlation with systolic and diastolic blood pressure in both sexes (Table 7). Level of saturated fat intake showed significant correlation with total cholesterol in both sexes but no correlation was observed with low- and high-density lipoprotein cholesterol and triglyceride.

Multivariate logistic regression analysis was performed to find out the relation of saturated fat consumption and other risk factors with CAD. The results showed a significant positive association of level of saturated fat consumption with the age

Table 3. Prevalence of Coronary Artery Disease in Relation to Saturated Fat Consumption by Sex

Saturated fat intake (% kcal/day)	Men (n=904)			Women (n=902)		
	Clinical and electrocardiographic	ST-T and Q wave changes	Q waves only	Clinical and electrocardiographic	ST-T and Q wave changes	Q waves only
Very low (<7%)	10 (4.7)	7 (3.3)	5 (2.3)	7 (3.3)	5 (2.4)	—
Low (7 to 10%)	52 (10.6)	40 (8.2)	32 (6.5)	30 (6.2)	28 (5.8)	6 (1.2)
High (>10%)	38 (18.5)	35 (17.0)	23 (11.2)	26 (12.2)	22 (10.3)	10 (4.7)
Total	100 (11.0)	82 (9.0)	60 (6.6)	63 (6.98)	55 (6.0)	16 (1.7)
Mantel-Haenzel X^2	17.2	24.2	11.4	12.6	11.0	7.7
P value	<0.001	<0.001	0.005	0.004	0.005	0.02

Numbers in parentheses represent percent of subjects.

Table 4. Prevalence of Coronary Risk Factors

Risk factors	Men (n=904)	Women (n=902)	Total (n=1806)
Body mass index (>27 kg/m^2)	95 (10)	120 (13)	215 (12)
Moderate physical activity			
Occupational	194 (21)	104 (11)	298 (16)
Spare time	92 (10)	60 (6)	152 (8)
Both	102 (11)	65 (7)	167 (9)
Cigarette smoking (current and past)			
Smoker (>15/day)	105 (12)	4 (0.4)	109 (6)
Mild smoker (1–15/day)	83 (9)	11 (1)	94 (5)
Total	188 (21)	15 (1.6)	203 (11)
Diabetes mellitus	63 (7)	45 (5)	108 (6)
Hypertension (mmHg)			
Blood pressure (>140/90)	226 (25)	202 (22)	428 (24)
Blood pressure (>160/95)	125 (13)	117 (13)	242 (13)
Abnormal lipid levels			
Cholesterol (>5.18 mmol/L)	302 (33)	306 (34)	608 (34)
Low-density lipoprotein cholesterol (>3.21 mmol/L)	282 (31)	285 (32)	567 (31)
High-density lipoprotein cholesterol (<0.9 mmol/L)	105 (12)	65 (7)	170 (9)
Triglycerides (>2.08 mmol/L)	194 (21)	202 (22)	396 (22)

Numbers in parentheses represent percent of subjects.

adjusted prevalence of CAD, hypercholesterolemia, hypertension, obesity and physical activity. Significant positive correlation was observed in men with smoking (>1 cigarettes or beedies/day) (Table 8). Adding serum cholesterol, systolic and diastolic blood pressure, physical activity, body mass index and smoking to the equation in both men (OR: 0.93, 95% CI: 0.85 to 1.08) and women (OR: 0.76, 95% CI: 0.56 to 1.05) abated the association of level of saturated fat intake with the prevalence of CAD.

DISCUSSION

The Indian Lifestyle and Heart Study shows that CAD and coronary risk factors were significantly associated with the level of saturated fat consumption in a cross-sectional study of a cohort of urban North Indians. High and low saturated fat intakes were associated with a higher prevalence of CAD. The relation of saturated fat consumption with CAD remained significant after adjustment of age but decreased after addition of other risk factors in a multivariate analysis. Hypertension, hypercholesterolemia, obesity and sedentary lifestyle were also more common among subjects consuming high (>10% en/day) and low (7 to 10% en/day) saturated fat compared to those taking very low (<7%, en/day) amounts of dietary saturated fat. While the prevalence of smoking was comparable for subjects in the three saturated fat intake categories, a greater proportion of subjects in the high saturated fat intake group was inactive compared with those in the low and very low saturated fat groups. In addition to the independent risk associated with low saturated fat intake and sedentary, lifestyle, the interaction between these variables may further increase the CAD risk in urban Indians.

Epidemiologic studies have demonstrated a significant positive association between total and saturated fat intake and increased risk of CAD [5–8]. These studies showed that populations with average saturated fat intake below 10% of energy intake had serum cholesterol level below 200 mg/dl (<5.17 mmol/L) and low CAD related mortality.

In view of these findings, populations in developed countries are advised to consume <30% total energy from fat and <10% en/day saturated fat for prevention of CAD [17]. However these limits of fat intake do not appear to be within safe limits for populations in developing countries because only a modest increase in fat intake and sedentary lifestyle during nutritional transition from poverty to affluence in these countries has been associated with rapid emergence of cardiovascular diseases and cancer [1–3]. In Indian immigrants to Great Britain, total fat (38.8 vs. 42.2% en/day) and saturated fat (13.7 vs. 18.5% en/day) intakes are lower than in British natives but the coronary death rate is 40% higher [3,9]. In the majority of the developing countries such as India, Sri Lanka, China, Thailand, Indonesia, Phillippines, Brazil, etc. [18] the total energy from fat intake is <30% en/day and from saturated fat intake is about 10% en/day, however, there is a rapid emergence of CAD in these countries [5–8].

In China the total fat (26% vs. 20% en/day) and saturated fat (8 vs. 6% en/day) intakes are higher in the urban compared to

Table 5. Prevalence of Major Risk Factors of Coronary Artery Disease in Relation to Saturated Fat Intake

Saturated fat intake (% kcal/day)	No. of subjects	Blood pressure >140/90 mmHg	Cholesterol >5.18 mmol/L	Body mass index >27 kg/m^2	Smoking	Sedentary lifestyle
			Men (n=904)			
Very low (<7%)	210	18 (8)	22 (10)	10 (5)	46 (22)	32 (15)
Low (7–10%)	489	140 (28)	168 (34)	45 (9)	99 (20)	250 (51)
High (>10%)	205	68 (33)	112 (54)	40 (19)	43 (21)	166 (80)
Mantel-Haenzel						
X^2		30.71	60.6	23.2	0.5	91.8
P value		<0.001	<0.001	<0.001	0.92	<0.001
			Women (n=902)			
Very low (<7%)	208	25 (12)	18 (18)	11 (5)	6 (3)	75 (35)
Low (7–10%)	482	110 (23)	162 (33)	60 (12)	9 (1.8)	280 (57)
High (>10%)	212	67 (32)	126 (61)	49 (24)	—	180 (88)
Mantel-Haenzel						
X^2		17.8	62.4	25.56	0.7	41.9
P value		<0.001	<0.001	<0.001	0.83	<0.001

Numbers in parentheses represent percent of subjects.

rural population which is characterized by higher serum cholesterol (4.7 vs. 4.1 mmol/L) and 2 to 3 times higher prevalence of CAD [7]. In India, saturated fat intake in rural, North Indian urban and South Indian urban populations were 4.9%, 9.2% and 14.2% and the prevalence of CAD were 3%, 8.6% and 13.9%, respectively [4,8]. The respective serum cholesterol levels in these populations were 4.3, 5.2 and 5.4 mmol/L indicating that low saturated fat intake may be associated with lower serum cholesterol level but a significant public health problem of CAD. In the Indian Lifestyle and Heart Study, the prevalence of CAD in subjects consuming low saturated fat (7 to 10% en/day) was 10.6% in men and 6.2% in women and the mean serum cholesterol levels were 5.01 and 5.02 mmol/L, respectively. These findings suggest that the prevalence of CAD even on low saturated fat intake is of sufficient magnitude that it should be considered a public health problem in the urban population of India. These levels of serum cholesterol, saturated fat intake and body mass index (22 kg/m^2) are considered within safe limits in developed countries (Table 6) [17].

It seems that the amount of total and saturated fat and dietary cholesterol consumed by Indian urbans is much lower than that reported for developed countries [1,9,17]. However

Table 6. Risk Factor Levels in Relation to Saturated Fat Intake

Saturated fat intake (% kcal/day)	Body mass index	Total cholesterol (mmol/L)	Low-density lipoprotein cholesterol (mmol/L)	High-density lipoprotein cholesterol (mmol/L)	Triglycerides (mmol/L)	Blood pressure/(mmHg)	
						Systolic	Diastolic
			Men				
Very low (<7%)	20.1 (3)	4.01 (0.9)	2.26 (0.8)	1.14 (0.2)	1.32 (0.4)	121 (15)	81 (11)
Low (7–10%)	22.0 (4)	5.01 (1.2)	2.84 (0.9)	1.16 (0.3)	1.71 (0.6)	127 (18)	85 (12)
High (>10%)	24.6 (4)	6.02 (1.4)	3.22 (1.1)	1.17 (0.3)	1.97 (0.5)	130 (18)	87 (13)
Kendall's test	0.058	0.059	0.028	−0.030	0.032	0.102	0.089
t value	2.61*	2.65*	1.26	−1.35	1.44	4.59**	4.0**
			Women				
Very low (<7%)	19.8 (3)	4.01 (0.8)	2.24 (0.7)	1.16 (0.2)	1.65 (0.4)	121 (14)	78 (10)
Low (7–10%)	22.1 (4)	5.02 (1.0)	2.75 (0.9)	1.21 (0.3)	1.67 (0.6)	123 (16)	80 (13)
High (>10%)	24.8 (4)	5.81 (1.1)	3.16 (1.1)	1.24 (0.4)	1.69 (0.6)	128 (17)	84 (13)
Kendall's test	0.062	0.058	0.032	−0.027	0.045	0.093	0.085
t value	2.79*	2.61*	1.44	1.21	2.02	4.18**	3.85*

* =p<0.01, ** =p<0.001.
Values are means (1 SD).

Table 7. Mean Levels of Clinical and Biochemical Risk Factors and Their Correlation with Saturated Fat Intake

	Men		Women	
	Mean	r	Mean	r
Mean age (years)	42.8 (10)	0.05	41.0 (9)	0.04
Mean body weight (kg)	64.3 (7)	0.08*	52.8 (4)	0.09*
Body mass index (kg/m^2)	22.6 (4)	0.08*	22.5 (4)	0.09**
Systolic blood pressure (mmHg)	126 (18)	0.19**	124 (17)	0.17**
Diastolic blood pressure (mmHg)	84 (14)	0.16**	81 (12)	0.14**
Total cholesterol (mmol/L)	4.92 (1)	0.08*	4.91 (1)	0.07*
Low-density lipoprotein cholesterol (mmol/L)	2.80 (1)	0.03	2.78 (1)	0.04
High-density lipoprotein cholesterol (mmol/L)	1.16 (0.3)	−0.04	1.22 (0.4)	−0.03
Triglyceride (mmol/L)	1.66 (0.05)	0.04	1.68 (0.6)	0.06*

** $=p<0.001$, * $=p<0.01$.
Numbers in parentheses are 1SD. (Spearman's rank correlation).

Table 8. Age-Adjusted Odds Ratios and Confidence Intervals for Association of Coronary Artery Disease with Risk Factors in Relation to Saturated Fat Intake by Logistic Regression

	Odds ratio	Men (95% CI)	Odds ratio	Women (95% CI)
Hypercholesterolemia	0.89	(0.80 to 0.98)**	0.68	(0.60 to 0.82)**
Hypertension	0.92	(0.81 to 0.99)*	0.56	(0.48 to 0.68)**
Smoking	0.70	(0.66 to 0.86)*	0.99	(0.72 to 1.36)
Obesity	0.82	(0.74 to 0.98)*	0.88	(0.73 to 0.98)*
Physical activity	0.80	(0.69 to 0.98)*	0.36	(0.18 to 0.52)*

* $=p<0.05$, ** $=p<0.01$.

the serum cholesterol of Indian urbans is not proportionately lower compared to serum cholesterol level in these countries [1,9,17]. Similar disparity in dietary fat intake and serum cholesterol levels has been observed in Hong Kong [19] among Chinese children which may be due to a possible genetic difference in the efficiency of handling dietary fat. Such genetic differences in handling of nutrients may be a manifestation of the thrifty phenotype which may have developed due to genetic and metabolic adaptations during scarcity or during poor nutrition in fetal life and infancy [20].

The Indian Lifestyle and Heart Study also showed that CAD was less common among unskilled workers and in no education and poor socioeconomic groups (Table 1). The majority of subjects in these subgroups had very low consumption of saturated fat (<7% kcal/day) and higher physical activity. Epidemiologic evidence [21,22] from developed countries indicate that during the past 30 years, CAD and coronary risk factors have become more prevalent among uneducated people and people of low social class, although before 1960 CAD may have been less common in the lower income group [23]. It seems that as economic development proceeds, CAD increases and as it proceeds further, it declines with prosperity. In China, CAD is less common in the low social class compared to higher class which is similar to our findings [7]. Only a few Indian studies have analyzed data according to social class [11,24,25]. These studies showed that CAD was more common in the higher income groups [25] and less common among unskilled workers engaged in physically demanding work [24,26]. Only one recent study in a rural population showed that CAD was more common among illiterate and less educated people [11] which may be due to absence of poor subjects in the population.

In India, the higher and middle social class which is more affluent and educated, especially in the urban areas, consumes clarified butter (ghee), butter, snacks cooked in hydrogenated fat or clarified butter and more animal foods. The low social class people are poor and illiterate or less educated and are usually engaged in unskilled physically demanding work. They consume either traditional mustard oil or hydrogenated fat and animal foods in amounts too low (total fat intake <15% kcal/day) to predispose CAD. According to national sample survey, fat intake is significantly higher in the higher income groups compared to low social class and people in the higher and middle social class are also more sedentary [14].

The mechanism whereby CAD is increased in Indians who consume low saturated fat intakes may be due to widespread malnutrition in communities adapted to survival on low fat intakes and physically demanding work which allows them to develop metabolic and genetic adaptations during periods of food scarcity and during fetal and infant life [20]. There is increased genetic and metabolic susceptibility to rapid change in diet and lifestyle which alters the metabolism of saturated fat, energy and dietary cholesterol predisposing atherosclerosis and thrombosis even at lower levels of risk factors [27]. While increased levels of lipoprotein (a) [12] observed in Indians may be a manifestation of genetic adaptation, insulin resistance syndrome [10] and hypercholesterolemia even on low energy and low saturated fat intake may be a manifestation of metabolic adaptations. In France and southern Europe, higher fat intake (45% en/day) is associated with a low prevalence of CAD which is called the French paradox [6,27]. In Indians, higher prevalence of CAD in association with low saturated fat intake may be called the Indian "paradox" which occurs due to their genetic and metabolic susceptibility to CAD [10,12]. Saturated fatty acids can also predispose arrhythmias and thrombosis [27,28], hypertension and insulin resistance [29]. Our data suggest that saturated fat intake >7% kcal/day of energy intake may be a risk factor for CAD in Indians. Therefore, for prevention of CAD in Indians, total energy from saturated fat should be <7% en/day. One potential limitation in our study was that the subjects were obtained from a cluster sample. Low education may have prevented accurate recording of food intakes, however, assistance from educated members of the family and neighbors and dietitians and the crosscheck questionnaires were useful to correct dietary assessment.

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