Original Research

Association of Ghee Consumption with Lowered CHD History: A Study in Urban North Indian Adults

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Commentary

Ghee has been described in Ayurveda and used in Indian subcontinent, parts of Middle East and Africa as a cooking medium and for its medicinal properties. In the 1950's, the emerging evidence in the West linked consumption of saturated fats to cardiovascular disease (CVD), leading to all international guidelines recommending replacing them with unsaturated fats. This was unfortunately translated to intake of ghee by doctors in India and was implicated with rising incidence of CVD. However, no direct studies have been performed to evaluate this association despite a continuing large consumption of ghee in India. Moreover, even the more recent scientific evidence in the form of meta-analysis are demonstrating lack of association between saturated fat consumption and CVD, implicating the increased use of trans-fatty acids, and also differentiating between fats from animal and dairy origins. The current article with a cross-sectional study evaluating the association of ghee consumption with lipid profile and coronary heart disease in Indian urban population is a welcome step in the right direction. However, there is an urgent need for a large multi-centre randomized prospectively study evaluating the effect of ghee on heart disease and cancers, due to rapidly rising epidemic of these lifestyle diseases in India.

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ABSTRACT

Aim

Ghee/clarified butter has often been implicated with risk of coronary heart disease (CHD) due to its saturated fatty acids and cholesterol content. Hence, the study was done to evaluate the association of ghee consumption & history of CHD among north Indians.

Methods

The cross-sectional study was done in 200 urban adults of India after random selection during the period of 2009 to 2011. The history of CHD was assessed after dividing the population into 3 groups based on oil (O) & ghee (G) consumption/ month: (Group A) O>1l/month, G<0.5kg/month; (Group B) 01 to >0.5 L/month, G 0.5-1.25kg/month; & (Group C) O 0.2-0.5l/month, G>1.25kg/month.

Results

Total ghee consumed per month had negative correlation with the history of CHD. Logistic regression analysis showed

that the odds of CHD among group C & B were 0.491 & 0.791 times that of group A over & beyond gender respectively.

Conclusions

History of CHD was lowest among the group with highest ghee & lowest oil consumption.

Keywords: Ghee,clarified butter, coronary heart disease, Coronary artery disease, cholesterol, Saturated fat, serum lipid profile

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Introduction

The word ghee comes from Sanskrit '*ghrita'*. Ghee is widely considered as the Indian name for clarified butterfat, usually prepared from cow's milk, buffalo's milk or mixed milk (1). The International Dairy Federation (1977) defined ghee as a product exclusively obtained from milk, cream or butter from various animal species by means of processes which result in the almost total removal of moisture and which gives the product a particular physical structure. The standard ghee contains 96% minimum milk fat, 0.3% maximum moisture, 0.3% maximum free fatty acids (FFA) (expressed as oleic acid), and a Peroxide Value (PV) less than 1.0 (2).

Ghee is widely used in Indian cuisine especially in Punjab, Haryana, Gujarat, Maharashtra, Bengal, South India, Orissa and many other states. Ghee is an ideal fat for deep-frying because it's smoke point (where its molecules begin to break down) is 250 °C (485 °F), which is well above desired cooking temperatures-around 200 °C (400 °F). In India, ghee is also considered as a sacred article used in religious rites (1).

Annual production of ghee in India, amounts to 800,000 tons, the bulk of which is produced by the indigenous method (3). Ghee is a source of lipid nutrients, fat-soluble vitamins and essential fatty acids (4). About 70% of the fatty acids in milk are saturated, of which about 60% are long-chain fatty acids (5). The monoenes, mainly 18: 1, constitute most of the remainder, with the dienes and trienes together only accounting for about 3%. Besides, being a concentrated source of energy (9kcal/gm), ghee is rich in vitamin A, D, riboflavin as well as in minerals such as calcium, magnesium, phosphorus and potassium (3).

The impact of various dietary fats on cardiovascular disease had been studied extensively using serum lipoproteins (6, 7). Controlled experimental studies by different groups had found that people consuming high-unsaturated fat diets experience negative cholesterol profile changes and lower cardiovascular risk (8-11). Although there are some study which showed no statistically significant relationship between cardiovascular disease and dietary saturated fat or, dairy products (12, 13).

All these studies had almost entirely based on dietary fats commonly used in western countries. Research on the effect of ghee on cardiovascular health in Indian population is limited. Study on healthy young Indian by Shankar SR et al. indicated that there is no serious adverse effect of ghee on lipoprotein profile. Consuming ghee at the level of 10% of total energy intake in a vegetarian diet generally has no effect on the serum lipid profile of young, healthy, physically active individuals (14, 15). Another study on Indian population by Gupta et al. showed that prevalence of coronary heart disease (CHD) in men were low, who consumed more ghee in their diet (16). On the contrary Ismail J (2004) showed that ghee intake are associated with premature acute myocardial infarction in South Asians population (17).

Our study was done with an aim to evaluate association of total ghee consumption per month with CHD history and lipid profile among the studied subjects.

Materials and methods

This cross-sectional study was carried out on urban population of Jodhpur city, Rajasthan, India during the

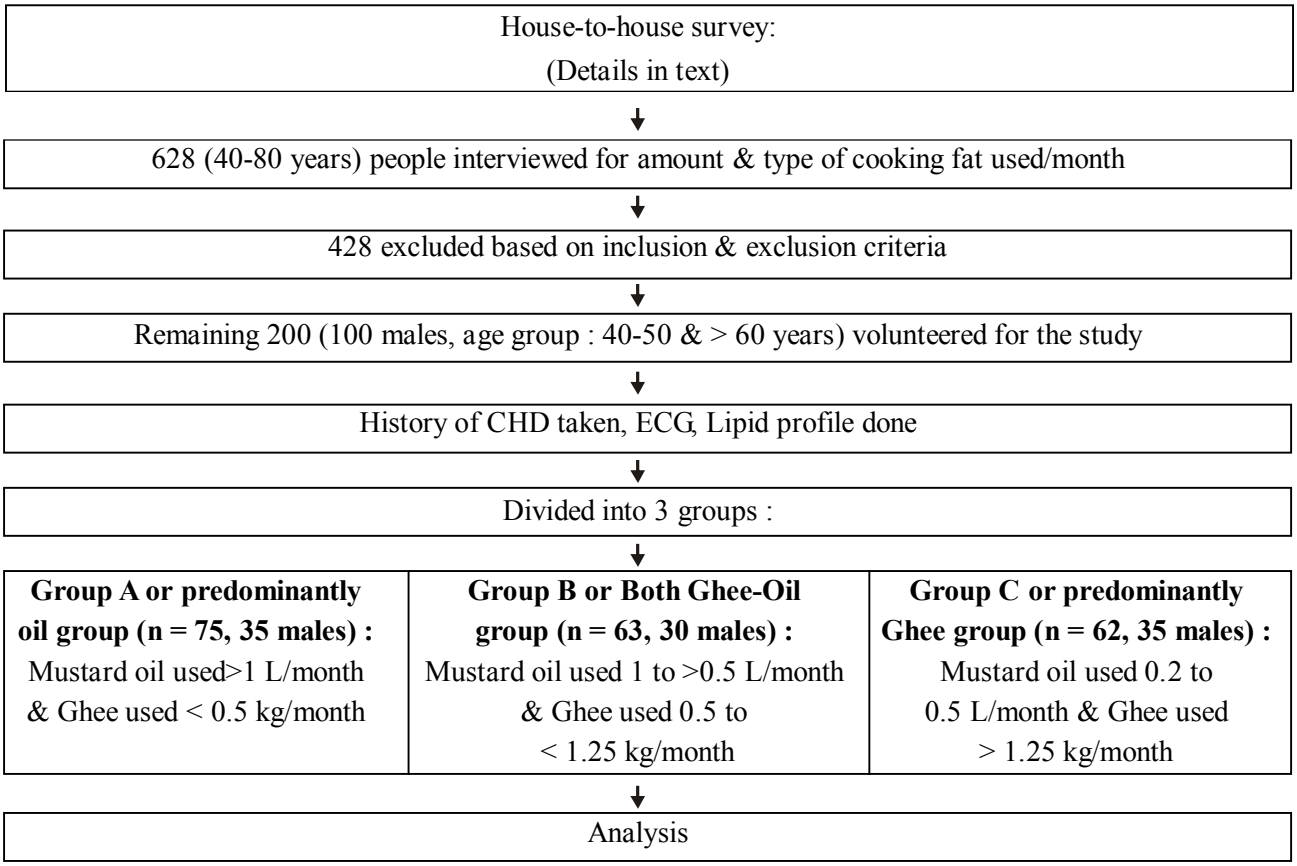
period of 2009 to 2011. 628 people aged between 40 to 80 years were interviewed for the amount and type of cooking fat (ghee and or, mustard oil) consumed and past history of CHD (myocardial infraction and or, angina) in a house-to-house survey. House-to-house survey was done in such a way that about 15-20 houses were covered in each 5km distance around Dr. S. N. Medical College upto a maximum of 25km from it. The first 5km distance was covered initially, then next 5 km and so on.

Out of the total population interviewed, 200 persons (100 males and 100 females) consuming ghee were selected for the study based on the following inclusion and exclusion criteria. Inclusion Criteria were: a. age: $\geq$40 years, b. apparently healthy with no health related complaints, c. non-obese (BMI < 30kg/m^2). Exclusion Criteria (risk factor for CHD) were a. chronic alcoholic, b. chronic smoker, c. history of diabetes mellitus, uncontrolled hypertension, deep vein thrombosis, d. low physical activity or sedentary life style, e. familial history of CHD.

Institutional Review Board and Ethical Committee approved the study.

The dietary records were obtained in the first house-to-house visit to collect data regarding amount and type of cooking fat consumed. The food frequency questionnaire (24-hour dietary recalls) method was used, subjected to confirmation by trained dieticians of the institute. The Food frequency questionnaire (FFQ) is a valid tool for the assessment of dietary habits of Indian subjects (18-20). Information on disease history such as alcoholism, hypertension, diabetes, myocardial infraction or, angina and lifestyle behaviors, including smoking and exercise were obtained through a self-report system.

Figure 1: Study Design



The total study population was evaluated for following laboratory tests: (a) Lipid profile [Serum TG, Total Cholesterol, LDL Cholesterol, VLDL Cholesterol, HDL Cholesterol, TC/HDL Ratio, LDL/HDL Ratio] by using ELISA. (b) 12 lead ECG were taken to determine old ischemic events, which were interpreted by specialist in the field.

To define the role of ghee, the average amount of ghee and /or mustard oil consumed in a month was determined and divided into 3 groups (Figure 1): Total 75 subjects (35 male and 40 female) consumed oil more than 1lit/month but ghee less than 0.5kg/month (group A), 63 subjects (30 male and 33 female) consumed oil 1 L to > 0.5 L/month but ghee consumption between 0.5kg/month to <1.25kg/ month (Group B) and 62 subjects (35 male and 27 female) consumed oil 0.2 to 0.5lit/month and ghee >1.25kg/month (group C). The cut off value for the group division was according to the previous study in Indian population (16).

Statistical Analysis

Pearson Chi-Square test was used for comparison of the history of CHD in different age groups, among gender and in groups with different fat consumption per month. Whenever the minimum expected count in any of the cell of contingency tables came to be less than 5, Likelihood Ratio was evaluated. Correlation of history of CHD with various variables was evaluated using Kendall's tau b in the two gender groups. Binary logistic regression with history of CHD as dependent variable, and gender and different fat consumption group as independent variables was done. Due to multicollinearity, other potential independent variables were not included in the model. Areas under the Receiver Operating Characteristic (ROC) curves were calculated for all the potential positive and negative predictor variables for CHD occurrence, so as to assess the best classifier. Cut off values with maximum Youden Index were chosen, where Youden Index was calculated as sensitivity+specificity-1. SPSS (Statistical Package for Social Science) version 20 software was used for data analysis. Statistical significance was chosen at α value of $\leq$ 5% for all the analyses.

Results

Out of total CHD subjects studied (n=28, 14%), maximum were males and belonging to 40-50 year age group (Table 1). There was no statistical significant difference in frequency of CHD between the two genders and also among the three age groups studied. Also, the frequency of CHD was similar among the three groups with different type of fat consumption per month in both the gender (Table 2).

However, the total ghee consumed per month had negative correlation with the history of CHD, which was significant in case of the males (Table 3). And the history of CHD was found to have significant positive correlation with total oil consumed per month in addition to the various lipid profile variables, except for HDL in both the gender (Table 3). The finding, thus, indicated that the frequency of CHD was less among the subjects who consumed more ghee, and less oil per month. This however didn't indicate cause and effect relationship.

Logistic regression analysis also showed that the odds of CHD among predominantly ghee group (group C) was 0.491 times that of predominantly oil group (group A); in other words, the odds of CHD was lower by 50.9% (odds ratio or OR=0.491) among predominantly ghee group as compared to predominantly oil group, independent of gender (Table 4). Also, the odds for CHD was lower by 20.9% (OR=0.791) among both oil & ghee group (group B), as compared to predominantly oil group (group A) over and beyond gender. Independent of type of fat consumption per month, the odds of CHD was lower by 31.9% (OR=0.681) among the females as compared to the males. However, both the findings were not statistically significant (Table 4).

Considering different areas under the ROC curves (AUCs), LDL by HDL ratio was found to be the best classifier for

positive CHD history in both the gender, and when all the studied subjects were considered as a whole (Table 5). Similarly, HDL was the best classifier for negative CHD history (Table 6). Interestingly, total oil consumed per month was a statistically significant classifier for positive CHD history (Table 5); and total ghee consumed per month, a statistically significant classifier (except among females) for negative CHD history (Table 6). This became also clearer from figures comparing ROC curves of total ghee consumed per month as classifiers for negative CHD history (Fig. 1 to 3) in both the gender, and when all the studied subjects were considered as a whole.

Table 5 & 6 also show the cut off values with corresponding sensitivity and specificity of different classifiers for positive and negative CHD history. The cut off value of total oil consumed per month for positive CHD history was 0.815 L/month for the studied males, females and all the subjects considered as a whole (Table 5). Similarly, the cut off value of total ghee consumed per month for negative CHD history was 0.815 Kg/month for studied males and all the subjects considered as a whole (Table 6). In the studied females, total ghee consumed per month was not a statistically significant classifier for negative CHD history. Hence, the present study indicated that total oil consumed per month of less than 0.815 L/month, and total ghee consumed per month of at least 0.815 Kg/month was associated with less CHD history.

Discussions

Our results showed: (a) Frequency of CHD was less among the subjects who consumed more ghee, and less oil per month. (b) CHD was positively correlated with increased oil intake, blood level of TG, TC, LDL, VLDL, TC/HDL and LDL/HDL ratio.

Many research reports had already been shown the beneficial properties of ghee and herbal mixtures containing ghee in the form of decrease in serum total cholesterol, LDL, VLDL, triglycerides and decreased liver total cholesterol.

In animal study on Sprague-Dawley outbred rats, which serve as a model for the general population, showed no effect of 5% and 10% ghee-supplemented diets on serum cholesterol and triglycerides. Similarly study by Sharma et al. on Fischer inbred rats, which serve as a model for genetic predisposition to diseases showed that 10% dietary ghee fed for 4 weeks did not increase liver microsomal lipid peroxidation or liver microsomal lipid peroxide levels. They also showed that 10% dietary ghee did not have any significant effect on levels of serum total cholesterol, but did increase triglyceride levels (21). Study on Wistar rats AIN-76 model by Kumar et al. also showed that ghee at a level greater than 2.5% in the diet for a period of 8 weeks caused dose dependent decrease in serum total cholesterol, low-density lipoproteins and very low-density lipoproteins cholesterol, and triglyceride levels (22). In their subsequent experiment they proposed that ghee in diet caused significantly increased biliary excretion of cholesterol, bile acids, uronic acid, phospholipids and thus lower serum cholesterol levels (23).

Some groups, however, also reported adverse effect of ghee on animal study. In 1996 study on Male Rattus Norwegicus rats fed with a diet fortified with 20% weight butterfat (ghee) (BF) found it potentially more atherogenic than coconut oil fed rat in terms of serum lipids and Lipoproteins (24).

Randomized controlled trial for a period of 8 weeks on 24 healthy Indian, Shankar et al. showed ghee has no significant effect on the serum lipid profile when it is consumed in <10% of total energy intake as compared to mustard oil (19). Another study by the same group showed that introducing ghee as a partial replacement for mustard oil leads to rise in TC as well as HDL-C levels, so no significant change in TC/HDL-C ratio. They concluded that the rise in HDL cholesterol might be due to the considerable MUFA content of ghee (20).

Similarly, in a randomized clinical trial by Mohammadifard N. et al. on 206 healthy (20 to 60 years age group) participants from Iran, showed that ghee significantly reduced the total

cholesterol (TC) and triglyceride (TG) in comparison to hydrogenated oil (25).

Willett WC (2012) reported that trans fatty acids from partially hydrogenated vegetable oils have more adverse effects on heart. Modest reductions in CHD rates with decreases in saturated fat are possible if saturated fat is replaced by a combination of poly- and mono-unsaturated fat (26). Recent meta-analysis by Chowdhury R et al. (2014) clearly showed that high consumption of polyunsaturated fatty acids and low consumption of total saturated fats are not the cardioprotective diet (27). Dalen et al. (2014) in their systemic review also concluded that dietary fat reduction had a disappointing result in cardioprotection (28).

In addition to the above literature, our study is supported by a similar study on a rural population of Rajasthan in India by Gupta et al. (1997), which showed a significantly lower prevalence of CHD in men who consumed higher amounts of ghee more than 1kg/month. Multivariate analysis confirmed this association ($p< 0.001$) (16).

The beneficial effect of ghee on CHD may be due to absence of cholesterol oxidation products (COPs) in ghee. COPs may be the cause of atherosclerotic lesions (29). Nath et al. (30) reported that ghee contained 0.3-0.4% cholesterol and when ghee was manufactured and stored under normal condition it did not contain COPs like oxidation products. When ghee used for short period of frying, which is very common practice in India, did not produces sufficient COPs. However, after 15 min of frying, oxidized form may start appearing. This may be the reason why CHD history was less among those who consumed more ghee & less oil in our study.

In the last two to three decades, ghee has been implicated in the increasing prevalence of coronary artery disease (CAD) in Asian Indians living outside India, as well as upper socioeconomic classes living in large towns and cities in India (31-33). Cross-sectional surveys in a large North Indian population (1769 rural and 1806 urban, age group of 25-64years) by Singh et al. (1996) showed that prevalence of CAD was higher with higher visible fat intake in both sexes and in both rural and urban population (34).

However, available data in the literature did not support a firm conclusion of harmful effects of the moderate consumption of ghee in the general population. Raheja (1986) had clearly pointed out that Asian Indians previously had a low incidence of CHD, although they had been using ghee in their cooking for generations. The epidemic of CHD in India had began two to three decades ago when traditional fats were replaced by oils rich in linoleic and arachidonic acid (32, 33) as well as trans fatty acids, which comprise 40% of vanaspati (35). Adulteration of commercially prepared ghee with vanaspati was also prevalent in India. In light of this, researchers investigating ghee should ensure that the ghee used in their experiments should not be adulterated with vanaspati, which could yield spurious results.

Conclusions

The above data indicate that male persons who were consuming oil more than 0.815 lt/month and ghee less than 0.815kg/month were more prone to CHD. And the increased ghee consumed per month is associated with low CHD history in both male and female subjects.

The present study suggests that the adverse opinion about ghee and prevalent of CHD in the medical community may not be valid. Instead, less history of CHD was associated with more ghee & less oil consumption.

Limitations

Our study was a preliminary survey to find out the association of CHD and levels of ghee fractions in both males and females consuming different types of fats. Study was having several limitations. Firstly, the sample size of the study was very small. A well designed, randomized controlled cohort study of sufficient sample size is needed

for better evaluating and establishing the cause and effect relation with increased ghee and/or decreased oil consumption with decreased CHD risk.

Secondly, it was just a survey. No subject was investigated in any laboratory or thoroughly examined in a hospital setup. Thirdly, to ascertain the fat intake we relied on the words of subjects. No advanced measurement or, analysis was done.

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Tables

Table 1. History of CHD in different age groups as per gender and in the two genders

Gender	History of CHD	Age Group (in years)			Total	χ^2, df (p-value)#	χ^2, df (p-value)^
		40 - 50	50 - 60	> 60			
Male (n = 100)	Absent	28 (33.3%)	25 (29.8%)	31 (36.9%)	84 (100.0%)	.995, 2 (.608)^^	.664, 1 (.415)
	Present	7 (43.8%)	5 (31.2%)	4 (25.0%)	16 (100.0%)		
	Total	35 (35.0%)	30 (30.0%)	35 (35.0%)	100 (100.0%)		
Female (n = 100)	Absent	34 (38.6%)	29 (33.0%)	25 (28.4%)	88 (100.0%)	.993, 2 (.627)^^	
	Present	6 (50.0%)	4 (33.3%)	2 (16.7%)	12 (100.0%)		
	Total	40 (40.0%)	33 (33.0%)	27 (27.0%)	100 (100.0%)		

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. # Pearson Chi-Square test between history of CHD & different age group as per gender. ^Pearson Chi-Square test between history of CHD & gender. ^^Likelihood Ratio. χ^2 = Chi-Square & df = degree of freedon.

Table 2. History of CHD in groups with different type of fat consumed per month as per gender

Gender	History of CHD	Type of Fat Consumed / month			Total	χ^2, df (p-value)
		Predominantly Oil (Group A)	Both Oil and Ghee (Group B)	Predominantly Ghee (Group C)		
Male (n = 100)	Absent	28 (33.3%)	25 (29.8%)	31 (36.9%)	84 (100.0%)	.995, 2 (.608)^
	Present	7 (43.8%)	5 (31.2%)	4 (25.0%)	16 (100.0%)	
	Total	35 (35.0%)	30 (30.0%)	35 (35.0%)	100 (100.0%)	
Female (n = 100)	Absent	34 (38.6%)	29 (33.0%)	25 (28.4%)	88 (100.0%)	.993, 2 (.627)^
	Present	6 (50.0%)	4 (33.3%)	2 (16.7%)	12 (100.0%)	
	Total	40 (40.0%)	33 (33.0%)	27 (27.0%)	100 (100.0%)	

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. Pearson Chi-Square test. ^Likelihood Ratio. χ^2 = Chi-Square & df = degree of freedon.

Table 3. Correlation of history of CHD with various variables as per gender

Variables	Age Group (in Years)^ (M, F)	Type of Fat Consumed per month^^ (M, F)	Total Oil Consumed (L/ month) (M, F)	Total Ghee Consumed (Kg/ month) (M, F)	TG (mg/ dl) (M. F)	TC (mg/ dl) (M. F)	HDL (mg/ dl) (M. F)	LDL (mg/ dl) (M. F)	VLDL (mg/ dl) (M, F)	TC/HDL (M, F)	LDL/HDL (M, F)
History of CHD#	(-.092, -0.87)	(-.092, -.087)	(.209*, .250**)	(-.180*, (-.155)	(.209*, .215*)	(.437**, .443**)	(-.466**, -.360**)	(.463**, .450**)	(.328**, .280**)	(.495**, .453**)	(.504**, .458**)

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. Kendall's tau b (r-value given). #History of CHD, 0 = Absent & 1 = Present, ^Age Group, 1 = 40-50, 2 = 50-60 & 3 = >60; and ^^ Type of Fat Consumed per Month, 1 = Predominantly Oil, 2 = Both Oil & Ghee, and 3 = Predominantly Ghee. M = Male & F = Female.

Table 4. Logistic regression model for history of CHD and type of fat consumption per month

Variables	B	p-value	Exp (B)	95% C.I. for Exp (B)		Hosmer and Lemeshow test $\chi 2$, df (p-Value)	Overall percentage correctly predicted
				Lower	Upper		
#Group (0)		.406					
#Group (1)	-.234	.620	.791	.313	1.999		
#Group (2)	-.711	.179	.491	.174	1.387	.014, 4	86%
^Gender (1)	-.383	.355	.681	.302	1.536	(1)	
Constant	-1.370**	.000	.254				

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. ^Gender, 0 - Male (reference) & 1 = Female; and #Group, 0 = Predominantly Oil (reference), 1 = Both Oil & Ghee, and 2 = Predominantly Ghee. B = Beta weights or regression coefficients, Exp (B) = e^B, C.I. = Confidence Interval, χ^2 =Chi-Square & df = degree of freedom.

Table 5. Area Under the Curve (AUC) of the variables for prediction of having CHD as per gender.

Gender	Variables	AUC	S.E.	p-value	Cut off value at maximum
Male (n=100)	LDL/HDL	.983**	.013	.000	4.97
	TC/HDL	.974**	.015	.000	6.09
	LDL (mg/dl)	.943**	.027	.000	171
	TC (mg/dl)	.913**	.039	.000	227.5
	VLDL (mg/dl)	.809**	.067	.000	39.5
	TG (mg/dl)	.697*	.066	.013	104.5
	Total Oil Consumed (L/month)	.671*	.081	.031	.815
Female (n=100)	LDL/HDL	.995**	.005	.000	5.01
	TC/HDL	.990**	.009	.000	6.76
	LDL (mg/dl)	.985**	.010	.000	154.5
	TC (mg/dl)	.972**	.015	.000	222
	VLDL (mg/dl)	.796**	.077	.001	35.5
	Total Oil Consumed (L/month)	.736**	.082	.008	.815
	TG (mg/dl)	.729**	.071	.010	97

	LDL/HDL	.988**	.008	.000	4.97
	TC/HDL	.980**	.009	.000	6.76
	LDL (mg/dl)	.964**	.014	.000	154.5
Combined	TC (mg/dl)	.939**	.021	.000	222
(n=100)	VLDL (mg/dl)	.806**	.050	.000	35.5
	TG (mg/dl)	.708**	.048	.000	99.5
	Total Oil Consumed (L/month)	.697**	.059	.001	.815

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. Receiver Operating Charactristic (ROC) curve. AUC = Area Under the Curve, S.E. = Standard Error, and J = Youden Index (J = Sensitivity+Specificity-1).

Table 6. Area Under the Curve (AUC) of the variables for prediction of not having CHD as per gender.

Gender	Variables	AUC	S.E.	p-value	Cut off value at maximum
Male	HDL (mg/dl)	.936**	.024	.000	35.5
(n = 100)	Total Ghee Consumed (Kg/Month)	.655*	.062	.050	.815
Female	HDL (mg/dl)	.881**	.043	.000	35.5
(n = 100)	Total Ghee Consumed (Kg/Month)	.648	.069	.098	1.125
Combined	HDL (mg/dl)	.890**	.025	.000	35.5
(n = 100)	Total Ghee Consumed (Kg/Month)	.647*	.046	.013	.815

* $p \leq 0.05$: significant; ** $p \leq 0.01$: highly significant. Receiver Operating Charactristic (ROC) curve. AUC = Area Under the Curve, S.E. = Standard Error, and J = Youden Index (J = Sensitivity+Specificity-1).

List of titles for all graphs

Graph. 1. ROC curves for total ghee consumption & total oil consumption per month for prediction of not having CHD among males (n=100).

Graph. 2. ROC curves for total ghee consumption & total oil consumption per month for prediction of not having CHD among females (n=100).

Graph. 3. ROC curves for total ghee consumption & total oil consumption per month for prediction of not having CHD among the total studied subjects (n=200).

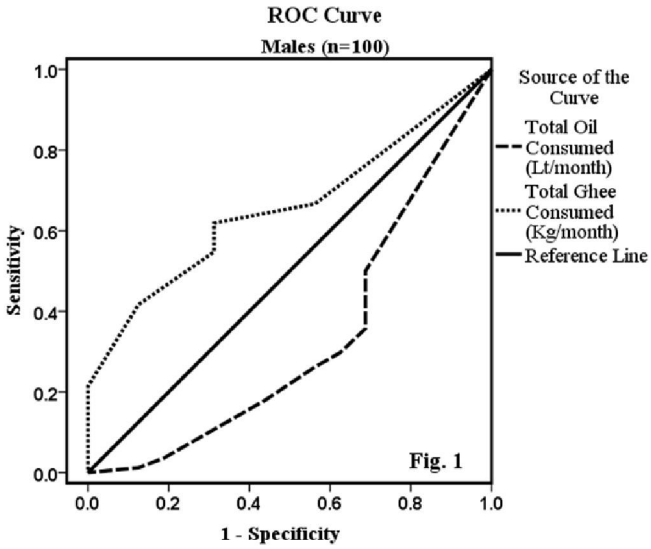

Fig. 1

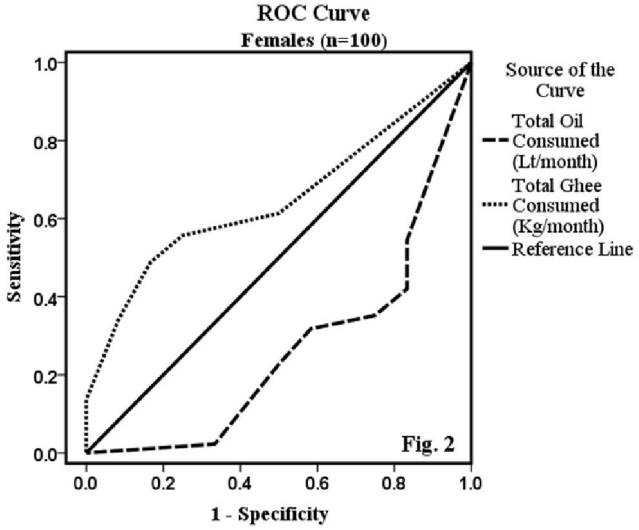

Fig. 2

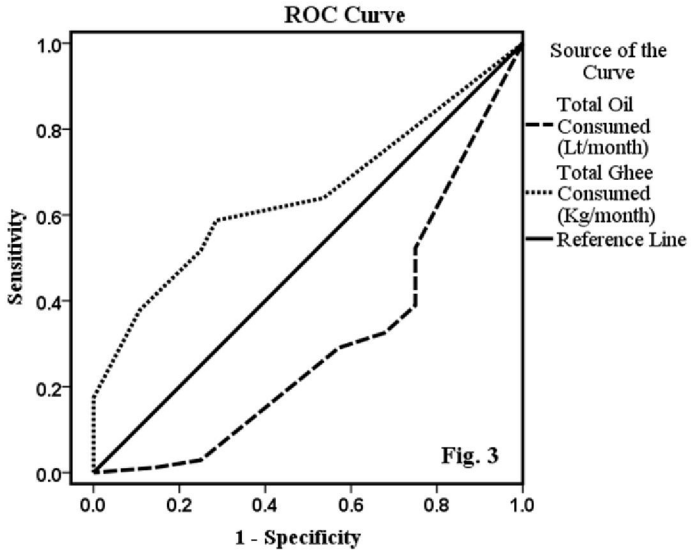

Fig. 3