EPIDEMIOLOGY OF DISEASES IN RELATION TO CONSUMPTION PATTERN OF FATS AND OILS AMONG SELECTED ADULTS IN COIMBATORE CITY

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CERTIFICATE

This is to certify that this thesis entitled, "Epidemiology of diseases in relation to consumption pattern of fats and oils among selected adults in Coimbatore city" submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, for the award of the degree of Doctor of Philosophy in Food Science and Nutrition, is a record of original research work done by G. Vasanthamani during the period of her study in the Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree/Diploma/ Associateship/Fellowship or similar title to any candidate of any University.

Signature of the guide

DECLARATION

I hereby declare that the matter embodied in this thesis is the result of investigation carried out by me in Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, under the supervision of Dr. P.Parvathy Easwaran, Dean, Faculty of Home Science, Professor and Head, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore and it has not been submitted for the award of any Degree/Diploma/Associateship/ Fellowship etc., of any other University or Institute.

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Introduction

I. INTRODUCTION

Promotion of health is basic to national progress. Good health is a dynamic force that extends to living in harmony with others and being in tune with the nature. Healthy population will be the best foundation for promoting productivity and progress of a nation, contrary to an unhealthy population which is a burden leading to set backs in all spheres of development. According to WHO (1997) to-day's emphasis is on health expectancy rather than life expectancy. Health expectancy can be defined as life expectancy in good health and amounts to the average number of years an individual can expect to live in such a favourable state.

Progress in technological development, industrialization and economic conditions have in addition to increasing the standard of living of people, created changes in food habits and life styles leading to health problems. The health problems that parallel economic development are largely those of chronic diseases such as cardiovascular diseases, hypertension, diabetes mellitus and cancer (Park, 1997). Almost 24 million people die every year due to chronic diseases, which is equivalent to half of all deaths worldwide (WHO, 1998).

All over the world, cardiovascular diseases (CVD) are now recognised as one of the main causes of death in adults (Medical Update, 1997 and MacCluer et al, 1999). In India cardiovascular diseases are important contributors to mortality (WHO, 1998). Sharma (1997) has reported that by 2000 A.D. nearly five crore people would be affected by cardiovascular diseases in India. To-day cardiovascular diseases and cancer account for about 19 million deaths or 36 per cent of global total. The great majority of deaths are among adults (WHO, 1997). Recent surveys in India (Aggarwal, 1996 and Trehan and Missra, 1996) have estimated the prevalence of cardiovascular diseases to be 74 to 79 per 1000 adults in urban population and 14.8 per 1000 adults in rural population. Chadha et al (1997) have reported that the over all prevalence of coronary heart disease among adults aged 25-64 years was estimated at 96.7 per 1000 and 27.1 per thousand in urban and rural Delhi population respectively. Coronary Heart Disease (CHD) accounts for more than seven million deaths world wide (WHO, 1997).

Most cases of CHD result from narrowing of the arteries due to fatty deposits called plaques. When a coronary artery is completely blocked, the result is a heart attack (myocardial infarction) or disturbed heart rate either of which may cause sudden death. Heart disease and stroke cause physical and mental trauma or premature death. Recent literature (Chen et al 1998) state that these diseases are steadily increasing and may become a public health problem by the turn of this century. Though the best medical and surgical treatments are available, it is ideal to prevent these diseases, especially because of the exorbitant cost involved in the treatment.

The basic pathological lesion underlying coronary heart diseases is the atheromatous plaque. A variety of cells and lipids including lipoproteins, cholesterol and triglycerides are involved in the pathogenesis. Blood lipids have been solidly established as fundamental to the atherosclerotic process (Kennel, 1995 and Tanphaichitr et al 1998).

Jayakumari et al (1995) point out that patients with coronary artery disease (CAD) had higher levels of total cholesterol (TC), triglyceride (TG), low density lipoprotein cholesterol (LDL-C), very low density lipoprotein cholesterol (VLDL-C) and depressed levels of high density lipoprotein cholesterol (HDL-C). Several studies (Spady et al ,1993, Ima-Nirwana et al, 1996 and Wenpin et al, 1998) have indicated that there is a positive association between plasma total cholesterol and low density lipoprotein cholesterol and risk of coronary heart disease in young men.

Countries which have higher mortality from coronary heart diseases tend to have a higher intake of energy from fat and higher proportion of fat from animal products, which in turn operate to increase blood lipids leading to hypercholesterolemia and over weight (Khor, 1997).

Hypertension and diabetes mellitus are the other chronic diseases that have close association with dietary fat and hyperlipidemia (Crockart, 1995). Hypertension may aggravate atherosclerotic conditions in the arteries and this in turn leads to coronary heart disease or heart failure. Mild hypertension carries double the risk of cardiovascular diseases. A direct association between diets high in saturated fats and blood pressure has been suggested by Sanchez et al (1992). Evidence from literature are indicative of the fact that saturated fat raises blood pressure as well as serum cholesterol (Fuentes, 1996).

There is an alarming increase in the prevalence of diabetes mellitus in India (Viswanathan, 1992 and Devadas, 1999). Diabetes mellitus is a disease leading to complications. It has been estimated that 80 per cent of all the diagnosed diabetics have atleast one or other chronic conditions aggravated by hypercholesterolemia, hypertriglyceridemia and hyperlipoproteinemia (WHO, 1998).

Studies on diabetics by Brien et al (1995) have revealed that subjects with non-insulin dependent diabetes mellitus had higher triglyceride and lower high density lipoprotein cholesterol levels. Subjects with non-insulin dependent diabetes and coronary heart disease had higher total cholesterol, triglyceride and low density lipoprotein cholesterol levels and low levels of high density lipoprotein cholesterol than non insulin dependent diabetic patients without coronary artery diseases. Berry (1997) found out that post prandial alterations of lipoprotein remnants may accelerate atherogenesis even in normoglycemic, non-insulin dependent diabetic patients.

Hyperlipidemia has been shown to be a major risk factor for cardiovascular diseases and hypertension. Dietary excess of five specific food factors are possibly implicated in hyperlipidemia - cholesterol, saturated fat, carbohydrate, total calories and alcohol.

Among the dietary factors the most important are the nature and quality of fat, type of fat and cholesterol intake. The growing incidence of cancer, cardiovascular diseases and diabetes mellitus in India could be due to dietary changes, especially the adoption of western-type foods rich in saturated fats (Tandon, 1999). Saturated fats present in animal foods cause ill-effects. An excess fat in the diet is recognised as a risk factor in influencing the development of chronic diseases (ICMR, 1998).

The last century has seen a remarkable improvement in health on a world wide scale. Average life expectancy at birth increased from 48 years in about 1950 to over 65 years in the early 1990s. Successful epidemiological studies in developed countries have led to significant preventive and therapeutic measures during the past 50 years. The major risk factors for diseases were identified largely by means of epidemiological studies in almost all developed countries.

Epidemiologic studies are concerned with evaluation of disease distributions, disease determinants and disease frequency in human populations (Hennekins and Buring, 1987). Analytical epidemiology focuses on the determination of the determinants of the disease with the ultimate goal of judging whether a particular exposure causes or prevents diseases.

The epidemiologic relationship between diet and cardiovascular diseases in western countries has been extensively studied (Ernst et al, 1997 and Chen et al, 1998). Though there are sporadic studies pertaining to cardiovascular diseases and its risk factors in India, still there is dearth of information.

It is undoubtedly essential and crucially relevant that such epidemiological studies on fat associated diseases and fat intake are undertaken in India, to investigate health differences, in order to prevent chronic diseases and to achieve health for all.

Hence the investigator was provoked to study the incidence of fat associated diseases namely cardiovascular diseases, hypertension and diabetes mellitus in relation to consumption pattern of fats and oils and its reflection on blood lipid levels.

In this era of increasing awareness of effective self-care, people have great responsibility to think about and make wise food choices to be free from diseases. Nutritionists and dietitians have greater responsibility to prescribe safe and adequate diets to people to keep them healthy. With this responsibility the present investigation on "Epidemiology of Diseases in Relation to Consumption Pattern of Fats and Oils Among Selected Adults in Coimbatore City" has been formulated.

The specific objectives of the study were : To

A. Analyse the incidence of cardiovascular diseases in adult population who attended the selected hospital of Coimbatore city, in 1985 and 1995 by collecting secondary data

B. Select adult population at random and study their socio-economic profile, personal habits, food intake, body mass index and incidence of fat associated diseases

C. Examine the association between the consumption of fats and oils and body mass index, serum lipid profile and incidence of diseases on a sub sample

D. Assess the serum lipid profile of adults consuming single plant oil/ animal foods

E. Find out the effect of replacement of saturated fats with plant oils in hyperlipidemic subjects

F. Cross-examine the intake of fats and oils and blood lipid profile of patients suffering from cardiovascular diseases, hypertension and diabetes mellitus

and G. Impart and evaluate the impact of diet counselling on hyperlipidemics.

II. REVIEW OF LITERATURE

The literature available with regard to the present study entitled, "Epidemiology of Diseases in Relation to Consumption Pattern of Fats and Oils Among Selected Adults in Coimbatore City" is reviewed and are presented under the following headings.

A. Prevalence of fat associated diseases - World's foremost killer diseases
B. Pattern of fat intake in India - Concern for nutrition and health professionals
C. Fatty acids - Effects on health and diseases
D. Lipid Profile - How do they change in diseases?
E. Impact of dietary and non-dietary factors on lipid profile

A. Prevalence of fat associated diseases - World's foremost killer diseases

Reddy et al (1993), Devadas et al (1996) and Kulkarni (1998) reported that coronary heart disease is the largest killer in developed countries and is rapidly assuming a similar role in developing ones. It has been predicted that cardiovascular disease will be the most important cause of mortality in India by the year 2015.

Kannel (1998) has indicated that cardiovascular disease continues to be the leading cause of death in the world accounting for half of all deaths.

In United States, it has been estimated that one out of every four has some form of cardiovascular disease (CVD) and it accounts for nearly one million deaths, almost one half of the total deaths, with 18 per cent of these deaths occurring in adults under 65 years of age (Shils et al, 1994).

Coronary heart disease (CHD) is the cause of 25-30 per cent of deaths in most industrialized countries and coronary heart disease is held responsible for about 30 per cent of deaths in men and 25 per cent deaths in women in western countries (Martins et al, 1998).

According to WHO (1998) cardiovascular diseases claim 15.3 million lives in 1997 and cancer 6.2 million. Much suffering and 63 to 80 per cent of deaths from these diseases could be prevented by adopting a healthy lifestyle, particularly in regard to food and nutrition, moderating alcohol consumption and significantly reducing the use of coffee, tea and tobacco (Bostic et al, 1999, Sesso et al, 1999 and Diehl, 1999) As stated by Krishnaswami et al (1991) many developing countries including India face a major challenge of adult morbidity and mortality due to non-communicable diseases specially cardiovascular diseases like coronary heart disease (CHD) and hypertension.

Dewan (1990) found out that the prevalence of CHD among rural population in India was 22.8 and 17.3 per 1000 males and females respectively.

Berry et al (1992) opine that on screening of persons over the age of 30 years the prevalence of CHD among urban population in Chandigarh was found to be 65.4 and 47.8 per 1000 males and females respectively.

Coronary heart disease incidence rates were higher in men than women until 79 years, thereafter the rates were higher in women (Lessa et al, 1997).

Gopalan (1996) opines that the striking difference in the prevalence of coronary artery disease (CAD) between the urban population of Delhi (14/1000 persons) may be due to pollutants emitted by its over 2 million vehicles, power houses and industrial units.

Chadha et al (1997) have reported that the overall prevalence of coronary heart disease among adults aged 25-64 years was estimated at 96.7 per 1000 and 27.1 per 1000 in the urban Delhi and rural Delhi populations respectively.

Indians are consistently reported to have the highest CHD mortality rate (Khor, 1997).

Sanchez et al (1992) found out that prevalence of lipid disturbances is greater among the hypertensive patients than in the general population. Presence of hyperlipidemia was high in both normotensives and hypertensives and a positive correlation between body mass index and low density lipoprotein cholesterol and triglycerides were found in normotensives.

Beegorn and Singh (1995) observed that the prevalence rate of hypertension was 189/1000 between 25 and 64 years and 335/1000 between 45 and 64 years in the urban population of South India. Singh et al (1995) in their studies in rural areas of Haryana have found out that hypertension was more prevalent in higher age group.

Studies conducted in Karachi, Pakistan by Hameed et al (1995) have shown that hypertension is more frequent in middle aged people. Prevalence of hypertension with systolic blood pressure more than 140 mm Hg was 10.5 per cent and with diastolic pressure more than or equal to 90 mm Hg was 9.0 per cent in Bangladesh.

Miller et al (1994) in their study in Trinidad indicate that the incidence of hypertension ranged between 33 to 41 per 1000 in men, between 27 and 32 per 1000 in women.

Diabetes mellitus is another disorder that has close association with fat intake. According to WHO (1998) in 1997, 63 per cent of persons with diabetes mellitus were resident in the developing countries. By 2025, this proportion will rise to 76 per cent. In both 1997 and 2025 the three countries with the largest number of persons with diabetes will be China, India and United states.

Diabetes mellitus described as a third world disease with rates high in developing countries has a global incidence of 1.3 per cent (Kumanyika, 1995).

According to American Heart Association (1997) diabetes mellitus killed 55,390 Americans in 1994. Nakamura et al (1998) indicated that the prevalence of diabetic patients in Japan would be 1.7 million among males and 1.5 million among females in 2008.

Pan and Chiang (1996) and Yang et al (1998) point out that the prevalence of diabetes in China is increasing with economic development and changes from traditional to modernized lifestyle, especially where people had lower level of education and socio-economic development.

According to WHO (1998) diabetes can develop acute as well as long term complications. Diabetes affects the structure of the blood vessels and nerves leading to impaired circulation, impaired vision and loss of sensation in the limbs. Persons developing diabetes at an earlier age have long period of the disease and are likely to develop the long term complications such as blindness, kidney failure and heart disease.

B. Pattern of fat intake in India - Concern for nutrition and health professionals

Fat is an important component of human diet and the quantity of fat present in it varies widely in both quantity and quality. Half of the total fat intake in Indian diets is obtained from edible oils. Fat in the diet is of two kinds visible fat and invisible fat. Visible fats are those which have been separated from animal tissues, milk, oilseeds, nut or other vegetable sources.

Invisible fats are those which have not been separated from their original source and are therefore consumed as part of the diet, principally as cereals, pulses, meat, fish, poultry and vegetables.

Georgiou (1992) points out that dietary fat is considered to be an important nutrient as a more concentrated source of energy. Fat as a nutrient definitely indicates that both the quality and quantity of fat have important repercussions on health and disease. The amount of fat consumed varies from one region to another and what may be health complication in one part of the world is not necessarily such in another (Kingella, 1988).

According to Nutrition News (1995) in an average Indian diet, fats contribute 8 to 10 per cent of the total energy.

According to Ahmed (1988) in India per capita consumption of fat is very low only about five kilograms per year. The consumption of fats in developing countries is much lower than in the developed countries because of their non-availability and high cost.

Kaare and Norrum (1992) state that the well known edible oil liked by the major section of the people globe wise is the groundnut oil. It is in use for many centuries though coconut oil, mustard oil and gingelly oil are also in use since long time. Sunflower oil is one of recent development. This oil is highly valued because of high percentage of polyunsaturated fatty acids. Soya bean oil is another widely accepted edible oil with more unsaturated fatty acids. Niger seed oil is quite common in Madhya Pradesh, Andhra Pradesh, Orissa and Maharashtra (Babu, 1996).

Achaya (1997) found out that in many developed countries the average fat intake is about 35 to 40 energy per cent. Levels of fat intake in India vary widely, partly from income differences and partly from differing regional culinary practices, (eg, high in Gujarat and Punjab, low in Kerala and Orissa). Intakes of fat range from about 10 energy per cent among the poor to about 35 per cent among the wealthy.

Visible fat intake in various states vary from nine to 25 grams per day. The average is 12 to 14 grams consisting approximately of vegetable oil 10 grams, vanaspathi 2.5 grams and ghee two grams. A variable portion of all families from 2 to 65 per cent in different states buy no visible fat at all. The invisible fat content of Indian cereal is substantial with 3.5 per cent in rice and two per cent in wheat. Average Indian diets in 1971 in four cardinal states in India carry 15 to 20 grams per day of invisible fat and even very poor diets consisting of cereals will supply 10 grams of invisible fat. The energy contribution of total visible and invisible fat ranges from 13 to 27 per cent with an average of 17 per cent (Achaya, 1986).

According to Achaya (1987) of the total fat intake which is close to 40 grams per day, 16 to 24 grams (40-60 per cent) per day is made up of invisible fat. Per capita daily consumption of visible fat is 15 grams.

Chandry and Chouchen (1988) have stated that the amount of fat intake by low income families in India is about 8.3 grams to 35 grams per day in different age groups. The contribution of invisible fat intake was more (57 per cent to 76 per cent of total fat). Visible fat in rural perdietary was predominantly vegetable oil with negligible amount of animal fat.

The report of the expert group of Indian Council of Medical Research (1995) states that in urban areas middle and upper income groups had daily intake of visible fat that ranged from 20 to 42 grams and the average intake of urban dwellers were much higher than those in rural areas.

Achaya (1987) found that fat consumption varies among the different income groups namely low, middle and high income groups. High income groups could be at a risk from over consumption of visible fat. In high income group total fat makes a 30 per cent contribution to energy while in low income group the contribution is nine to 11 per cent energy from total fat. Visible and invisible fat consumption reflects strong income dependence. The visible fat consumption ratio averaged to three between high and low income group. The invisible fat consumption ratio was two between the high and low income groups.

WHO study group (1990) reports that a striking change in developing countries has been the rapid increase in the proportion of people living in urban areas. There is a change in fat and sugar consumption in urban areas compared with that of rural communities. In addition Ghafoorunissa (1987) points out that the intake of edible oil is dependent on income and region.

Indian Council of Medical Research (1995) points out that the desirable amount of linoleic acid to be consumed by normal adult person has been placed at three per cent.

Achaya (1989) observed that rural Indian diets supply a balanced proportion of saturated fatty acids, oleic and linoleic acid with about three per cent linolenic acid. It is concluded that the pattern of fat consumption in rural areas is conducive to good health but that of urban upper income groups is high in saturated fatty acid and too low in oleic and linoleic acid.

World Health Organisation (1996) recommends that a minimum of 15 to 20 per cent of the calories should be derived from fat. A diet where more than 40 per cent of calories is from fats could lead to many health related problems.

According to ICMR (1995) fat ingested is of two types, visible fat mainly oil used for cooking varies from 3 g to 20 g per capita per day in different states in India and invisible fat consumption is about 20 g daily per person. The total fat consumption, visible and invisible in the country as a whole averages 13.2 energy per cent.

Durairaj (1997) reported that in India lowest income groups get just 10 energy per cent, all of which is invisible fat. Upper income groups with a visible fat consumption of about 50 grams and invisible fat amounting to 40 g daily, consume 20-25 energy per cent of fat.

According to Robinson et al (1986) and Krause (1996) people of the orient consume diets that provide around 10 per cent or less of calories from fat. Consumption of fat as percentage of total kilo calories has decreased from 40 per cent in 1977 to 34 per cent in 1988-91. Although total fat, SFA and cholesterol intakes have fallen, intake of total fats remain above recommended levels.

According to Ernst et al (1997) in affluent western societies, the per capita intake of dietary fat tends to be high (about 40 per cent of dietary energy) and hence fatty acid and main constituents of fat are a major component of diet, often in excess of 100 grams per person per day.

People from the United States consumed approximately 50 kilo grams of fat on an yearly basis (Nancy et al, 1997) but in developing countries where the per capita consumption of vegetable oil is more than 20 kilo grams, but in Indian sub continent the availability is only 7 kilo grams per day (Rethinam, 1996)

Fuentes (1996) had reported that in Spain the fat intake of 5 to 12 years age group was 30 to 35 per cent above the recommended value. The high level of fat consumption was mainly due to the consumption of saturated vegetable fats mainly from palm oil which is used in the production of cakes, ice cream and pre cooked meals.

According to Maniam et al (1996) fat intake markedly increased from 42.8 to 71.5 grams in Singapore. Fat from vegetable products was up by 29 per cent while that from animal products increased by 92 per cent.

According to American Medical Association (1990) fifty per cent of the Italian population reported no use of butter in cooking, while

PUFA oil (eg. corn oil, soya bean oil, sunflower oil and mixed vegetable oil) were reported to be used more often in cooking.

C. Fatty acids - Effects on health and diseases

According to Scott (1989) dietary fat is known to affect serum concentration of total and lipoprotein cholesterol. However, all components of dietary triglycerides namely saturated, mono-unsaturated and polyunsaturated fatty acids do not have identical effects on serum cholesterol levels. Adamopoulos et al (1996) agree with the above statement and declare that not only the amount, but also the type of dietary fat can influence serum lipid concentrations.

Fat quality has a more significant effect on plasma lipids than does fat quantity. Saturated fatty acids (SFAs) increase serum lipids and are primary determinants of serum cholesterol. MUFAs have no independent effect on serum cholesterol while PUFAs activity lower it (Hegsted et al, 1993).

Strong correlations with both TC and low density lipoprotein cholesterol are obtained with cholesterol raising SFAs (Lauric, myristic and palmitic) (Denke, 1994).

Studies conducted by ICMR (1995) arrived at the result that derivatives of essential fatty acids protected individuals against CVD and served as a precursor for polyunsaturated fatty acids. These unsaturated fatty acids reduced serum cholesterol values and diminished the risk factors associated with CVD.

Gurr et al (1989) provided ample evidence to confirm that plasma lipoprotein concentrations could be raised or lowered by dietary fat modification.

WHO expert group (1995) revealed that the dietary changes from a high to a low intake of saturated fats and replacing the fat with n-6 polyunsaturated fatty acids (linoleic acid) decrease serum cholesterol by 15 per cent.

Debakey and Micheal (1989), Hornstra (1991) and Shahar, (1995) reviewed the effect of omega-3 fatty acids on plasma cholesterol and concluded that they have no effect on plasma cholesterol levels but do lower plasma triglycerides.

Nestel (1990) and Noakes et al (1995) confirmed that in hypercholesterolemic men, a modest increase in palmitic acid increases LDL cholesterol relative to oleic acid.

Dietary polyunsaturated fatty acid seems to provide protection against the development of atherosclerosis, possibly by causing redistribution of cholesterol between plasma lipoproteins and various tissues including adipose tissue (Lipsky, 1990). It was observed by Kurup (1989) that the more unsaturated the fat, the greater the decrease in cholesterol and triglyceride concentration in serum. It was found that more unsaturated fat showed increased faecal excretion of neutral sterols and bile acids and increased catabolism of serum lipoproteins - as was evident from the increased activity of lipoprotein lipase in extrahepatic tissues.

Van et al (1992) suggested that high polyunsaturated fatty acid levels, when insufficiently protected by antioxidants against peroxidation may indicate a higher risk of atherosclerosis.

Bulur et al (1996) found that high cholesterol diet supplemented with polyunsaturated fat, but not with monounsaturated fats, seemed to have a tendency to exaggerate lipid peroxidation.

According to Flynn et al (1991) feeding pork with diet high in monounsaturated fatty acids had a beneficial effect on serum lipids and found out monounsaturated fatty acid to be equivalent to polyunsaturated fatty acids in lowering blood cholesterol level. Monounsaturated fat have the added advantage of not causing a decrease in HDL-C or an increase in triglyceride (Mattson, 1992). Berry et al (1992) and Fuller and Jialal (1994) observed that dietary monounsaturated fatty acid lowers total cholesterol and LDL cholesterol concentrations independently of other dietary fatty acids and in addition may reduce susceptibility of LDL-C to oxidative stress.

Blenford (1992) reported that high level of monounsaturated fat in milk is considered to be beneficial being equivalent to healthy attributes associated with polyunsaturated fatty acids.

Monounsaturated fatty acids increased the resistance of plasma low density lipoproteins to oxidative modification, independent of their content of antioxidants. This effect could lower the atherogenecity of these lipoproteins (Bonanome et al, 1992).

Mensink and Katan (1987) showed that total cholesterol concentrations were lowered by 8 per cent and HDL-C rose by two per cent by diets containing predominantly monounsaturated fatty acids.

Nielsen et al (1996) concluded that replacement of dietary saturated fat with monounsaturated fat brought about significant positive changes in plasma cholesterol levels.

Alteration in dietary fatty acid composition can effectively alter the fatty acid distribution of LDL-C and HDL-C in hypercholesterol subjects and substitution of monounsaturated rather than saturated fatty acid in the diet might be preferable for prevention of atherosclerosis (Miller, 1994).

Addition of monounsaturated and polyunsaturated fatty acids to a very low fat diet increased the HDL cholesterol levels. Reduction of saturated fat content reduced the total cholesterol levels in normo cholesterolemic subjects (Sanders et al, 1995). Monounsaturated fatty acid diet may be more advantageous than polunsaturated fatty acid diet because it does not lower apolipoprotein A-1 concentration as much as polyunsaturated fatty acid rich diet (Wahrburg et al, 1993).

Monounsaturated fatty acid diet resulted in significantly lower LDL-cholesterol whereas HDL-C concentration was not affected. Compared to polyunsaturated fatty acid rich diet, saturated fat rich diet had both LDL-C and HDL-C concentrations lower (Rudel et al, 1992).

Saturated fatty acids are the primary determinants of serum cholesterol. Polyunsaturated fatty acids actively lower serum cholesterol.

Monounsaturated fatty acid has no independent effect on serum cholesterol. Dietary cholesterol increases serum cholesterol (Mark et al, 1993).

Stearic acid and oleic acid are hypocholesterolemic compared to lauric, palmitic and myristic acids. Lauric acid is less and myristic acid probably is more hypercholesterolemic than palmitic acid. Stearic acid lowers HDL-C relative to other saturated fatty acids (Mensink et al, 1993).

Recent evidences suggest that not all saturated fatty acids are cholesterol raising. When all dietary fatty acids are oxidized, palmitic acid appears to have no impact on plasma cholesterol in normocholesterolemic subjects, when dietary cholesterol intake is below a certain critical level (Khosla and Hays, 1995).

Kaufman et al (1995) observed that rats fed on saturated fat diet and polyunsaturated fat diet had higher blood pressure than low fat diet fed rats. It was concluded by Mensink et al (1992) that neither trans nor saturated fatty acids influence blood pressure levels in normotensive subjects relative to oleic acid. An unsaturated fat diet prevented the development of hypertension compared to higher saturated fat diet and normo fat diet (Norton et al, 1996).

Polyunsaturated and monounsaturated fatty acids decrease LDL-C when substituted for saturated fat. The concentration of triglycerides depends on both the amount and type of fat in the diet. Saturated and monounsaturated fatty acids normally do not raise triglycerides. A diet high in saturated fatty acid increases plasma VLDL-C. The amount and type of fat have profound effects on plasma lipids and lipoproteins and this may explain the influence lipids have on risk factors for several major diseases (Kaare and Norum 1992). Evidence from literature [Mattson and Grundy (1986), Denke (1994) and Zock et al (1994] iindicate that some dietary fatty acids raise serum cholesterol concentrations. These include palmitic acid, myristic acid and lauric acid. In contrast another saturated fatty acid stearic acid does not raise serum cholesterol. Mensink (1994) showed that palmitic acid raises total cholesterol concentrations by 2.5 mg/dl for every one per cent of total energy used in replacement of oleic acid.

Aro (1995) points out that dietary trans fatty acids increase serum low density lipoprotein cholesterol (LDL-C). They may also increase the concentration of lipoprotein (a) which is a risk factor for heart disease.

Trans-fatty acids raise TC, LDL-C and lipoprotein (a) levels and decrease HDL-C levels. Trans-fatty acids are positively related to ratios of TC : HDL-C and LDL-C : HDL-C (Wood et al, 1994 and Richardson, 1997).

PUFA consumption correlated negatively with concentration of serum TG, TC, LDL-C, VLDL-C, total lipoprotein mass of smaller - LDL particles and VLDL-C (Williams, 1989). Diets high in PUFA raise LDL-C levels but do not necessarily lower HDL-C levels (Fumeron et al, 1991).

Two of the principal saturated fatty acids in butter fat, myristic and palmitic acids have been identified as major risk factors that raise LDL-C. Myristic acid is reputedly more potent than palmitic acid in lipid raising effects (Noakes et al, 1996).

Rangarao et al (1986) observed that an increase in polyunsaturated fat content in the diet brings down total cholesterol in non-insulin dependent diabetes mellitus patients. The decrease in total cholesterol is unaccompanied by changes in HDL-C but HDL-C percentage of total cholesterol showed an increased parallel glycaemic control status.

An isoenergetic, high monounsaturated fatty acid, low carbohydrate diet can be consumed by non-insulin dependent diabetic patients without deleterious effects on lipid and glucose metabolism (Rasmussen et al, 1996).

Howard et al (1996) demonstrated that substitution of polyunsaturated fatty acid for monounsaturated fatty acids reduced total cholesterol levels without decreasing the HDL-C levels. Levels of total cholesterol and LDL-C decreased in proportion to the increasing amount of polyunsaturated fatty acids in the diet.

Chanderbhan et al (1997) found out that concentrations of serum total cholesterol and LDL-C were significantly decreased when sesame oil was used by adults whereas serum triacylglycerol and HDL-C concentrations did not differ significantly.

According to Garg and Blake (1997) rapeseed oil rich in monoenoic and n-3 fatty acids decreased the total body cholesterol unlike sunflower oil rich in n-6 fatty acids, which seemed to bring about a redistribution in the exchangeable body cholesterol pools.

Cater et al (1997) carried out a study comparing the effects of medium chain triglycerides, fatty acids and lipid and lipoprotein concentration in humans. The results suggested that medium chain fatty acids have one-half the potency that palmitic acid has at increasing total and low density lipoprotein cholesterol.

According to Ronald (1993) not all saturated fatty acids have the same effect on serum cholesterol levels.

Palmitic acid and myristic acid present in butter fat raise the LDL cholesterol level more than do stearic acid and oleic acid present in pork. Lauric acid also induces hypercholesterolemia although to a lesser degree than palmitic and myristic acid, which are present in palm oil, coconut oil and dairy fats (Denke and Grundy, 1992).

Lesdema et al (1997) concluded that a high lipid, high monounsaturated fatty acid avocado enriched diet improved lipid profiles in mildly hypercholesterolemic subjects even if hypertriglyceridemia was present.

If saturated fats are kept to a minimum monounsaturated fatty acid diets improve lipid profiles and may also have antioxidant properties (Berry, 1997).

D. Lipid profile - How do they change in diseases?

The basic pathological lesion underlying coronary heart disease (CHD) is the atheromatus plaque. A variety of cells and lipids including lipoproteins, cholesterol and triglycerides are involved in its pathogenesis.

Blood lipids have been solidly established as fundamental to the atherosclerotic process (Kennel, 1995).

Olson (1998) had indicated that the high density lipoprotein cholesterol (HDL-C) was first isolated in 1929, low density lipoprotein cholesterol (LDL-C) in 1950 and a recepto - mediated delivery system of lipoproteins to target tissues in 1974. Defects in this system due to genetically altered or absent receptors explained dyslipidemias, which promoted atherosclerosis, xanthomas and Alzhemier's disease.

Plasma total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), very low density lipoprotein cholesterol (VLDL-C) and triglycerides (TG) are positively related while high density lipoprotein cholesterol (HDL-C) is negatively related to coronary heart disease risk (Ball and Mann, 1988). Patients with coronary artery disease (CAD) had higher levels of TC, TG, LDL-C, VLDL-C and depressed levels of HDL-C (Jayakumari et al, 1995).

Steinberg et al (1989) and Stamler (1989) have stated that hyper cholesterolemia is an important cause of CHD. The Framingham study had showed that an elevated serum cholesterol level was a risk factor for coronary heart disease in women above 65 years. Kris - Etherton et al (1988) had reported that because dietary cholesterol increases plasma cholesterol and lipoprotein cholesterol levels, cholesterol intake should not exceed 300 mg/ day. More over Stamler (1989) also had indicated that dietary cholesterol increases the cholesterol content of chylomicrons and chylomicron remnants and that these cholesterol rich particles may be atherogenic.

Lamarche et al (1995) have found out that elevated plasma cholesterol and decreased HDL-C are risk factors for ischemic heart disease. Ima-Nirwana et al (1996) reported that lipid peroxidation and hypercholesterolemia are both risk factors in the promotion and progression of atherosclerosis.

According to Gopalan (1994) plasma total cholesterol, low density lipoprotein cholesterol and high density lipoprotein cholesterol are strong predictors of coronary heart disease risk. Studies by Stampfer et al (1996) have proved the role of serum total cholesterol determination in predicting initial coronary artery disease.

Low density lipoprotein is a risk factor for coronary artery disease in association with higher total cholesterol levels (Khan et al, 1995) and Hallikainen and Unsitupa, 1999). LDL-C that has undergone oxidative modification is atherogenic due to the peroxidation of its polyunsaturated fatty acids (Ostenburg et al, 1993). Oxidised low density lipoprotein cholesterol has several atherogenic properties including that it is chemotatic, increases platelet aggregation and promotes smooth muscle proliferation. It is taken up by macrophages forming foam cells. These cells accumulate as fatty streaks in the intima of the arteries leading to irregular narrowing of the blood vessels (Steinberg et al,1989 and Spady et al, 1993).

Khor (1997) had concluded that there is a positive association between plasma total cholesterol and low density lipoprotein cholesterol and risk of coronary heart diseases in young men.

Grundy et al (1989) reported that the guidelines developed by the Adult Treatment Panel of the NCEP identified LDL-C as the major atherogenic lipoprotein and high levels of LDL-C as the primary target of cholesterol lowering therapy. Low levels of HDL-C were recognised as a major risk factor for heart diseases.

According to Keys (1997) of the known risk factors for coronary heart disease, total plasma cholesterol appears to be the most important determinant of the geographical distribution of the disease.

Smaller LDL-C are thought to be more atherogenic than larger LDL-C (Williamson et al, 1992). The particle size of LDL is inversely associated with plasma TG and directly associated with HDL-C levels (Mc Namara et al, 1993).

Kris-Etherton (1990) found out that LDL-C/HDL-C ratio is an important indicator of CHD risk. A higher ratio is strongly associated with increased risk of ischemic heart disease.

The study of plasma triglycerides showed that high TG levels may be associated with an increased thrombotic tendency in any artery and this may occur even in the absence of marked atherosclerosis. Higher levels of TG and VLDL-C were seen in people who have had myocardial infarction.

Raised levels of TG are associated with increased CHD risk when HDL-C levels are low (Castelli, 1986). Patsch et al (1993) have pointed out that a positive relationship exists between CAD and TG levels. TG levels and platelet aggregability are early predictors for any ischemic episodes (Khalil et al, 1995).

Studies by Assamann (1991) have shown a positive correlation between elevated serum triglyceride levels and increased coronary heart disease risk in both men and women.

Hyper triglyceridemia may be due to accumulation of chylomicrons, VLDL-C or IDL-C in circulation. Chylomicrons accumulation is generally the result of impaired lipoprotein input, while accumulation of VLDL-C or IDL-C are usually the consequence of excess lipoprotein input and or impaired removal (Mancini, 1991).

According to Gordon et al (1989) plasma HDL-C is a risk factor for CHD and the ratio of LDL-C to HDL-C is one of the strong determinants of CHD risk.

Ima-Nirwana et al (1996) substantiated that raised levels of low density lipoprotein cholesterol as well as reduced high density lipoprotein cholesterol : low density lipoprotein cholesterol (HDL-C: LDL-C) ratios are risk factors in atherosclerosis.

According to Framingham study, most of the patients who had myocardial infarctions at low cholesterol levels had HDL-C levels < 35mg/dl; emphasising the importance of the total to HDL-C ratio in determining the atherogenic potential of blood lipids. Williams (1995) pointed out that the risk of CAD events increased with increase in the risk of total to HDL cholesterol ratio and inferred that lower the HDL-C levels, more are the number of vessels diseased. HDL-C is a better predictor of CHD risk than total cholesterol or LDL-C.

Kancharla et al (1990) reported that serum cholesterol was low and the sub fractions of HDL, LDL-C, VLDL-C and triacylglycerols were significantly higher in CHD patients in South India than in western populations.

Brien et al (1995) have observed that subjects with non-insulin dependent diabetes mellitus had higher triglyceride and lower HDL-C levels. Subjects with NIDDM and coronary heart disease had higher total cholesterol, triglyceride and LDL-C levels and lower HDL levels than non insulin dependent diabetic patients without coronary artery disease . Reznick et al (1996) opine that postprandial alterations of lipoprotein remnants may accelerate atherogenesis even in normoglycemic NIDDM patients. Eliseev (1992) found out that type II, III and IV hyperlipoproteinemia with lipoproteins of low, intermediate and VLDL -C respectively can be the cause of atherosclerosis.

A moderate increase of serum LDL-C in asymptomatic adults might be associated with early carotid atherosclerosis (Fisicardo et al, 1995). Nikkila et al (1995) reported that the increase in triglyceride levels during the fat load was highest in CAD patients with small size of LDL particles. Significantly higher values of TG, LDL-C and lower HDL-C levels have often been found in CHD patients.

According to Pan and Chiang et al (1996) TG level is an independent risk factor for stroke and cardiovascular disease.

Wolf (1996) reported that ischemic heart disease patients showed a cluster of risk factors like obesity, diabetes, hypertension which also includes low HDL-C concentration.

E. Impact of dietary and non-dietary factors on lipid profile

1. Dietary factors

Food and nutrient intake is the essential factor that increases or decreases the lipid profile of a person. WHO (1992) has indicated that vegetarian diet that is low in total and saturated fat and high in plant foods is consistent with a low risk of CHD.

a. Carbohydrate: According to Grundy and Mattson (1986) increasing carbohydrate to around 60 per cent of total energy from more usual levels in affluent societies (around 45 per cent) is associated with small but significant decrease in HDL-C.

Grundy et al (1991), Rao et al (1992) and Sidossis and Mittendorfer (1999) have observed that replacement of fat calories with complex carbohydrate has a number of effects on plasma lipids including an increase of plasma triglyceride concentration, a fall in high density lipoprotein cholesterol (HDL-C) level and minimal change in LDL-C level.

High carbohydrate diets usually low in fat, especially saturated fat are hypocholesterolemic. The consumption of a diet containing approximately 80 per cent of calories from carbohydrate decreases plasma TC and LDL-C but also increases HDL-C and serum TG (Kris-Etherton et al 1993).

Norum (1992) opines that high intake of refined sugars are more atherogenic than high intake of complex carbohydrates.

Longfield (1991) concluded that when large amounts of sugars are included in the diet, serum TG and LDL-C levels increase while HDL-C level decreases.

Weidner et al (1993) found out that participants who consumed a diet low in fat and high in complex carbohydrate showed significantly greater improvement in depression and aggressive hostility as well as a reduction in plasma cholesterol levels than did those who ate a high-fat "American diet" .

b. Protein: High protein foods such as soyabeans may be a better substitute for fat in the diet than carbohydrates because high carbohydrate diets result in less production and increased breakdown of HDL-C (Wolfe, 1995).

Ratnayake et al (1997) have observed that plant protein correlated negatively while animal protein correlated positively with TG, smaller-LDL mass, VLDL-C and VLDL-C mass levels and arginine in plant protein is thought to be responsible for a decrease in the serum lipid levels.

Different kinds of beans and lentils or pulses and legumes have cholesterol lowering action (Vardan, 1995).

Denke (1994) concluded that dietary proteins per se have little effect on cholesterol concentration but may affect TG concentrations.

c. Fat: According to Katan et al (1995) if any fat is replaced by carbohydrate, fasting TG values rise and HDL-C levels fall; the effect on LDL-C depends on the type of fat being replaced.

Moderate amounts of dietary cholesterol within the range that people ordinarily consume in their self selected diets do not generally affect serum cholesterol. The number of eggs eaten can influence serum cholesterol, but the effect is slight in the range of common dietary variation. Eating even three eggs per day makes only a moderate difference (Flynn et al, 1991).

Vardan (1995) concluded that an inverse relation exists between risk for CHD and consumption of low fat milk, yoghurt and fermented milk products.

Ghee contains substantial amounts of cholesterol oxide - 1,2,3, sterol which is angiotoxic and more atherogenic than pure cholesterol (Raheja, 1995).

d. Vitamins: Smith et al (1990), Ringer et al (1991) and Hilner (1995) pointed out that plasma beta-carotene has been observed to be associated with a modest increase in HDL-C levels, although not in total cholesterol levels and to have no effect on triglyceride or LDL-C concentration.

Duthie et al (1989), Oostenburg et al (1993) and Singh et al (1995) reported that antioxidant vitamins C and E and beta carotene have the potential to retard or prevent atherogenesis by inhibiting the oxidation of LDL-C which makes it atherogenic. Populations with high rates of CHD have been suggested to consume antioxidant rich foods. There is an increased risk of IHD and stroke at low concentrations of vitamin E, C and A, and beta carotene (Kardinaal et al, 1993).

Salonen et al (1989), Enstron and Gartside (1993) and Slattery (1995) pointed out the protective effect of dietary vitamin C on CVD mortality in men and women who consumed >50 mg of vitamin C per day and took supplements on a regular basis, after adjusting for other CHD risk factors.

It has been found out that plasma vitamin E accounted for more of the variability in coronary heart disease mortality than either serum cholesterol levels or blood pressure (Conning, 1990)

Deficiencies of folic acid and vitamin B12 are accompanied by increased blood levels of homocysteins and highly as well as moderately are connected with an increased risk of CVD (Kihlberg, 1995).

e. Minerals: A reduction in dietary minerals increase concentrations of LDL-C (Carroll and Guthrie, 1993). Manganese, chromium, vanadium, molybdenum, silver, zinc and bromine had a protective function in cardiovascular disease and high copper and titanium have a harmful effect on the cardiovascular system (Anan'ev, 1988 and Kok et al, 1988). High and probably low serum copper levels may be associated with increased CVD risk (Kok et al, 1988). An inverse correlation between iron stores and mortality from cardiovascular causes was noted by Sempos et al (1994).

Chromium is known to drop cholesterol levels while HDL cholesterol rise when the diet is supplemented with chromium. This has a protective role against plaque formation (Zimaldi et al, 1994).

Kaplan (1990) opines that large amounts of calcium have been shown to lower cholesterol and triglyceride levels and the body tends to manufacture triglyceride when sucrose is consumed in large amounts.

Watson et al (1994) and Maker (1995) have pointed out that there may be an inverse association of iron stores with overall mortality and with mortality from cardiovascular causes.

Insel et al (1991) pointed out that zinc deficiency lowers blood cholesterol levels.

Reduction of dietary sodium to a moderate intake between 1.6 to 3g is recommended to help control any potential cardiac edema in CHD or reduce the added risk factor of hypertension (Mailloux, 1989).

Salonen (1996) pointed out that more the mercury in the hair, the higher the risk of heart disease and even in relatively low levels, mercury is known to trigger oxidation of fats in the blood, which can damage the heart, blood vessels and other organs.

f. Plant foods: Consumption of carrots, beets, and green leafy vegetable rich in antioxidants may reduce risk of myocardial infarctions by reducing lipid peroxidation, thromboxane synthesis and platelet adhesiveness and by neutralising free radicals (Duthie et al, 1989 and Kardinaal et al, 1993).

Vardan (1995) found out that garlic, onions and turmeric have cholesterol lowering and antiaggregant effects.

Studies show fruits and vegetables to be major sources of the essential micronutrients i.e., antioxidants and certain trace elements which have potential protective effects (Duthie et al, 1989).

g. Plant Fiber: A high fiber intake from cereals is related to lower incidence of CHD (Thorgood et al, 1990). A high soluble fiber intake from refined wheat based bakery products, caused a decrease in serum LDL-C and apolipoprotein B (Anderson et al, 1995 and Chang et al, 1997).

Dietary fiber can lower serum TC and LDL-C in normal and mildly hypercholesterolemic humans. The most effective are water soluble non-starch polysaccharides while insoluble fibers have no effect on serum lipids (Dubois et al, 1995 and Fremont et al, 1993).

Fulgoni et al (1995) pointed out that psyllium fiber (6.7 grams daily) with a low fat diet reduces serum cholesterol levels in both men and women with hyperlipidemia.

Investigation about the role of diet as a risk factor, showed that a daily diet rich in fruits and vegetables with 27.5 per cent energy from total fat, including 10.2 per cent energy from monounsaturated fat, a P/S ratio of 1.79, dietary cholesterol 125mg, dietary fiber 26.5g and magnesium 551 mg/1000 kcal in association with moderate physical activity and weight loss can modulate lipid metabolism without a decrease in HDL-C (Singh et al, 1994).

Dietary intake has been thought to play a major role in the etiology of CHD for many years, with the focus of this relation being primarily on fat and fiber in the diet and their influence on lipid levels (Kagan, 1990).

h. Animal foods:

i. Milk: Leung et al (1994) have observed that myristic acid mainly present in milk raises plasma cholesterol. Milk protein, casein raises serum TC and LDL-C. Essential amino acids in casein are mainly responsible for this (Carroll and Kurowska, 1995).

ii. Fish: According to Kromhout (1990) and ICMR (1998) consumption of 100 to 200g of fish two to three times a week helps to prevent heart disease. As a therapy, fish oils containing essential fatty acids, can be recommended under medical supervision. These findings have shown an inverse relationship between fish consumption and heart disease.

A high dietary fish intake and marine n-3 PUFAs have been proposed by Marckmann et al (1995) to protect against cardiovascular diseases (CVD) by way of their metabolic effects.

Biro (1996) have proved the positive effects of n-3 PUFAs (found in marine oils) on platelet activity, lipid profile, blood rheology and blood pressure - all factors important in the pathogenesis of atherosclerosis.

Omega-3-fatty acids from fish and fish oils significantly lowered plasma TC, TG, LDL-C, HDL-C and VLDL-C (Nordoy et al, 1993).

Harris et al (1990) have noted that consumption of n-3 fatty acids in moderate to high amounts may cause a deleterious rise in LDL-C and apolipoprotein B concentrations in normotriglyceridemic males.

Regular fish eaters who do not eat meat have higher levels of HDL-C than vegetarians, vegans and regular meat eaters (Thorgood et al, 1990). Fish oil caused a decrease in serum triglyceride levels in hypertriglyceridemic patients (Naber et al, 1992).

Hirai et al, (1989) noted that incidence of thrombotic cardiovascular disease was lower in residents of Japanese fishing village who consumed larger amounts of fresh fish than those who consumed lesser fish in the inland farming villages.

The favourable lipid profile of Naulias (fishermen of the coromandel coast) was attributed to their intake of fish (Mandal et al, 1995).

iii. Eggs: Vorster et al (1992) pointed out that a limited egg intake, without changes in other factors known to influence plasma lipids and lipoproteins, will not affect known biochemical risk markers of CHD.

Ball and Mann (1988), Longfield (1991) and Walquist and Dalais (1999) have put forth the fact that dietary cholesterol from eggs increases blood cholesterol when levels of saturated fat in the diet is high. Strategies of CHD prevention may not be compromised by steady egg ingestion if total fat and saturated fat intake are controlled (Morgan et al, 1993).

Nestel (1986) opined that a lacto-ovo-vegetarian diet was more effective in lowering serum cholesterol.

The low density lipoprotein cholesterol levels among lacto-ovo-vegetarians was within the normal range and LDL-C : HDL-C ratio was slightly higher than that observed for vegans (Thorgood et al, 1990).

iv.Chicken: Chicken without skin is a good low saturated fat alternative to red meat. But due to modern production methods fat level of poultry is high and if the skin is left on, it can be fattier than some lean cuts of meat (Longfield, 1991).

Liver phospholipid and liver total cholesterol was significantly higher in rats fed chicken fat than in rats fed on soybean oil (Cheng et al, 1995).

v. Beef: According to Denke (1994) beef tallow is enriched with stearic acid but is still hypercholesterolemic compared with fats lower in saturated fatty acids. Therefore curtailment of beef tallow in a cholesterol-lowering diet is appropriate. Lean beef is no more hypercholesterolemic than chicken and fish and therefore lean beef can easily fit into a cholesterol lowering diet.

vi Pork: A significant proportion of fatty acids in pork is saturated. The dietary fat of swine is reflected in the fatty acid composition of tissues. Feeding pork high in monounsaturated fatty acids (MUFA) may have a beneficial effect on serum lipids (Flynn et al, 1991).

Liver TG and phospholipid were highest in rats fed with lard when compared to those fed chicken fat or soybean oil. Liver TC was highest at 15 per cent lard fed group (Cheng et al, 1995).

vii. Cholesterol: Dietary cholesterol increases serum TC levels and smaller LDL particles. The plasma lipid response to dietary cholesterol depends upon the type of fat in the diet and baseline cholesterol intake (Katan, 1997; Kris-Etherton et al, 1988 and Hegsted et al, 1993). Shekelle and Stamler (1988) concluded from the western study that dietary cholesterol was positively and independently related to risk of death from CHD.

With diets high in cholesterol, casein was sharply hypercholesterolemic compared to soy protein. This effect is mainly due to lysine and methionine present in casein. Substitution of soy proteins for animal proteins in the diet reduces the serum cholesterol levels in humans (Carroll and Kurowska, 1995).

2. Non Dietary Factors

a. Obesity: According to Ostlund et al (1992) abdominal obesity, so prevalent among affluent Indian adults provides the metabolic background for the development of coronary heart diseases.

Hubert et al (1983) have indicated that obesity is a risk factor for coronary heart disease. Overweight/obesity is associated with elevations in plasma triglycerides, total cholesterol and LDL-C and lower level of HDL-C. The distribution of excess adipose tissue also seems to be an important determinant of cardiovascular disease risk. Exercise favourably affects plasma HDL-C levels during a calorie restricted weight loss programme (Jonnalagadda et al, 1996).

Obesity and plasma lipid relationships have been examined in investigations. In general, obesity is associated with a more atherogenic lipoprotein profile. When assessed by relative weight or body mass index, obesity was positively correlated with total cholesterol, LDL-C and triglycerides and negatively correlated with HDL-C (Martins et al, 1998).

Obesity has been shown to be a significant independent predictor of cardiovascular disease in the Framingham study. The major diseases linked to obesity include hypertension, coronary heart disease, diabetes, gall stones and gastro intestinal disorders (WHO, 1991).

According to a study at Vellore, in Indian patients, it is angiographically proved that CAD can be seen with low body mass index (Thomas and Krishnaswamy, 1995). Eight point two per cent of the patients with CAD had body mass index over 27 kg/m^2 while 91.8 per cent had body mass index within the range accepted as normal by western standards with a mean around 23 kg/m^2 as being associated with minimum mortality in both men and women.

According to Gotto et al (1990) and Mc Namara et al (1993) obesity itself is a risk factor independent of its associated metabolic effects.

Overweight or obesity is associated with increased plasma TG, TC, LDL-C and decreased HDL-C levels (Kris-Etherton et al, 1993).

b. Smoking: According to Vardan (1995), risk of developing coronary heart disease is directly related to the number of cigarettes smoked per day. Studies by Whig et al (1992) say that active smoking causes an increase in total cholesterol, triglycerides, LDL-C and VLDL-C whereas HDL-C content is lowered resulting in decreased ratios of HDL-C/TC and HDL-C/LDL-C. The passive smokers also showed slightly high levels of LDL-C and VLDL-C but lower levels of HDL-C and a lower HDL-C/LDL-C ratio. The findings suggest that smoking alters serum lipids and lipoproteins and those changes are related to duration and amount of smoking.

According to a British study (1992), smokers in their 30's or 40's are 5 times more likely than their non-smoking counterparts to have a heart attack because smoking can worsen the hypofunction of the thyroid gland causing severe gland failure which results in a further rise of cholesterol levels.

The risk of coronary heart disease is higher in those with elevated cholesterol levels, cigarette smoking, obesity, alcohol consumption and oral contraceptive use. All had a significant effect on adult cholesterol levels. Similarly a family history of ischemic heart disease was correlated with high cholesterol levels in adulthood.

The relationship between fibrinogen level and ischemic heart disease (IHD) incidence is strong and may well explain the larger part of the relationship between smoking and IHD because smoking directly influences fibrinogen levels (Marin et al. 1996).

c.Alcohol consumption: According to Lawrence et al (1993) and Whitehead et al (1996) small amounts of alcohol that is equivalent to one drink per day, may offer protection against coronary heart disease in part because of its effect on HDL-C.

Studies have shown that people who drink a lot of alcohol have a higher risk of developing coronary heart disease. Since alcohol contains seven calories per gram (second only to fat) increased consumption often leads to weight problems (Longfield, 1991). Vasisht et al (1992) found increased levels of atherogenic lipids (triglycerides, VLDL-C, LDL-C and apo-B) in high as well as moderate drinkers.

Alcohol increases total HDL-C and apolipoprotein A-I levels but increased levels of atherogenic lipids - TG, VLDL-C, LDL-C and apolipoprotein B were found in moderate to high drinkers (Ziegler et al, 1995).

Hegsted et al (1993), Igarashi (1995) and Drocin (1995) have found out that CHD incidence and mortality are decreased by moderate alcohol intake.

Gartside et al (1994) revealed substantial inverse, protective association between linoleic acid and alcohol intake and strongly positive association of cigarette smoking and coffee intake with coronary heart disease.

These associations, internally consistent with significant relationship between diet, coffee, alcohol and lipid and lipoprotein cholesterol emphasize the important role of modifiable dietary and behavioural characters in the causation and prevention of coronary heart and vascular diseases.

d. Coffee consumption: According to Harris and Myers (1995) the administration of large doses of caffeine results in a small blood pressure increase in those who have not recently ingested drinks containing caffeine. Boiled coffee contains an unidentified lipid that increases serum cholesterol and subjects who consumed 6 cups of boiled cofffee/day had higher serum cholesterol level (Beynen et al ,1995 and Hutchings et al, 1995).

Epidemiological research has quantified that some reduction in coffee consumption, together with a preference for percolated coffee, will reduce the risk of cardiovascular disease upto 30 per cent (Thorp, 1995).

Coffee component other than caffeine is responsible for increased LDL-C and apolipoprotein-B levels (Superko, 1991).

Kono et al (1993) noted an inverse relation between tea consumption and serum TC levels. Serum TC is directly related to the cups of coffee drunk each day and reduction in coffee consumption decreases risk of CVD (Kris-Etherton et al, 1988).

e. Physical activity: Stern (1994) opines that regular dynamic exercise is very beneficial for primary and secondary prevention of CHD and exercise associated with better control of blood pressure, improved lipid profile, weight management, improved insulin sensitivity, glucose tolerance and diabetes management.

Mac Nair (1995) pointed out that physical activity, not diet should be the focus of measures for the primary prevention of CVD.

Nakamura et al (1995) pointed out that there was a significant inverse correlation between the energy expenditure/kg body weight and serum triglyceride and between the BMI and serum triglyceride and total cholesterol.

Luc et al (1991), Stampfer et al (1991) and Slattery (1995) have declared that dietary antioxidants are associated with lifestyle factors such as being more physically active and not smoking cigarettes which may alter the risk of CVD.

f. Emotions and eating habits: Vardan (1995) suggested a direct association between CHD and stress A personality. Tension, anxiety, fatigue, depression and confusion increased and vigour decreased during meat supplementation.

Peters (1989) pointed out that even moderately raised levels of circulating haemoglobin are associated with an increased risk of CHD.

Jenkins (1991) and Denollet (1996) observed that people who experienced distress but tended not to talk about it known as a type D personality were almost 4 times more likely to die in the next 6 to 10 years than people with other types of personality.

Jenkins et al (1995) reported that increased meal frequency or nibbling decreases serum TC and incidence of CVD.

It has been hypothesized that hyper-cholesterolemia may be the common underlying factor that leads both to atherosclerosis and its complication such as CHD, stroke and peripheral vascular disease (Phillips, 1989).

Mann (1990) pointed out that women using oral contraceptives have higher systolic and diastolic blood pressure and the risk of myocardial infarction is increased which is compounded by cigarette smoking.

Most healthy pre-menopausal women have a significantly lower risk of heart disease than men, but women with polycystic ovary syndrome which is characterized by hormonal abnormalities and infertility tend to be overweight and have increased levels of LDL-C and decreased levels of HDL-C (Lewis, 1995).

Bullock (1994) revealed that men under 5 feet 7 inch and women under 5 feet 1 inch were more likely to show signs of significant coronary diseases than taller subjects.

Hyperinsulinemia increases serum TG, decreases HDL-C and atherogenic small, dense, LDL particles are seen (Solymoss et al, 1995).

Williams et al (1992) found out that CHD has increased much more in those towns with the softer water than in those with the harder water.

Chronic infection with a common bacteria that can cause ulcers, helicobacterpylori or another bacteria that can lead to pneumonia may contribute to the development of heart disease (Stenson, 1995).

According to British Medical Journal (1993) tooth decay is linked to an increased risk of CHD and mortality particularly in young men and this study also found out that the men under 50 years with periodontitis or who had no teeth were 70 per cent more likely to have CHD than men with no dental disease.

Environmental factors are increasingly being recognised as a cause of heart disease. Such factors include pollution of the atmosphere particularly by free radicals and pollution of water particularly by mercury and nitrate (Aggarwal, 1996 and Gopalan, 1996).

The higher the average blood sugar levels, the higher was the risk of heart attacks and glucose level itself is a strong predictor of heart diseases as any other recognised risk factors like smoking or high LDL-C (Nathan, 1995).

Methodology

III. METHODOLOGY

The steps involved in carrying out the current investigation entitled "Epidemiology of Diseases in Relation to Consumption Pattern of Fats and Oils Among Selected Adults in Coimbatore City" are as follows:

A. Analysis of the incidence of cardiovascular diseases in 1985 and 1995

B. Study of the target adults in terms of

1. Socio-economic profile
2. Food intake with special reference to fats and oils and personal habits
3. Body mass index
4. Prevalence of fat associated diseases and
5. Serum lipids

C. Assess the impact of consuming single plant oil/animal foods on serum lipid profile

D. Study on the replacement of saturated fats with plant oils on selected hyperlipidemics

E. Estimation of fat intake and lipid profile of patients suffering from cardiovascular diseases, hypertension and diabetes mellitus

and F. Impart and assess the impact of diet counselling on selected hyperlipidemics

A. Analysis of the incidence of cardiovascular diseases in 1985 and 1995

To study the incidence of cardiovascular diseases in 1985 and 1995, G. Kuppuswamy Naidu Memorial Hospital, a reputed hospital in Coimbatore, Tamil Nadu, India, was selected. In addition to providing special treatments to cardiovascular diseases, hypertension and diabetes mellitus, this hospital also maintained records of the treatments offered to the patients.

Incidence of cardiovascular diseases was studied by collecting secondary data from the hospital records. This included details on in-patient and out-patient treatment, name, age, sex and type of health disorder.

Analysis of data over a decade indicated a distressingly high rate of prevalence of cardiovascular diseases in 1995. Hence, the investigator further probed to re-examine the crucially important and highly over looked diet related aspects of these diseases, to formulate dietary guidelines, to reduce the incidence of diet linked diseases with particular reference to quantity and quality of fat consumed.

B. Study of the target adults in terms of

1. Socio-economic profile

a. Selection of the target adults

As the investigator was a resident of Coimbatore city the target group of adults were selected from three prominent residential areas of Coimbatore city namely a part of Gandhipuram, R.S.Puram and Saibaba colony. These areas had close proximity to the University.

Using systematic random sampling technique (Kothari, 1998) the target group of adults were selected for the study. Every third house of the target area was surveyed and all the adult male and female subjects between 25 and 55 years of age in the selected houses were included in the study till the required number of subjects were selected. A total number of 1200 subjects comprising of 720 male and 480 female subjects formed part of the study. There were 240 males and 160 females each in low, middle and high income groups.

A sub-sample of 120 subjects, representing 25 males and 15 females in each income group between 25 and 45 years of age were randomly selected from the target adults of 1200 subjects to study the association between the consumption of fats and oils, body mass index, blood lipid profile and incidence of diseases.

b. Collection of socio-economic data

To collect the socio-economic profile of all the selected subjects an interview schedule was developed (Annexure I) which included questions on age, educational status, occupation, level of activity, income and type of family of the subjects.

All the 1200 subjects were personally interviewed at their residence and the relevant data were collected. Maximum reliability of the data was ensured by questioning and cross questioning the subjects.

2. Quantifying the food intake with special reference to fat intake and study of the personal habits

Data on food intake pattern were collected through the schedule given in Annexure I. The schedule contained questions regarding the nature and amount of diet consumed, types of fats and oils and animal foods consumed by the family and by the selected adults. Quantification of the food and nutrient intake was carried out through a 24 hour food recall survey for three consecutive days. Household cups and spoons were used to quantify the food consumption. From the food consumption data, raw equivalents were calculated and mean food and nutrient consumption were arrived at using the nutritive value of Indian foods by ICMR (1998) for the sub sample of 120 subjects.

3. Computation of body mass index

The anthropometric measurements namely height and weight of all the subjects were measured using standard procedures (Jelliffe, 1991) and recorded.

a. Height

The non-stretch tape was fixed to a vertical flat wall for measuring the height. After removing the shoes, the subject was made to stand straight on a flat floor by the scale, with feet together, legs straight, heels, buttocks and shoulders and the back of the head touching the wall. The head was held comfortably erect, looking straight forward, shoulders relaxed and arms hanging by the side in a natural manner, a scale was gently lowered by compressing the hair and making contact with the head and height was measured to 0.5 cm accuracy against the marking on the tape fixed to the wall (Jelliffe, 1991).

b. Weight

The weight of all the subjects was measured using a portable spring balance. The scale was kept on a firm flat floor and the accuracy checked with standard weights for the range of weights for which they were used. The subject was made to stand on the scale with feet bare and wearing minimum essential clothing and weight was taken to 0.5 kg accuracy. Care was taken to ensure that the weight was not taken after a full meal or with a full bladder (Jelliffe, 1991).

From the height, weight measurements, the body mass index of all the subjects were calculated using the formula given by Garrow (1993)

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height } (\text{M}^2)}$$

4. Prevalence of fat associated diseases

A check-list was prepared (Annexure II) listing the fat associated diseases. During the survey each subject was enquired about the presence of fat associated diseases and accordingly markings were made on the check list. Thus the disease prevalence was assessed.

5. Estimation of serum lipids

As the risk for cardiovascular diseases can be predicted using lipid profile, the serum lipid fractions were tested for all the sub-sample of 120 subjects.

The serum total cholesterol (TC) was estimated by colorimetric method as per the procedure recommended by Trinder (1969) and Roeschian et al (1974) given in Annexure III. The high density lipoprotein cholesterol (HDL-C) was estimated using colorimetric method of Gordon (1977) and the procedure followed is given in Annexure IV. Serum triglyceride was estimated by Bucolo and David (1973) and Werner et al (1981) explained in Annexure V.

Low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (VLDL-C) were computed using the formula given by Friedwald et al (1992).

$$\text{LDL-C} = \text{Total cholestero l} - \frac{\text{TG}}{5} - \text{HDL-C}$$

$$\text{VLDL-C} = \text{Total cholesterol} - \text{LDL-C-HDL-C}$$

The subjects were required to be on an over night fast of 12 hours. Then 5 ml of fasting venous blood was drawn and the lipid profile was analysed.

C. Assess the impact of consuming single plant oil/animal foods on serum lipid profile

To further examine the effect of consuming any one plant oil or any one animal food on health, subjects consuming only one plant oil were picked out from the target 1200 adults. Fifty subjects each consuming either ground nut oil or refined ground nut oil or gingelly oil (Sesame oil) or sunflower oil or coconut oil were identified. Ten subjects each consuming only milk or egg or fish or chicken or mutton or beef or pork were located The impact of single plant oil/animal foods on incidence of diseases was investigated using this subsample of 270 adults. Animal food consumers ate the particular animal food atleast four times a week totalling one kg/week. Total visible and invisible fat intake, body mass index, waist/hip ratio, incidence of diseases and serum lipid profile were assessed for all the 270 target adults, using the procedures already mentioned.

The waist and hip circumferences were measured using a non-stretch fibre-glass tape with 0.1 cm accuracy. Waist circumference was taken on the narrowest circumference between the ribs. Hip measurement was taken at the widest circumference over the buttocks. Then the waist, hip ratio was calculated using the formula suggested by Boyle (1993)

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

D. Study on the replacement of saturated fats with plant oils on selected hyperlipidemics

The hyperlipidemic subjects screened from the 1200 target adults were found to consume saturated fats in the form of butter, ghee and vanaspathi in quantities exceeding recommended allowance. Hence a total number of forty hyperlipidemics were selected to study the effect of replacement of saturated fats with plant oils. These hyperlipidemics were selected on the basis that their serum total cholesterol values were more than the high risk level (>240 mg/dl) suggested by NCEP (1988).

The selected 40 hyperlipidemics were divided into four groups (Group I to IV) of 10 subjects each. The visible saturated fats and oils present in the diets of the first three groups were replaced with 30 grams each of ground nut oil/gingelly oil/sunflower oil respectively. The fourth group served as control without any oil replacement.

Before effecting the replacement of the oils, the investigator collected the subjects in each experimental group separately in one common place and enlightened them on the purpose of the study. The need for the study and the importance of strict adherence by the subjects to the instructions given for the successful conduct of the study were explained and thus co-operation of the subjects was ensured.

The replacement of plant oils was carried out for a period of two months. During the replacement period uniform energy intake by the three groups of subjects was also ensured. The subjects were closely monitored during the study period by the investigator. The fourth group of 10 hyperlipidemics did not receive any replacement and served as control for comparison. The body mass index and serum lipid profile of all the four groups were estimated before and after replacement with plant oils.

E. Estimation of fat intake and serum lipid profile of patients suffering from cardiovascular diseases, hypertension and diabetes mellitus

Three groups of one hundred patients, each suffering from cardiovascular diseases, hypertension and diabetes mellitus respectively were separately selected from one of the reputed hospitals of Coimbatore city, using simple random selection procedure (Kothari, 1998). Fats and oil intake, body mass index , waist hip ratio and serum lipid profile of all the patients were measured. The association of all these parameters with their diseases was studied.

F. Impart and assess the impact of diet counselling on selected hyperlipidemics

High correlation observed between fats and oil intake, serum lipid profile and incidence of fat associated diseases in the study made it imperative to explore ways and means of reducing the incidence of these diet associated diseases. As a result, diet counselling of hyperlipidemic subjects was undertaken as a strategy for preventing the onset of degenerative diseases.

A total number of 100 hyperlipidemics were selected from the same hospital using simple random sampling method (Kothari, 1998) for the purpose of imparting diet counselling.

Diet counselling was imparted for a period of two months. Before the start of diet counselling the knowledge, attitude and practices of the subjects regarding foods and nutrients, and their food beliefs were tested with the help of a questionnaire (Annexure VI).

Based on the initial knowledge and dietary practices of the subjects, lessons were developed.

The lessons in counselling included the definition of good nutrition and good health, foods to be included and restricted by obese hyperlipidemics, role of fats and oils in the body, concept of saturated and unsaturated fats, need for essential fatty acids, foods rich in essential fatty acids, role of anti oxidants and dietary fibre, normal serum lipid levels, and ways and means to maintain serum lipid profile.

Audio visual aids like charts, posters, pamphlets, and models were used in the education process. All the themes were taught and retaught to make counselling more effective and intense. Each subject was personally counselled twice in a week for a duration of one hour. Group counselling was also given twice in a week for a duration of one hour. Group counselling was carried out by gathering all the subjects in one place.

After a period of two months of counselling, the knowledge, attitude and practices of the subjects were tested through the same questionnaire used before counselling and marks were awarded according to their answers.

The body mass index and the serum lipid profile were estimated before and after diet counselling and the results were statistically analysed.

IV RESULTS AND DISCUSSION

The data obtained in the present investigation entitled,"Epidemiology of Diseases in Relation to Consumption Pattern of Fats and Oils Among Selected Adults in Coimbatore City", were tabulated and discussed under the following headings.

A. Incidence of cardiovascular diseases in 1985 and 1995

B. Association between consumption of fats and oils, body mass index and incidence of diseases among the target adults

C. Impact of consuming single plant oil/ animal foods on adults

D. Effect of replacement of saturated fats with plant oils

E. Pattern of body mass index and serum lipid profile of selected patients suffering from fat associated diseases in relation to the intake of fats and oils and

F. Impact of diet counselling on selected hyperlipidemic adults

A. Incidence of cardiovascular diseases in 1985 and 1995

The first step of the investigation was to analyse the incidence of cardiovascular diseases in 1985 and 1995 in one of the leading private hospitals of Coimbatore city. The results of data collected as per the hospital records for 1985 and 1995 are presented in Table I.

TABLE I

NUMBER OF CARDIOVASCULAR DISEASE PATIENTS REGISTERED IN 1985 AND 1995 IN THE SELECTED HOSPITAL

Age	1985						1995					
(years)	M	%	F	%	Total	%	M	%	F	%	Total	%
26-35	18	3	10	4	28	3	30	2	20	3	50	2
36-45	49	9	43	19	92	12	125	9	45	6	170	7
46-55	124	23	54	24	178	23	311	22	200	26	511	23
56-65	177	33	59	26	236	31	458	32	247	31	705	33
66-75	111	20	39	17	150	19	327	23	206	26	533	24
76-85	52	9	16	7	68	9	121	9	55	7	176	8
86-95	13	2	4	2	17	2	38	3	9	1	47	2
96-100	1	1	3	1	4	1	6	1	0	0	6	1
Total	545	100	228	100	773	100	1416	100	782	100	2198	100
		71		29				64		36		

The data presented in Table I shows that the number of patients registered in the hospital for treatment of cardiovascular diseases was 773 in 1985 as against 2198 in 1995 indicating a three fold increase over a decade in the incidence of cardiovascular diseases. This data is illustrated in Figure 1

During 1985 the percentage of incidence among males was 71 per cent and among females it was 29 per cent. In 1995 the pattern of

NUMBER OF CARDIOVASCULAR DISEASE PATIENTS
REGISTERED IN 1985 AND 1995 IN THE
SELECTED HOSPITAL

Fig. 1

higher incidence among the males continued but the percentage incidence in the females had increased by 7 per cent. The increase could be due to people becoming more health conscious and avail health care facilities even with the least provocation. Females have become more prone to cardiovascular diseases compared to the data a decade ago. This can also be attributed to the fact that gender bias in availing health care facilities is changing.

The highest incidence was found in the age group of 56 to 65 years in both males and females in 1985 and in 1995 followed by 46 to 55 years in 1985 and 66 to 75 years in 1995. Between 76 to 85 years the incidence had again increased in 1995. Beyond 96 years of age only one person was treated for cardiovascular disease in 1985 whereas in 1995, six subjects had been registered. This data confirm the fact that as life expectancy of people has increased, the number of older adults surviving and subsequent necessity for treatment has also increased.

The pattern of incidence of cardiovascular diseases in the present study points out the fact that beyond the age of 46, people should have regular health checkup to avert becoming victims of killer diseases.

This three fold increase in cardiovascular diseases over ten years made it necessary to analyse the contributory factors responsible for this condition. In the midst of all the other precipitating factors, nutritional factor deserves immediate attention and analysis since fat intake has been shown to be closely associated with cardiovascular diseases in clinical as well as epidemiological studies (Park et al, 1996, Khor, 1997 and Achaya, 1997).

Hence further analysis was undertaken to findout the epidemiology of fat related diseases in selected adults of Coimbatore city, Tamil Nadu, India

B. Association between consumption of fats and oils, body mass index and incidence of diseases among the target adults

1. Socio-economic profile

The results of the cross sectional data collected from 1200 subjects in terms of income, age, sex, educational status and occupation are presented and discussed below

a. Age and sex of the selected sample in the three income groups

All the subjects were classified into low income, middle income and high income groups according to the monthly per capita income.

Income classification was done by the investigator based on the prevailing cost of living in Coimbatore city and according to the classification given by Express Publication (1997). The subjects were classified according to age and sex and are presented in the three income brackets in Table II and in Figure 2.

TABLE II

PERCAPITA INCOME-WISE CLASSIFICATION OF THE SELECTED SUBJECTS ACCORDING TO AGE AND SEX

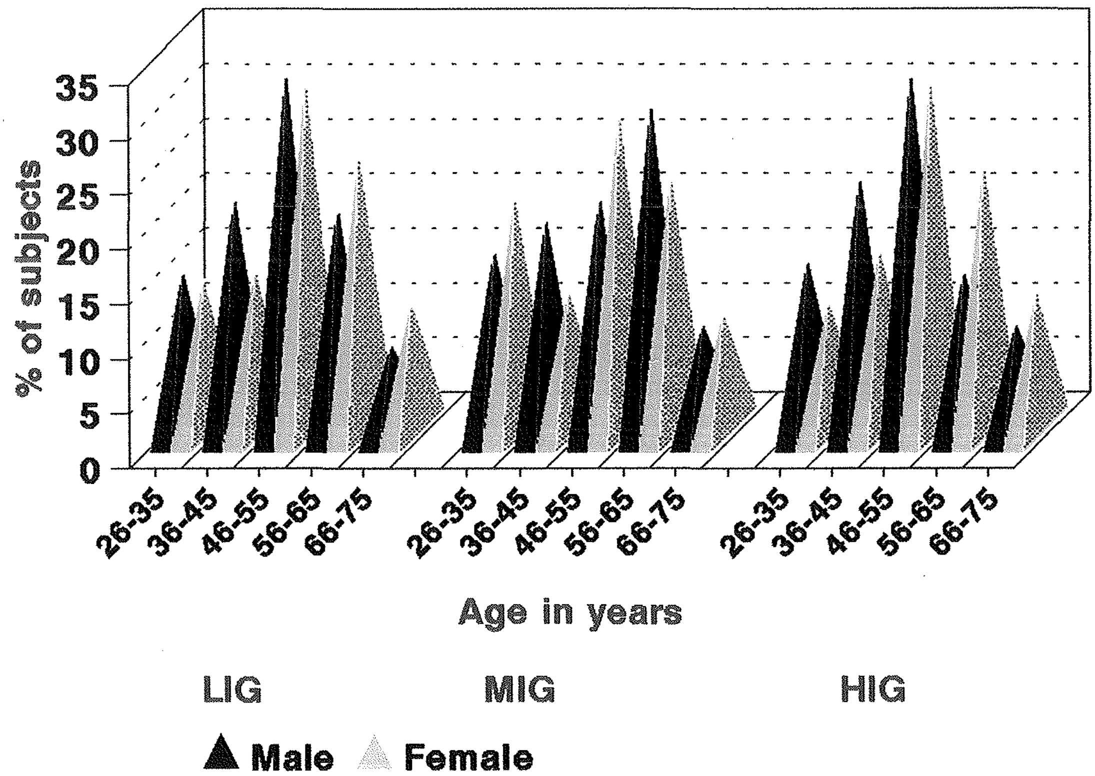
(N = 1200)

Income classi-/fication	Monthly per capita income											
	Upto Rs.900 LIG*				Rs. 900 to 2000 MIG**				Rs. 2000 & above HIG***			
	Male		Female		Male		Female		Male		Female	
Age	N	%	N	%	N	%	N	%	N	%	N	%
26-35	35	15	22	14	45	17	32	22	39	16	19	12
36-45	52	22	25	15	48	20	21	13	67	25	27	17
46-55	82	34	53	33	52	22	50	30	89	34	52	33
56-65	51	21	42	26	74	31	39	24	37	15	40	25
66-75	20	8	18	12	21	10	18	11	23	10	22	13
	240	100	160	100	240	100	160	100	240	100	160	100
		400				400				400		

* LIG = Low Income Group
** MIG = Middle Income Group
*** HIG = High Income Group

In the age group 46 to 55 years, there were more number of subjects in all the three income groups. This trend was noticed in both male and female population. In the age group 66 to 75 years, there were least number of subjects.

Nuclear family system predominated in all the income groups ranging from 64 to 72 per cent. This well reflects the present day trend of



PERCAPITA INCOME-WISE CLASSIFICATION OF THE SELECTED SUBJECTS ACCORDING TO AGE AND SEX

Fig. 2

moving from joint family to nuclear family system.

b. Educational status of the selected subjects

The distribution of the subjects according to their level of education is presented in Table III.

TABLE III

DISTRIBUTION OF THE SUBJECTS ACCORDING TO EDUCATIONAL STATUS

(N=1200)

	LIG (400)				MIG (400)				HIG (400)			
Educational status	M	%	F	%	M	%	F	%	M	%	F	%
Illiterates	15	6	27	17	-	-	-	-	-	-	-	-
Primary school	62	26	72	45	33	14	12	8	10	4	18	11
High school	71	30	35	22	75	31	28	18	30	13	27	17
Higher secondary	82	34	20	12	35	15	30	19	52	22	31	20
Under graduate	10	4	6	4	82	34	78	49	85	35	50	31
Post graduate	-	-	-	-	15	6	12	8	63	26	34	21
Total	240	100	160	100	240	100	160	100	240	100	160	100

Number in parentheses indicate sample size in each income group

Literacy level was high among the selected subjects with no illiterates in high and middle income groups. Forty to 50 per cent of the subjects had completed graduation and post graduation in middle and high income groups, indicating a direct relationship between educational status and income.

In the low income group six and 17 per cent were illiterates among males and females respectively. Availability of man power involving low wage, labour intensive activities combined with necessity for earning money for livelihood has resulted in illiteracy among low income groups. Only a small percentage (4 per cent males and 4 percent females) of low income subjects had college education.

c. Occupational status of the selected subjects

Table IV presents the occupational status of the selected subjects.

TABLE IV

OCCUPATIONAL STATUS* OF THE SELECTED SAMPLE

(N=1200)

Level of activity	LIG (400)				MIG (400)				HIG (400)			
	Male		Female		Male		Female		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%
Sedentary	28	12	15	9	49	20	107	67	166	69	125	78
Moderate	75	31	56	35	116	48	42	26	74	31	35	22
Heavy	137	57	89	56	75	32	11	7	-	-	-	-
	240	100	160	100	240	100	160	100	240	100	160	100

* According to norms prescribed by ICMR, 1998

Analysis of the occupational status of the subjects presented in Table IV indicates that 57 per cent of males and 56 per cent of females in the low income group were employed in occupations requiring heavy activity. They were engaged in building work, sales men, street vendors or appointed in workshops. Building work and appointment in houses to do the heavy activity were the main job of women. Rest (31 per cent males and 35 per cent females) were doing moderate activity and only 12 per cent males and 9 per cent females were occupied in sedentary activity. Unless there was some health problem they did not stay at home.

Contrary to low income picture in high income group none of the subjects were doing heavy activity. They were occupied in sedentary activities only. In the middle income group 48 per cent of the male were occupied in moderate activity with 32 per cent doing heavy work. Here too females (67 per cent) were doing sedentary activity only. High income combined with higher educational qualification, led to preference for employment in white collar jobs, with less physical activity. Thus the subjects in high income families were engaged in employment requiring less physical activity.

d. Food consumption pattern of the selected subjects

The data collected on food consumption pattern of the selected subjects is presented in the following Tables V and VI.

Table V presents the nature of diet consumed by the selected subjects.

TABLE V

NATURE OF DIET CONSUMED BY THE SELECTED SUBJECTS

(N=1200)

Nature of food	LIG (400)		MIG (400)		HIG (400)		Total (1200)	
	N	%	N	%	N	%	N	%
Vegetarian	82	20	133	33	88	22	303	25
Ovo-vegetarian	31	8	62	16	50	12	143	12
Non-vegetarian	287	72	205	51	262	66	754	63
Total	400	100	400	100	400	100	1200	100

Figure in parentheses indicate sample size.

Of the 1200 subjects, 754 (63 per cent) were non-vegetarians and 143 (12 per cent) were ovo-vegetarians. Vegetarians consuming only milk were only 303 (25 per cent). When this number is analysed in the incomewise classification, 72 per cent of subjects in LIG were non vegetarians, against 66 per cent in the high income group. Adults from LIG consumed more of non-vegetarian foods like beef and pork which were available at a comparatively cheaper rate. The subjects belonging to HIG were in a position to afford money to get what they wanted. But the MIG subjects could neither go for the cheaper non vegetarian foods nor could afford other expensive non vegetarian foods. Hence there were more vegetarians and ovo vegetarians in the MIG. Number of vegetarians in the LIG and HIG were very less (20 per cent and 22 per cent respectively).

Day's per capita food consumption of the 1200 subjects, 400 in each income group are presented in Table VI.

TABLE VI

DAY'S PER CAPITA FOOD CONSUMPTION OF THE SELECTED SUBJECTS

(N=1200)

	LIG (400)				MIG (400)				HIG (400)			
Food stuffs	Male		Female		Male		Female		Male		Female	
(g/day)	N	%	N	%	N	%	N	%	N	%	N	%
Cereals												
100-200	-	-	-	-	36	15	48	30	81	34	12	8
200-300	68	28	56	35	109	45	75	47	80	33	56	35
300-400	138	58	95	59	85	36	34	21	55	23	79	49
400-500	34	14	9	6	10	4	3	2	24	10	13	8
	240	100	160	100	240	100	160	100	240	100	160	100
Pulses												
< 20	68	28	77	48	10	4	39	24	-	-	-	-
20-40	143	60	67	42	49	20	30	19	46	19	28	18
40-60	29	12	16	10	102	43	42	26	72	30	67	42
60-80	-	-	-	-	79	33	49	31	122	51	65	40
	240	100	160	100	240	100	160	100	240	100	160	100
Green leafyvegetables												
< 50	177	74	99	62	74	31	48	30	59	24	48	30
50-100	53	22	53	33	102	42	67	42	148	62	73	46
100-150	10	4	8	5	64	27	45	28	33	14	39	24
	240	100	160	100	240	100	160	100	240	100	160	100

Food stuffs (g/day)	LIG (400) Male N	%	Female N	%	MIG (400) Male N	%	Female N	%	HIG (400) Male N	%	Female N	%
Roots and Tubers												
< 50	192	80	127	79	63	26	45	28	20	8	42	26
50-100	38	16	25	16	143	60	87	54	59	25	24	15
100-150	10	4	8	5	34	14	28	18	77	32	39	24
> 150	-	-	-	-	-	-	-	-	84	35	55	35
	240	100	160	100	240	100	160	100	240	100	160	100
Other vegetables												
< 50	217	90	151	94	42	17	37	23	20	9	42	26
50 -100	23	10	9	6	163	68	85	53	152	63	82	51
100 -150	-	-	-	-	35	15	38	24	68	28	36	23
	240	100	160	100	240	100	160	100	240	100	160	100
Fruits												
< 50	186	78	138	86	73	30	59	37	47	20	29	18
50-100	54	22	22	14	151	63	95	59	139	58	86	54
> 100	-	-	-	-	16	7	6	4	54	22	45	28
	240	100	160	100	240	100	160	100	240	100	160	100
Sugar												
< 25	58	24	83	52	13	5	45	28	80	33	52	33
25-50	151	63	64	40	197	82	81	51	69	29	64	40
50-75	31	13	13	8	30	13	34	21	91	38	44	27
	240	100	160	100	240	100	160	100	240	100	160	100

Food stuffs (g/day)	LIG (400) Male N	%	Female N	%	MIG (400) Male N	%	Female N	%	HIG (400) Male N	%	Female N	%
Milk and milk products												
< 100	149	62	126	79	-	-	25	16	-	-	-	-
100-200	79	33	26	16	36	15	34	21	7	3	23	14
200-300	12	5	8	5	66	27	36	23	19	8	28	18
300-400	-	-	-	-	98	41	39	24	33	14	33	21
400-500	-	-	-	-	40	17	26	16	117	49	47	29
> 500	-	-	-	-	-	-	-	-	64	26	29	18
	240	100	160	100	240	100	160	100	240	100	160	100
Fats and oils												
< 20	147	61	98	61	40	17	46	29	-	-	-	-
20-40	80	33	57	36	49	20	40	25	20	8	17	11
40-60	13	6	5	3	103	43	45	28	28	12	37	23
60-80	-	-	-	-	48	20	29	18	84	35	46	29
80-100	-	-	-	-	-	-	-	-	108	45	60	37
	240	100	160	100	240	100	160	100	240	100	160	100
Flesh foods												
< 50	198	83	139	87	208	87	133	83	89	37	92	57
50-100	42	17	21	13	32	13	27	17	114	48	54	34
100-150	-	-	-	-	-	-	-	-	37	15	14	9
	240	100	160	100	240	100	160	100	240	100	160	100

The data in Table VI brings out the following consumption patterns in the three income groups.

i. In the case of low income group, the amount of cereals, roots and tubers and sugar and jaggery which are the major sources of carbohydrate were consumed in larger quantities while consumption of pulses, fruits, milk, fats and oils and amount of flesh foods were less compared to HIG and MIG. The main sources of fibre in the diet namely vegetables and fruits were low in the diet of low income group.

ii. The diet of middle income group revealed the fact that consumption of cereals is comparatively lesser than the LIG and higher than the HIG. Pulse consumption was higher compared to those in the LIG. The subjects in the middle income group consumed more than 40g of fats and oils while 90 per cent of subjects in low income group consumed less than 40g.

iii. Cereals consumption by adults of HIG was less compared to those in LIG and MIG. But the consumption of all the other groups of foods was high with variety of vegetables and fruits. Consumption of milk, oils and fats and flesh foods was high leading to increase in the consumption of saturated fats.

e. Personal habits of the selected subjects

The personal habits of the selected subjects assessed through administration of interview schedule are presented in Table VII.

TABLE VII

PERSONAL HABITS OF THE SELECTED SUBJECTS

(N=1200)

Personal habits	Sex	LIG (400)		MIG (400)		HIG (400)	
		N	%	N	%	N	%
Alcohol consumption	Male	135	34	22	6	112	28
	Female	-	-	-	-	-	-
Smoking	Male	186	47	55	14	175	44
	Female	-	-	-	-	-	-
Tobacco chewing	Male	12	3	26	7	18	5
	Female	25	6	39	10	7	2
Betel leaves consumption	Male	145	36	23	6	32	8
	Female	65	16	77	19	47	12

Personal habits of the subjects such as alcohol consumption, smoking, tobacco chewing and chewing betel leaves are the contributory factors in the incidence of fat related diseases (Vardan, 1995 and Vasisht et al, 1992).

The habit of consuming alcohol was prevalent among 34 per cent of the subjects in the low income group followed by the high and middle income groups. In all these groups only men were found to consume alcohol. All the women in the selected sample reported that they do not have the habit of consuming alcohol or smoking. One hundred and eighty six male subjects in low income group were smokers compared to high and middle income groups. Subjects from low income groups smoked beedies* while those in HIG smoked cigarettes. Neufeld et al (1997) have indicated from their study in USA that high density lipoprotein cholesterol levels are lower in smokers than in non-smokers.

Tobacco chewing was greater in females than males in low and middle income groups whereas in high income group there were more males with this habit.

Betel leaves were consumed by 145 males in LIG and by 77 and 47 females in MIG and HIG respectively.

3. Body mass index

The height and weight of all the 1200 subjects were measured and the body mass indices were calculated. Table VIII presents the mean height, weight and BMI of the subjects in the three income groups. Table IX presents the distribution of the 1200 subjects according to the BMI classification suggested by Garrow (1987).

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* Beedies - Tobacco wrapped in palm leaf used for smoking.

TABLE VIII

MEAN HEIGHT, WEIGHT AND BODY MASS INDEX OF THE SELECTED SUBJECTS

(N-1200)

	LIG (N 400)						MIG (N 400)						HIG (N 400)					
	Male			Female			Male			Female			Male			Female		
Age (years)	Height m	Weight kg	BMI	Height m	Weight kg	BMI	Height m	Weight kg	BMI	Height m	Weight kg	BMI	Height m	Weight kg	BMI	Height m	Weight kg	BMI
26-35	1.67	50.3	18.1	1.53	47.0	19.9	1.72	54.4	18.5	1.56	49.3	20.4	1.69	58.2	20.6	1.57	49.3	20.0
	+0.05	+5.5	+2.9	+0.04	-6.1	+2.2	-0.8	+5.0	+2.2	+0.04	+6.6	+2.8	+0.02	+3.0	+0.8	+0.06	+1.8	+1.5
36-45	1.58	51.0	20.8	1.58	46.4	18.5	1.68	60.4	22.3	1.53	48.2	20.6	1.69	62.3	21.5	1.56	56.2	23.1
	+0.08	+5.6	+4.4	+0.08	-5.0	+1.9	-0.09	+11.3	+3.7	+0.06	+2.8	+1.0	+0.06	+9.9	+2.0	+0.04	+6.8	+2.6
46-55	1.61	56.2	21.6	1.51	47.0	19.0	1.58	55.2	22.1	1.54	53.6	22.9	1.65	60.0	22.1	1.57	57.3	22.5
	+0.07	+4.5	+2.7	+0.06	-4.9	+1.7	-0.05	+6.7	+2.2	+0.05	+12.2	+6.5	+0.01	+7.0	+2.4	+0.02	+13.4	+4.9
55-65	1.63	57.0	24.5	1.57	43.7	17.9	1.59	52.0	20.3	1.56	58.0	24.4	1.64	53.0	19.7	1.48	62.0	28.3
	+0.06	+3.8	+3.3	+0.08	-8.5	+3.9	-0.04	+6.3	+4.4	+0.06	+11.0	+7.0	+0.01	+2.0	+2.2	+0.03	+8.3	+5.2
Mean	1.62	53.6	21.3	1.56	46.03	18.83	1.64	55.54	20.8	1.55	52.28	22.08	1.67	58.38	20.98	1.55	56.2	23.48

BMI grade suggested by Garrow (1993).

Chronic energy deficiency = <18.5

Normal = 18.5 to 25

I Grade obesity = 25 to 30

II Grade obesity = > 30

III Grade obesity = > 40

Number in parentheses indicate sample size

The mean weight of male subjects of low income group gradually increased with age. In other income groups for male subjects as age advanced above 45 years the body weight decreased. But it was vice-versa in the case of females of the low income group. As age advanced beyond 45 years there was an increase in the body weight in middle and high income group females.

With regard to BMI, only in the case of male subjects in low income group, who were between 26 to 35 years, the BMI was less than 18.5 denoting chronic energy deficiency as per the cut off values of Garrow (1993). All the other subjects recorded normal body mass index. The BMI of female subjects in middle and high income groups were more than the BMI of male subjects. The highest BMI (28.3) was registered by female subjects between 56 to 65 years of age in the high income group. In the case of females as income increased there was a gradual increase in the BMI. Tanphaichitr et al (1998) have also reported that dyslipidemia was prevalent in affluent urban Thai women. Overall and abdominal obesity were important causes of their dyslipidemia. In the case of men, considering all age groups together in the three income groups the average BMI ranged between 20.8 to 21.3.

Obesity has been shown to be a risk factor for coronary heart disease and hyperlipidemia by several workers (WHO 1991and Ostlund et al,1992) According to a study at Vellore, in Indian patients, it was angiographically proved that coronary artery disease can be seen with low body mass index. Only 8.2 per cent of the patients with coronary artery disease had body mass index over 27, while 91.8 per cent had body mass index within the range accepted as normal by western standards with a mean around 23 (Thomas and Krishnaswami, 1995).

These studies indicate that in Indians coronary artery disease occurs at a lower BMI level. Even at BMI below 25, if other precipitating factors are present, there are chances for occurrence of coronary artery diseases.

Table IX depicts the distribution of the sample according to body mass index

TABLE IX

DISTRIBUTION OF THE SAMPLE ACCORDING TO BODY MASS INDEX

(N=1200)

Body mass index *	LIG (N 400)				MIG (N 400)				HIG (N 400)			
	Male		Female		Male		Female		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%
< 16	15	6	85	5	-	-	-	-	-	-	-	-
16 to 17	28	12	20	13	13	5	11	7	-	-	-	-
17 to 18.5	61	25	26	16	37	16	26	16	7	3	8	5
18.5 to 20	84	35	29	19	80	33	68	43	60	25	54	34
20 to 25	29	12	65	40	74	31	47	29	87	36	65	41
25 to 30	23	10	12	7	20	8	8	5	56	23	21	13
> 30	-	-	-	-	16	7	-	-	30	13	12	7
Total	240	100	160	100	240	100	160	100	240	100	160	100

*Classification given by Garrow (1987).

Distribution of the subjects according to body mass index classification given by Garrow (1987) indicates that more than 50 per cent of subjects in each income group fell in the normal BMI range. Obesity was present in only 10, 15 and 36 per cent of the male subjects in low middle and high income groups respectively. . The percentages were reverse with regard to low BMI. In low, middle and high income groups 43 , 21 and 3 per cent of male subjects respectively were under weight. Similar trend was observed in the case of females also.

Tian et al (1995) have concluded in their study in China that body mass index was a strong and independent predictor of serum lipids in both sexes. BMI was positively related to serum cholesterol, triglyceride and low density lipoprotein cholesterol and inversely related to high density lipoprotein cholesterol.

Park et al (1996) observed that in Korean population the prevalence of obesity impaired hyper triglyceridemia and hypercholesterolemia and thus was found to be an atherosclerotic risk factor.

4. Prevalence of fat associated diseases

The prevalence of fat associated diseases was identified in the selected subjects and are presented in Table X. Figure 3 also depicts the prevalence of fat associated diseases in the selected subjects.

TABLE X

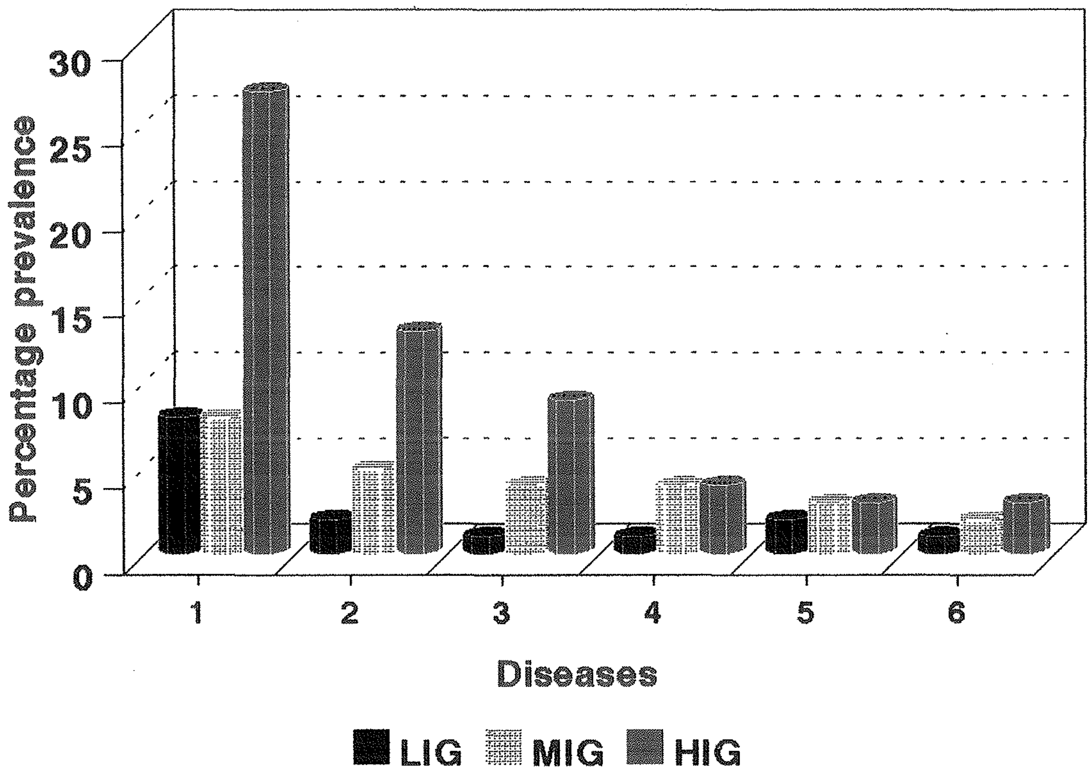
PREVALENCE OF FAT ASSOCIATED DISEASES IN THE SELECTED SUBJECTS

N=1200

Diseases	LIG (400)		MIG (400)		HIG (400)		Total (1200)	
	N	%	N	%	N	%	N	%
Obesity	29	8	32	8	107	27	168	17
Diabetes mellitus	6	2	18	5	52	13	76	6
Hypetension diabetes mellitus	5	1	15	4	35	9	55	5
Cardiovascular diseases	4	1	14	4	15	4	33	3
Hypertension and obesity	6	2	12	3	12	3	30	3
Hypertension	5	1	7	2	12	3	24	2
Total	61	15	98	26	233	59	416	36

Prevalence of fat associated diseases in the selected sample indicates that the percentage of obese subjects in the three income groups ranged between 8 to 27 per cent, the highest being in the high income group. Diabetes mellitus ranked second in the prevalence ranging between 2 to 13 per cent.

Cardiovascular diseases had affected 4 per cent of the subjects each in high income and middle income groups and only one per cent of the subjects in the low income group.



PREVALENCE OF FAT ASSOCIATED DISEASES
IN THE SELECTED SUBJECTS
Fig. 3

1. Obesity
2. Diabetes mellitus
3. Hypertension and diabetes mellitus
4. Cardiovascular diseases
5. Hypertension and obesity
6. Hypertension

Incidence of hypertension alone or in association with diabetes mellitus or obesity was 15 per cent in the high income group as against four per cent in low income group. In the middle income group 9 per cent were hypertensives.

The results of the study indicate a high association between disease prevalence and fat intake. The association between the consumption of fats and oils, body mass index, serum lipid profile and incidence of diseases was studied in a sub-sample of 120 representing both the sexes distributed in the three income levels.

Mean food intake

The day's mean food intake of the selected sub-sample is presented in Table XI.

TABLE XI

DAY'S MEAN FOOD INTAKE OF THE SELECTED SUBSAMPLE

(N-40 ineach income group)

R.D.A* Food stuffs (g/day)	R.D.A* for adult man (Moderate activity)	for adult woman (Moderate activity)	LIG Male	LIG Female	MIG Male	MIG Female	HIG Male	HIG Female
Cereals	475	350	405	378	372	304	293	283
			(-15)	(+8)	(-22)	(-13)	(-38)	(-19)
Pulses	72.5	62.5	43	42	45	46	59	61
			(-40)	(-33)	(-38)	(-26)	(-19)	(-3)
Green leafy vegetables	100	125	40	35	82	78	100	95
			(-69)	(-72)	(-38)	(-38)	(0)	(-24)
Roots and tubers	75	50	63	54	65	51	79	73
			(-16)	(+8)	(-13)	(+2)	(+5)	(+46)
Other vegetables	75	75	46	36	69	64	100	75
			(-39)	(-52)	(-8)	(-15)	(+33)	(0)
Visible fats and oils	35	30	26	20	40	47	66	61
			(-26)	(-33)	(+14)	(+57)	(+89)	(+103)
Flesh foods	30	30	34	32	35	37	57	50
			(+13)	(+7)	(+17)	(+23)	(+90)	(+70)
Sugar	30	30	39	38	47	48	58	51
			(+13)	(+27)	(+57)	(+60)	(+93)	(+70)
Milk and	200	200	130	150	250	200	450	300
milk products			(-35)	(-25)	(+25)	(0)	(+125)	(+50)
Fruits	30	30	38	30	42	46	75	75
			(+27)	(0)	(+42)	(+53)	(+150)	(+150

* ICMR (1998)

Number in parentheses denote percent deficit or surplus

Table XI on food intake pattern of the sub-sample point out the vast difference prevailing between the intake of subjects and the amounts recommended. The subjects in the low income group had met the RDA for flesh foods, sugar and fruits only. Though fruit intake (+27 per cent) was adequate, the fruit consumed was mainly plantains with inclusion of guavas during the season. Other fruits were consumed very rarely. Consumption of roots and tubers was deficient (-16 per cent) by the male subjects of LIG.

In the case of male subjects in middle income group the consumption of cereals, pulses, and all types of vegetables were less than the RDA. Cereal intake was deficient by 22 per cent, pulses and vegetables by 8 to 38 per cent. Consumption of other foods namely fats and oils (visible), flesh foods, sugar, milk and milk products and fruits met the RDA. The intake of female subjects of middle income group was less than the RDA for cereals (-13 per cent), pulses (-26 per cent) and green leafy vegetables (-38 per cent) while all the other foods consumption met the RDA.

Only cereal consumption was less by 38 per cent than the RDA, in the case of male subjects of high income group. Females consumed inadequate quantities of cereals (-19 per cent) and green leafy vegetables (-24 per cent). Consumption of all the other foods was more than the recommended allowances. Consumption of fats and oils, flesh foods and milk and milk products was double the recommended allowances. The consumption of fruits was more by 150 per cent and at the same time there was variety in the consumption of fruits.

b. Mean nutrient intake

The mean nutrient intake of the sub sample of 120 subjects is presented in Table XII. Figure 4 shows the energy contribution from carbohydrate, protein and fat.

TABLE XII

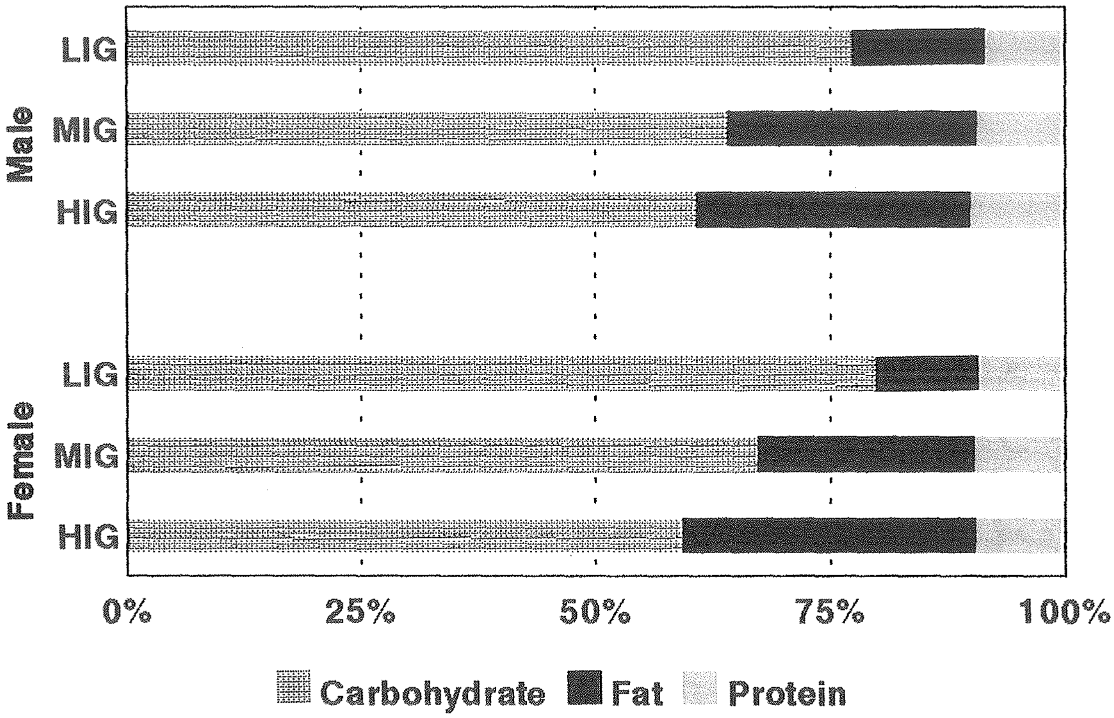
MEAN NUTRIENT INTAKE OF THE SELECTED SUBSAMPLE

(N-40 in each income group)

Nutrients	R.D.A* for adult man (Moderate Activity)	R.D.A* for adult woman (Moderate Activity)	LIG Male	LIG Female	MIG Male	MIG Female	HIG Male	HIG Female
Energy (kcal)	2875	2225	2284 (-21)	2049 (-8)	2222 (-23)	2012 (-10)	2423 (-16)	2346 (+5)
Carbohydrate (g)	-	-	442	409	355	337	367	346
Protein (g)	60	50	48 (-20)	47 (-6)	52 (-13)	49 (-2)	61 (+2)	56 (+12)
Fat (g) (Visible+Invisible)	20-40	20-40	36	25	66	52	79	82
Calcium (mg)	400	400	412 (+3)	402 (0.5)	980 (+145)	911 (+128)	1334 (+234)	949 (+137)
Iron (mg)	28	30	22 (-21)	20 (-33)	35 (+25)	33 (+10)	46 (+64)	45 (+50)
Beta carotene (µg)	2400	2400	1758 (-27)	1134 (-53)	2333 (-3)	2062 (-14)	2788 (+16)	2166 (-10)
Thiamine (mg)	1.4	1.1	1.5 (+7)	1.4 (+27)	1.8 (+29)	1.7 (+55)	1.7 (+21)	1.5 (+30)
Riboflavin (mg)	1.6	1.3	1.2 (-25)	1.3 (0)	1.4 (-13)	1.4 (+8)	1.6 (0)	1.3 (0)
Niacin (mg)	18	14	19.3 (-7)	16.1 (+15)	14.5 (-19)	16.4 (+17)	15.8 (-12)	17.1 (+22)
Vitamin C (mg)	40	40	29 (-28)	25 (-38)	46 (+15)	62 (+55)	87 (+118)	88 (+120)

* .ICMR (1998)

Numbers given in parentheses indicate percentage deficit or surplus



PERCENTAGE ENERGY CONTRIBUTION FROM CARBOHYDRATE, FAT AND PROTEIN IN THE DIETS OF THE SUB SAMPLE

Fig. 4

In the case of low income group, corollary to food intake, the intake of energy was inadequate compared to RDA. Intake of iron, beta-carotene and vitamin C was inadequate, since green leafy vegetable consumption was less than the RDA. Foods containing vitamin C were not included in the diet. The total fat intake (both visible and invisible fat) was within the amount recommended by ICMR (1998).

The nutrient intake of middle income group met the RDA for all the nutrients except energy, beta-carotene and niacin. In the case of fat both male and female subjects consumed 66 and 52g respectively compared to 20-40g suggested by ICMR (1998).

Both male and female subjects in the high income group met more than the recommended allowances of all the nutrients except energy. The male subjects of HIG consumed 79g of total fat and female subjects consumed 82g of fat which was equivalent to 29 to 31 energy per cent. This result is in concurrence with that of Durairaj (1997) who has also reported that in India upper income groups consume a visible fat of about 50 grams and invisible fat amounting to about 40g daily equivalent to 20-35 energy per cent of fat. He has also indicated that low income groups get just 10 energy per cent.

Ghafoorunissa (1987) has pointed out that the intake of edible oil is dependent on income and region.

Achaya (1987) has also found out that fat consumption varies among the different income groups namely low, middle and high. High income groups could be at a risk from over consumption of visible fat.

In the present study the ratio between the amount of visible fat consumed by male of high and low income group is 2.5 as against 3 in the case of females. That of invisible fat is 2 in males and 3 in females. Achaya (1987) has given a ratio of 3 and 2 between high and low income groups respectively for the amount of visible and invisible fats consumption.

c. Type and quantity of fat consumption

Table XIII gives the distribution of the sub sample according to the type of oil consumed with quantity per day.

TABLE XIII

DISTRIBUTION OF THE SUB-SAMPLE ACCORDING TO THE TYPE AND QUANTITY OF OIL CONSUMED

(N=40 in each income group)

Type of oil / Quantity g/	LIG			MIG			HIG		
	< 20	20-40	40-60	20-40	40-60	60-80	40-60	60-80	80-100
					No. consumed				
Single oil									
Groundnut oil (G.N.O)	2	2	2	-	2	-	-	-	-
Gingelly oil (Sesame oil (G.O)	-	4	2	-	1	2	-	2	-
Palm oil	2	4	5	-	-	-	-	-	-
Refined groundnut oil (R.G.N.O.)	-	4	-	5	2	2	-	-	4
Sunflower oil (S.F.O)	-	4	-	-	4	-	-	3	4
Coconut oil (C.O)	-	-	2	-	4	-	-	-	-
Mixed oils									
G.N.O.+ Palm oil	-	4	-	-	-	-	-	-	-
G.N.0+R.G.N.0	5	-	-	-	2	-	3	-	-
G.N.0+Gingelly oil + S.F.0+Ghee + Vanaspathi+Butter	-	-	-	-	-	7	3	8	4
Gingelly oil +S. F.O + R.G.N. +Ghee +Vanaspathi+Butter	-	-	-	1	5	3	-	3	6

The subjects of low income groups consumed any one plant oil only. Of the 40 only 9 subjects consumed combination of two or three oils as against 18 and 27 subjects in MIG and HIG. There were no subjects consuming more than 60g of oil in low income group. In the case of middle income group, the quantity of oil consumed by the adults of MIG was high (40 to 80g). Families of the high income group consumed different types of oils in different combinations. Saturated fats, especially, butter, ghee and vanaspathi were consumed by subjects in the middle and high income groups. Butter and ghee are sources of saturated fatty acids and vanaspathi is the source of trans-fatty acids that raise the serum cholesterol concentrations relative to cis-fatty acids. Grundy (1997) has recommended that intake of trans-fatty acid should be reduced from total energy intake to prevent atherosclerosis. WHO (1997) points out the ill-effects of excessive amounts of saturated fatty acids.

In the present study the subjects in the high income group were found to consume more saturated fats and trans-fatty acids, that are injurious to health and thus were under risk.

d. Mean fat consumption and percentage energy contribution from fat

Mean consumption of different types of fats and their energy contribution in the diets of the three income groups are presented in Table XIV and Figure 5.

TABLE XIV
MEAN CONSUMPTION OF DIFFERENT TYPES OF FATS AND THEIR ENERGYCONTRIBUTION
TO THE DIETS OF THE SUBJECTS IN THE THREE INCOME GROUPS

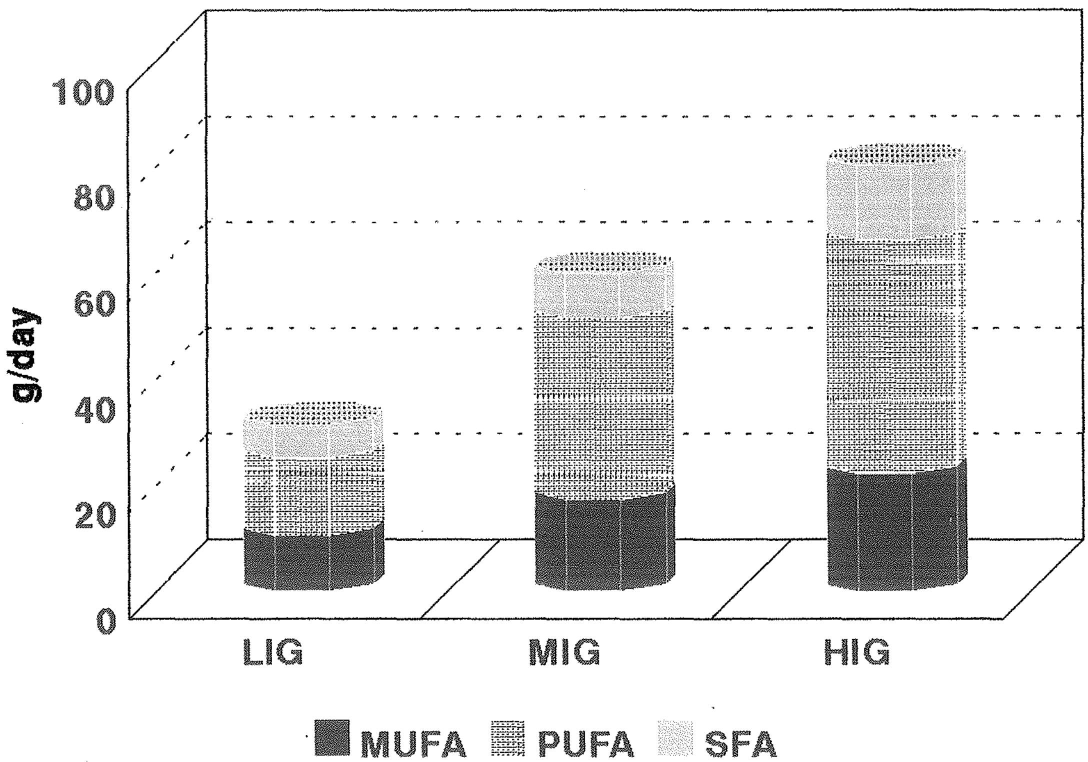
(N=40 in each income group)

Type of fat	LIG		MIG		HIG	
	Quantity (g)	% energy contribution	Quantity (g)	% energy contribution	Quantity (g)	% energy contribution
Total fat	31.5	12.4	60.0	24.3	80.4	29.8
MUFA	10.5	4.1	17.3	7.0	22.2	8.2
PUFA	14.8	5.8	34.4	13.9	44.2	16.4
SFA	6.2	2.5	8.3	3.4	14.0	5.2
P/s ratio	2.4	-	4.2	-	3.2	-

MUFA - Monounsaturated Fatty Acid
PUFA - Polyunsaturated Fatty Acid
SFA - Saturated Fatty Acid

The total fat intake of the subjects in low income group was 31.5 grams only. The subjects of middle and high income groups consumed 60g and 80.4g of total fat respectively. Chadha et al (1997) have reported an average fat consumption of 61.4g by the urban male subjects in Delhi. The fat consumption of subjects of the middle income group in the present study is in line with these results.

The fat consumption by the low income group contributed 12.4 per cent of total energy as against 24. 3 and 29.8 per cent of energy contribution by fat in the case of middle and high income groups. Studies by Achaya (1987) indicate that in low income group the contribution is 9 to 11 per cent



MEAN CONSUMPTION OF DIFFERENT TYPES OF FATS IN THE DIETS OF THE SUB SAMPLE

Fig. 5

energy from total fat. ICMR (1998) recommended that energy contribution from fat can be from 10.2 to 18.8 per cent. Subjects in the middle income group obtained 24.3 per cent energy from fat which is in line with the observation made by Sundaram (1996) in his study in Malaysia in which the dietery fat energy approximated 25 per cent of the total energy intake. Sugano (1996) has also recommended dietary fat levels of 20 to 25 energy per cent as ideal or appropriate healthy level for Japanese. But these quantities are very much less than that found in western countries. Calder (1998) has pointed out that in western countries, 100 to 200 grams of fat is consumed per day, and fat contributes 35 to 45 per cent of dietary energy.

World Health Organisation (1996) recommends that a minimum of 15 to 20 per cent of the energy should be derived from fat and a diet where more than 40 per cent of energy is from fats could lead to many health related problems. The subjects in the high income group of the present study derived 30 per cent of energy from fat which is in agreement with the results of Achaya (1987) who observed that, in high income groups in India, total fat makes 30 per cent contribution to energy. ICMR (1998) has reported that an intake of fat energy at 30 per cent or more of total calories is undesirable particularly in sedentary individuals as this may lead to health hazards like cardiovascular diseases. The subjects of the high income groups in the present study who performed sedentary activity consumed 80g of fat contributing 30 per cent energy. These individuals are at a greater risk of developing cardiovascular diseases.

The proportion of different types of fat in the three income groups showed that the saturated fat intake of the high income group subjects was 14g which was almost twice the amount consumed by the subjects in low and middle income groups (6.2 and 8.3g respectively). In all the three groups PUFA intake was greater than MUFA and SFA.

Lipsky (1990) has established that polyunsaturated fatty acids seem to provide protection against development of atherosclerosis. According to Mark et al (1993) saturated fatty acids are the primary determinants of serum cholesterol. Since the saturated fat intake of the high income group is to the tune of 14g in the present study, and hence this group may be considered to be at risk. At the same time subjects in low and middle income groups whose saturated fatty acid intake is less may be at a lower risk level.

Ghafoorunissa and Kamala Krishnaswamy (1995) have given the desirable polyunsaturated/saturated fatty acid ratio as 0.8 to 1. In the present study the p/s ratio for low income group is 2.4 which ranges to 4.1 for middle income and 3.2 for high income subjects.

e. Prevalence of fat associated diseases

The prevalence of fat associated diseases in the selected subsample are presented in Table XV.

TABLE XV

PREVALENCE OF FAT ASSOCIATED DISEASES IN THE SELECTED SUB SAMPLE

(N 40 in each income group)

Diseases	LIG		MIG		HIG	
	N	%	N	%	N	%
Cardiovascular diseases	-	-	1	3	2	5
Hypertension	2	5	-	-	2	5
Diabetes mellitus	1	3	2	5	6	15
Obesity	2	5	3	8	11	28
Hypertension and diabetes mellitus	2	5	1	3	2	5
Hypertension and obesity	1	3	2	5	3	8
Total	9	21	8	24	26	66

The prevalence of fat associated diseases presented in Table XV shows that obesity is the disorder most prevalent in the sub-sample. Three subjects from low income group, five from middle income group and 14 subjects from high ncome group were obese.

Three subjects each from LIG and MIG had non-insulin dependent diabetes mellitus. In the high income group eight subjects were diabetic out of whom two subjects were insulin dependent and the rest were non-insulin dependent diabetics.

Apart from obesity and diabetes mellitus, hypertension in association with or without obesity and diabetes mellitus was the next fat associated disease prevalent in the selected sub-sample. Hypertension was present in five subjects in low income group, four subjects in middle income group and seven subjects in the high income group.

Cardiovascular disease did not exist in the subjects of the low income group. There was one male subject in middle income group and two male subjects in the high income group showing a total prevalence of 8 per cent in the selected sub-sample of 120 subjects.

Thus the direct relationship between the fat consumption pattern and incidence of fat associated diseases is well established in the present study.

Subjects from the low income group consumed polyunsaturated fats and oils containing mono unsaturated and polyunsaturated fatty acids and there were no subjects with cardiovascular diseases. But in high income group the subjects consumed greater proportion of saturated fats (14 g) as indicated in Table XIV on fat intake and hence were prone to higher incidence of fat associated diseases.

Apart from saturated fat consumption the total fat intake (80g) and energy contribution (30 energy per cent) from fat were also high for the subjects in the high income group. This may be the factor responsible for the prevalence of fat associated diseases in subjects of HIG.

Low and high saturated fat intake were positively and significantly associated with higher prevalence of coronary artery disease.

f. Lipid profile

The serum lipid profile of the subsample of 120 subjects were estimated and the mean values are presented in Table XVI and Figure 6.

TABLE XVI

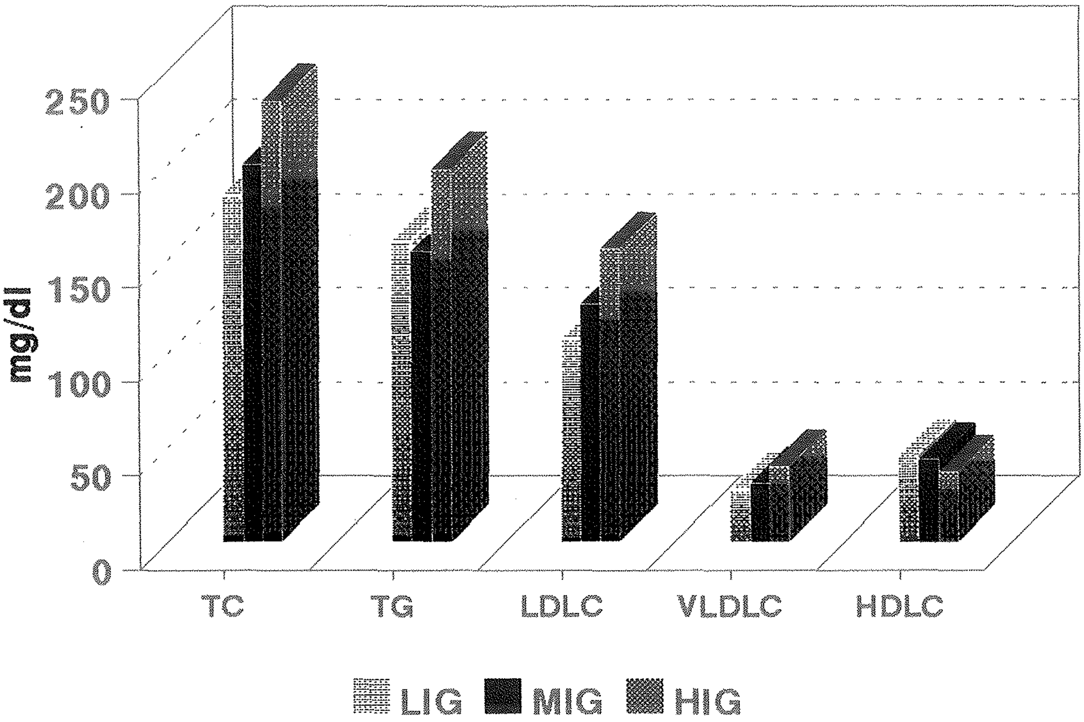
MEAN BLOOD LIPID LEVELS OF THE SELECTED SUBSAMPLE

Lipid fractions	Income groups	Serum level mg/dl	Groups compared	't' value
	LIG (40)	184.2±30.1	LIG Vs MIG	2.1*
TC	MIG (40)	200.4±37.5	LIG Vs HIG	4.9**
	HIG (40)	234.1±56.4	HIG Vs MIG	3.1**
	LIG (40)	159.7±46.4	LIG Vs MIG	0.5NS
TG	MIG (40)	153.9±49.8	LIG Vs HIG	3.2**
	HIG (40)	197.9±57.7	MIG Vs HIG	3.6**
	LIG (40)	106.6±34.1	LIG Vs MIG	2.2*
LDL-C	MIG (40)	125.9±39.4	LIG Vs HIG	4.6**
	HIG (40)	155.4±55.9	MIG Vs HIG	2.6**
	LIG (40)	31.9±9.3	LIG Vs MIG	1.3 NS
VLDL-C	MIG (40)	30.7±9.9	LIG Vs HIG	5.1**
	HIG (40)	39.7±11.4	MIG Vs HIG	3.7**
	LIG (40)	45.9±7.9	LIG Vs MIG	1.1NS
HDL-C	MIG (40)	43.8±8.9	LIG Vs HIG	3.9**
	HIG (40)	39.1±7.3	MIG Vs HIG	2.5**

Values in parentheses indicate sample size
* - Significant at five per cent level
** - Significant at one per cent level
NS - Not Significant

Values suggested by NCEP (1988)

	Desirable	Border line	High risk
TC	<200	200-240	>240
LDL-C	<130	130-160	>160
HDL-C	>50	-	<35
TG	<150	150-500	>500



MEAN SERUM LIPID LEVELS OF THE SELECTED SUB SAMPLE

Fig. 6

Serum lipid levels of the sub-sample indicate that the mean total cholesterol (TC) level of the low income group was within the desirable value suggested by NCEP (1988). Eleven subjects (28 per cent) in low income group had more than 200 mg/dl. Only two subjects in the low income group had high risk value of more than 240 mg/dl.

Subjects of middle income group had registered a mean total cholesterol value coinciding with the upper limit of the desirable value (200mg/dl). Ernst et al (1997) have found out that for the past 30 years there has been a decline in the serum total cholsterol of adults in the United States and have indicated a mean value of 205 mg/dl. This value coincides with the value of the subjects in the middle income group of the present study. There were 17 subjects (43 per cent) in MIG with borderline value of more than 200 mg/dl. Only eight subjects in MIG had high risk value of more than 240 mg/dl.

The mean total cholesterol of the subjects in high income group was 234.1 mg/dl which itself is nearer to the high risk level of 240 mg/dl. There were 11 subjects (28 per cent) in the high income group who had total cholesterol values below 200 mg/dl and 15 subjects (38 per cent) had values above 240 mg/dl which is the high risk level.

Serum cholesterol values are positively associated with saturated fat intake and incidence of fat associated diseases. As evident from

Table XV there were more obese subjects in HIG and Table XIV indicates that the saturated fat intake was high by the subjects in the high income group and is evident from Table XV that incidence of fat associated diseases was also high in the subjects of HIG. This reflects the results of Patsch (1993) and Khor (1997) who have indicated that there is a positive association between total cholesterol and risk of coronary heart diseases in young men.

The subjects in the high income group in the selected sub-sample manifest the risk factors such as high saturated fat intake, high total cholesterol and increased prevalence of fat associated diseases.

The serum triglyceride values (Table XVI) show a different picture from that of total cholesterol. For the subjects in LIG the mean triglyceride value is higher (159.7 mg/dl) than that of the subjects in the middle income group (153.9 mg/dl). Though saturated fat intake of subjects in the low income group is only 6.2g their serum triglyceride values are high. This may be because of the increased carbohydrate intake (Table XII) by the subjects in the low income group. Grundy et al (1991) and Rao et al (1992) have proved that replacement of fat calories by carbohydrate increases the serum triglyceride level. The results of the present study are corollary to this finding. But as evident from Table XV incidence of diseases is low in subjects from low income group. Thus triglyceride value is negatively correlated with incidence of diseases in the case of subjects from low income group. According to Framingham study elevations in plasma triglyceride levels in the presence of a high total cholesterol to HDL cholesterol ratio (> 3.5) increases CHD risk. In the present study 63 per cent of the subjects in low income have total cholesterol : HDL-C ratio less than 4.0 which may be the factor that has reduced CHD risk in low income group.

The mean triglyceride value of the subjects in the middle income group was (153.9 mg/dl) less than the mean value registered by the low income group (159.7 mg/dl). But the ratio of total cholesterol to HDL cholesterol is more than 4.5 which is a risk factor for cardiovascular diseases.

The mean value of triglyceride for the subjects in the high income group is in the borderline risk value suggested by NCEP (1988) which is 150-500 mg/dl. At the same time the total cholesterol to high density lipoprotein cholesterol ratio of the subjects in the high income group is also high (5.9) which poses greater risk for coronary heart diseases. The incidence of fat associated diseases in the subjects of the high income group is also more (Table XV)

The low density lipoprotein values of the subjects in the low and middle income groups were within the desirable value suggested by NCEP (1988). Low density lipoprotein is considered to be the most atherogenic lipoprotein. But low density lipoprotein cholesterol level is within the normal value for subjects in all the three income groups.

The high density lipoprotein cholesterol referred to as good cholesterol, appears to be protective against coronary heart diseases and decreased high density lipoprotein cholesterol is a risk factor (Nikkila et al, 1995; Lamarche et al, 1995; Wolf, 1996 and Ima - Nirwana et al, 1996).

The results of the present study indicate that the mean high density lipoprotein cholesterol values of all the three income groups were above 35 mg/dl and thus no group was in the high risk level of less than 35 mg/dl suggested by NCEP (1988). The individual high density lipoprotein cholesterol values indicate that 5 per cent (2), 15 per cent (6), and 25 per cent (10) of the subjects from low, middle and high income groups respectively have fallen in the high risk group with less than 35 mg/dl of high density lipoprotein cholesterol values. The present results show an inverse relationship between high density lipoprotein cholesterol and incidence of diseases. At the same time intake of unsaturated plant oils show a direct relation to high density lipoprotein as in low and middle income groups (Table XIV). Intake of more saturated fats by the subjects in the high income group may be the reason for the lowered high density lipoprotein cholesterol levels of subjects in the high income group. The subjects in the low income group were engaged in occupations requiring more physical exercise which might have aided in increasing the high density lipoprotein cholesterol. The subjects in the high income group did sedentary activity which did not increased high density lipoprotein cholesterol.

C. Impact of consuming single plant oil/animal foods on adults

1.Single plant oil consumption

To study the effect of consuming any one plant oil on the health of adults, 50 vegetarian adult male subjects, each consuming any one plant oil namely ground nut oil or refined ground nut oil or gingelly oil or sunflower oil or coconut oil were selected. The quantity of each oil consumed, incidence of diseases in these subjects, body mass index, waist hip ratio and serum lipid profile were studied.

Table XVII presents the mean quantities of each oil consumed by the subject in the five groups as well as body mass index , waist hip ratio and the serum lipid profile.

Table XVIII presents the correlation co-efficient (r) of oil intake with lipid profile, body mass index and waist hip ratio of the single plant oil consuming subjects.

TABLE XVII

MEAN FAT INTAKE, BMI, WHR, AND LIPID PROFILE OF SUBJECTSCONSUMING SINGLE PLANT OIL

(N = 50 in each plant oil consuming group)

Group	Oil Consumed	Visible oil intake g/day	BMI	WHR	Serum lipids (mg/dl) TC	TG	LDL-C	VLDL-C	HDL-C
I	Ground nut oil	43.3 ±5.2	22.4 ±2.3	0.83 ±0.078	184.6 ±10.6	136.8 ±60.9	102.8 ±16.0	24.5 ±3.8	47.1 ±4.0
II	Refined ground nut oil	38.8 ±12.0	23.7 ±2.6	0.81 ±0.012	193.8 ±5.0	110.5 ±15.6	130.1 ±25.6	21.8 ±3.0	40.6 ±4.3
III	Gingelly oil (Sesame oil)	42.6 ±15.5	22.9 ±2.5	0.83 ±0.092	172.6 ±8.3	117.5 ±8.6	119.5 ±21.0	21.8 ±2.1	42.2 ±3.3
IV	Sun flower oil	49.3 ±10.9	23.0 ±2.3	0.82 ±0.10	183.3 ±23.7	129.1 ±26.7	130.3 ±20.3	24.5 ±3.1	42.1 ±3.1
V	Coconut oil	45.6 ±10.7	22.1 ±2.2	0.87 ±0.12	196.8 ±13.3	151.0 ±33.6	120.1 ±24.6	25.0 ±2.7	42.8 ±5.4

Cut off point for WHR = Men = < 0.95, (Croft et al, 1995).

consumed

TABLE XVIII

CORRELATION CO-EFFICIENT (r) OF OIL INTAKE WITH LIPID PROFILE BMI AND WHR OF SINGLE PLANT OIL CONSUMING GROUPS

Group	Quantity of oil consumed g	Serum lipids (mg/dl)					BMI	WHR
		TC	TG	LDL-C	VLDL-C	HDL-C		
I Ground nut oil	43.3+5.2	0.7375*	0.6204NS	0.9490*	0.7652*	0.3724NS	0.9718**	0.5227NS
II Refined ground nut oil	38.8+12.0	0.9089**	0.9493**	0.4388NS	0.9850**	-0.1295NS	0.9866**	0.6103NS
III Gingelly oil	42.6+15.5	0.8799**	0.7607*	0.9281**	0.9661**	0.9482**	0.9497**	0.8785**
IV Sunflower oil	49.3+10.9	0.7507*	0.9328**	0.4441NS	0.9213**	0.6667*	0.8948**	0.7020*
V Coconut oil	45.6+10.7	0.6219NS	0.6009NS	0.9897**	0.9012**	0.6458*	0.9753**	0.7914**

* - Significant at five per cent level
**- Significant at one per cent level
NS- Not significant

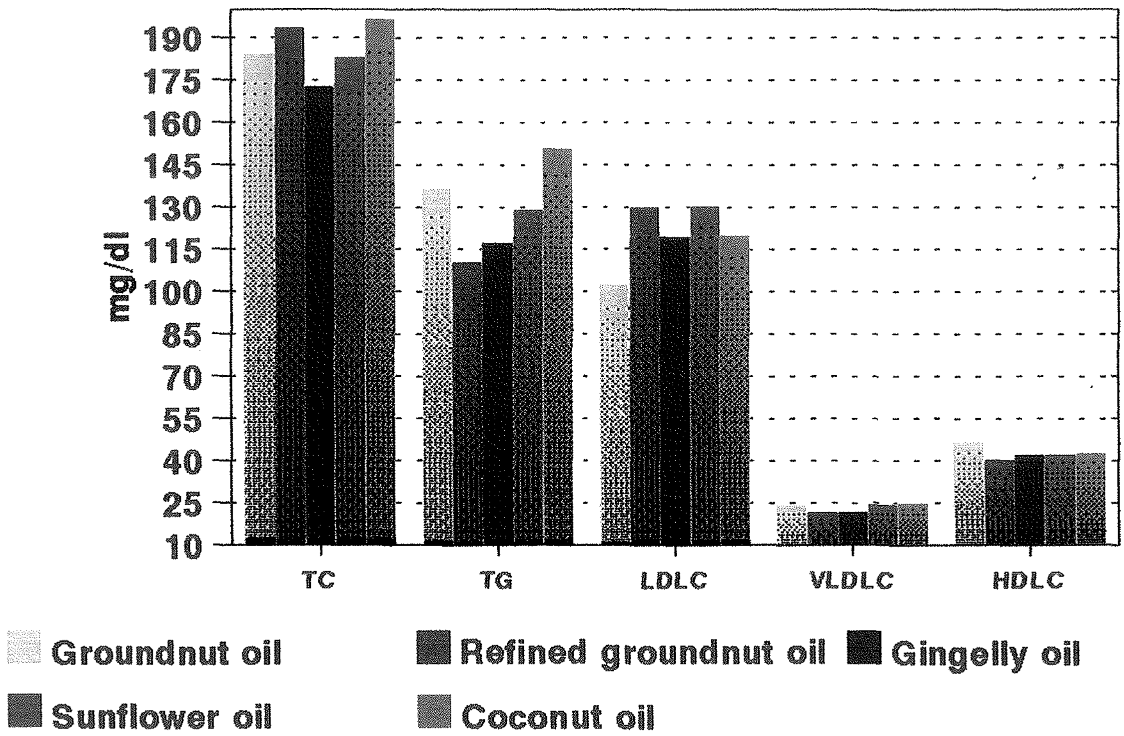
Table XVII indicates that the mean oil intake/day by the different groups ranged from 38.8g by group II consuming refined ground nut oil to 49.3g by group IV consuming sunflower oil, the difference being 10.5 grams. The report of the expert group of ICMR (1998) has stated that in urban areas middle income groups had daily visible fat intake of 20 to 42 grams. Similar trends were observed in the present study.

The mean body mass index of the adults in all the five groups were within the normal value suggested by Garrow (1993). The WHR values of all the subjects were between 0.81 to 0.87, which again were within the normal value (<0.95) suggested by Croft et al (1995) for men.

With regard to lipid profile (Figure 7) all the values were within the normal range suggested by NCEP (1988). The adults consuming coconut oil had registered the highest value for total cholesterol, triglyceride and very low density lipoprotein cholesterol, while the lowest total cholesterol was registered by adults consuming gingelly oil and this group had registered favourable values for all the serum parameters. The high density lipoprotein cholesterol values were greater for adults consuming ground nut oil followed by those consuming coconut oil, gingelly oil, sunflower oil and refined ground nut oil. These results point out that among the plant oils, gingelly oil ranked first in the maintenance of normal serum lipid profile. This was followed by sun flower oil, ground nut oil, refined ground nut oil and coconut oil.

The results of the present study reiterate the results of Chanderbhan et al (1997) who have also found out that when gingelly oil was used the serum total cholesterol and low density lipoprotein cholesterol were significantly decreased while high density lipoprotein cholesterol concentrations did not differ significantly. Gingelly oil which is rich in poly unsaturated fatty acids had registered favourable total cholesterol, triglyceride and low density lipoprotein cholesterol levels. Sunflower oil is also rich in polyunsaturated fatty acids and has produced low risk levels of serum lipids.

Subjects consuming ground nut oil which is rich in monounsaturated fatty acid had the highest high density lipoprotein cholesterol level which provides protection against coronary artery diseases.



MEAN SERUM LIPID PROFILE OF THE SUBJECTS CONSUMING SINGLE PLANT OIL

Fig. 7

This result synchronises with that of Mattson (1992) who has reported that monounsaturated fatty acid has the added advantage of not causing a decrease in high density lipoprotein cholesterol level.

Coconut oil is rich in saturated fatty acids namely myristic acid and lauric acid, which are medium chain fatty acids. These saturated fatty acids might have been responsible for the comparative increase in total cholesterol and triglyceride levels. Sen and Sen (1990), Narasingha Rao (1992) and Raghuram (1996) have indicated that coconut oil and hydrogenated oils are saturated and they do not lower serum cholesterol.

At the same time high density lipoprotein cholesterol level has not been lowered in coconut oil consumers which coincides with the results of Baba et al (1994) who have found out that coconut oil fed rats maintained higher high density lipoprotein cholesterol levels as coconut oil raises high density lipoprotein cholesterol levels than butter.

Intake of ground nut oil showed positive correlation with total cholesterol, triglyceride, low density lipoprotein cholesterol, very low density lipoprotein cholesterol and high density lipoprotein cholesterol. Correlation of low density lipoprotein cholesterol with ground nut oil consumption was significant at one per cent level while correlation of total cholesterol and very low density lipoprotein cholesterol was significant only at 5 per cent level.

Correlation of ground nut oil intake with triglyceride and high density lipoprotein cholesterol was not significant. This indicates that increased ground nut oil consumption increases low density lipoprotein cholesterol than the other lipids, at the same time triglyceride and high density lipoprotein cholesterol were not affected.

Consumption of refined ground nut oil positively correlated with total cholesterol,triglyceride,very low density lipoprotein cholesterol and low density lipoprotein, cholesterol. High density lipoprotein cholesterol showed a negative correlation. Gingelly oil intake had strong positive correlation with all the serum lipid fractions, again pointing out that as the quantity of oil consumption increases serum lipid level gets elevated. In the case of gingelly oil, sunflower oil and coconut oil, amount of oil intake positively correlated with serum high density lipoprotein cholesterol..

Quantity of sun flower oil consumption also significantly and positively correlated with all the lipid fractions but only with low density lipoprotein cholesterol the correlation was not statistically significant.

The total cholesterol and triglyceride corrrelation was insignificant in the coconut oil consuming group. There was a high correlation with low density lipoprotein cholesterol and very low density lipoprotein cholesterol of coconut oil consuming groups.

These results indicate that as the amount of oil consumption increases blood lipid fractions also increase. But an amount of 38 to 49 grams of oil per day consumed in the present study seems to be an optimum level that has not produced any dyslipidemia and has kept all lipid values within the desirable levels suggested by NCEP (1988).

All the body mass index values were below 25 which is the normal value suggested by Garrow (1993). Correlation of quantity of oil intake with BMI showed a highly significant ($P<0.01$) positive correlation.

Waist hip ratio was also positively correlated with quantity of oil intake. But in groups consuming ground nut oil and refined ground nut oil the correlations were not statistically significant.

These results indicate that plant oil consumption ranging between 30 to 50g/day do not produce adverse effects in the serum lipid levels, BMI and waist-hip ratio. As stated by Berry (1997) the polyunsaturated fatty acid and antioxidants present in plant oils may be the protective factors in the maintenance of normal lipid profile.

Table XIX presents the diseases prevalent in the single plant oil consuming subjects.

TABLE XIX

PREVALENCE OF FAT ASSOCIATED DISEASES IN THE SINGLE PLANT OIL CONSUMING SUBJECTS

(N=50 in each group)

Diseases	Groundnut oil (Group I)	Refined ground nut oil (Group II)	Gingelly oil (Group III)	Sunflower oil (Group IV)	Coconut oil (Group V)
Diabetes mellitus	2	7	4	4	3
	(4)	(14)	(8)	(8)	(6)
Hypertension	4	2	1	2	8
	(8)	(4)	(2)	(4)	(16)
Diabetes mellitus and hypertension	-	-	2	2	-
			(4)	(4)	
Angina pectoris	-	1	-	1	1
		(2)		(2)	(2)
Total	7	10	8	9	12
	(14)	(20)	(16)	(18)	(24)

Values given in parentheses indicate percentage

Table XIX on prevalence of diseases in the different oil consuming groups point out that there were maximum number of patients in coconut oil consuming group (24 per cent) followed by subjects consuming refined ground nut oil, sunflower oil, gingelly oil and ground nut oil. The incidence of diseases was minimum (14 per cent) in the ground nut oil consuming subjects. Ground nut oil is rich in MUFA which has protected the subjects from fat associated diseases. Subjects consuming coconut oil which is rich in saturated fatty acids have shown increased incidence of diseases.

The results on incidence of diseases, compared with serum lipid profile showed that there is association between incidence of diseases and lipid profile of different oil consuming subjects.

2. Single animal food consumption

Subjects consuming minimum one kg of a particular animal food in a week were selected. The quantity of animal food consumed, body mass index and serum lipid profile were analysed. The mean values are presented in Table XX .

Table XXI presents the correlation co-efficient (r) between amount of animal food consumed and lipid profile.

TABLE XX
ANIMAL FOODS CONSUMPTION, FAT INTAKE, BMI AND LIPID PROFILE OF SELECTED SUBJECTS

(N=10 in each group)

Group	Amount consumed g/day				BMI	Serum lipid profile (mg/dl)				
	Animal food	Total fat	Visible fat	Invisible fat		TC	TG	LDL-C	VLDL-C	HDL-C
I Milk	502	74	38	36	25.8	208.3	164.0	130.6	32.8	44.8
					±0.6	±34.1	±5.6	±42.9	±11.5	±4.6
II Egg	85	71	42	29	26.1	231.0	290.8	127.5	58.1	45.3
					±1.9	±55.4	±150.7	±36.0	±30.1	±11.8
III Fish	222	67	54	13	24.9	193.1	129.3	123.8	25.8	43.5
					±0.5	±56.2	±19.7	±51.5	±4.1	±7.7
IV Chicken	171	64	33	31	26.0	225.1	141.6	148.2	28.3	48.6
					±1.5	±37.4	±44.8	±25.3	±13.0	±6.7
V Mutton	211	75	47	29	26.4	167.6	113.6	104.3	22.6	40.3
					±1.9	±14.9	±54.4	±12.6	±10.9	±4.5
VI Beef	213	78	42	36	25.2	241.1	236.5	140.5	47.1	53.5
					±1.2	±39.7	±100.2	±31.3	±20.0	±6.0
VII Pork	181	95	21	74	25.8	236.6	302.8	122.3	60.5	53.8
					±1.1	±17.5	±102.2	±32.8	±20.4	±4.4

TABLE XXI

CORRELATION COEFFICIENT BETWEEN AMOUNT OF ANIMAL FOOD CONSUMED AND LIPID PROFILE

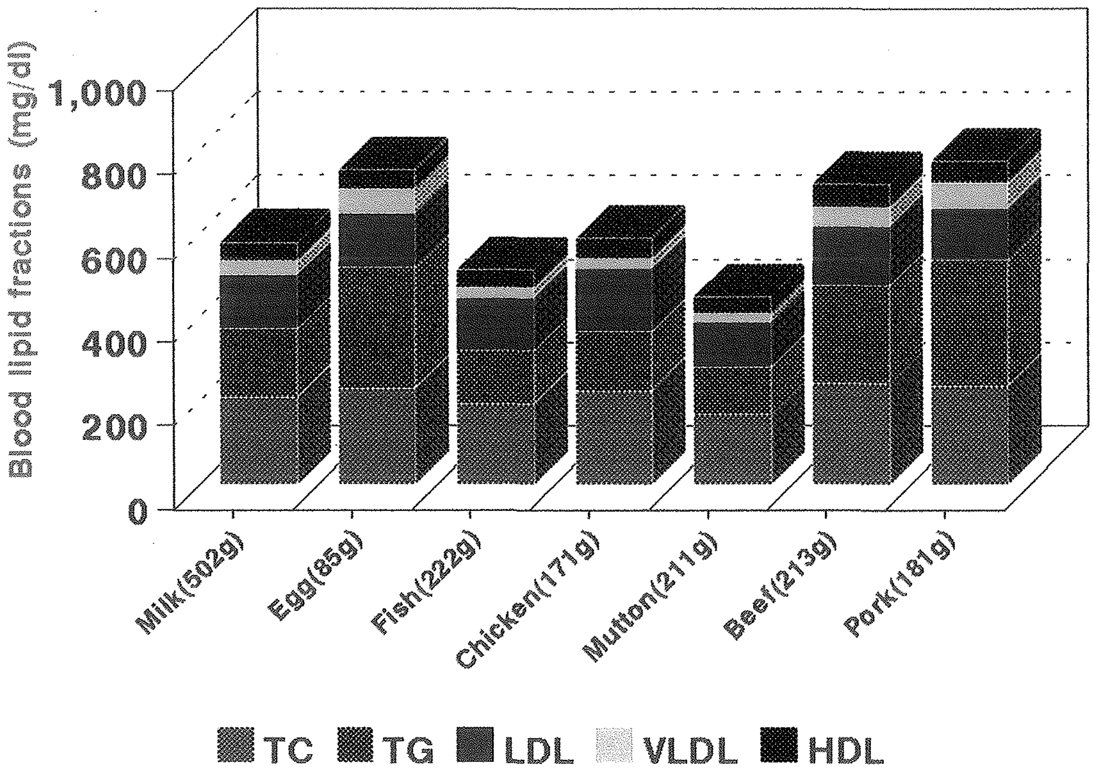
Groups	Amount of animal food consumed g/day	TC	TG	LDL-C	VLDL-C	HDL-C
I Milk	502	0.8092*	-0.1003	0.8545*	-0.1034	0.8226*
II Egg	85	0.8354*	0.7613	0.6583	0.7617	-0.0341
III Fish	222	-0.7862	-0.9695*	-0.7110	-0.9608*	0.4592
IV Chicken	171	0.9883*	0.5295	0.9364*	0.7927	0.4472
V Mutton	211	0.9043*	0.6758	0.3699	0.6713	0.3472
VI Beef	213	0.9779*	0.7210	0.7307	0.7161	0.2741
VII Pork	181	0.9812*	-0.8164*	0.9660*	-0.8185*	0.4896

*** Significant at five per cent level**

The total fat intake of subjects consuming pork was 85g/day which was the highest compared to subjects in the other groups. This was followed by beef, mutton, milk and egg consuming groups. Subjects consuming two eggs per day had registered the lowest fat intake. The total visible fat intake which was mainly mixed plant oils, ranged between 21 to 47g among the different animal food consuming subjects. The invisible fat intake was also high (64g) for subjects consuming pork and this was mainly saturated fat. But the invisible fat intake was the lowest for subjects consuming fish. The invisible fat present in the animal foods was the main contributor to the increased total fat intake.

The mean body mass index values of subjects of all the groups were greater than 25 which denotes Grade I obesity according to Garrow (1993). The lowest body mass index was registered by the subjects in fish consuming group which was 24.99. The highest BMI was recorded by adults in the group consuming mutton (26.4) followed by the ovo-vegetarians who consumed atleast two eggs per day. This group was followed by chicken consumers (26). The vegetarians who consumed 500g of milk daily registered 25.8 and subjects in the pork group had registered the same BMI value of 25.8 followed by the subjects in the beef group. The groups consuming different animal foods did not show much difference in the BMI values.

The subjects in beef group had registered the highest blood cholesterol value of 241.1 mg/dl, followed by the subjects in egg, pork, chicken, milk and fish groups. The lowest value was recorded by the subjects in the mutton group. The triglycerides were the highest for the subjects in pork group (302.8 mg/dl) followed by those consume egg (290.8 mg/dl) beef (236.5 mg/dl), milk (164.5 mg/dl) and chicken (141.6 mg/dl). Interestingly the subjects in mutton group showed lowest value which was equivalent to those of fish group. Low density lipoprotein cholesterol values were higher for beef and chicken consuming groups. The lipid profile of subjects consuming different animal foods indicate a high risk for the beef eating subjects followed by pork, egg, chicken, milk and fish. This is depicted in



MEAN BLOOD LIPID PROFILE OF SUBJECTS CONSUMING DIFFERENT ANIMAL FOODS

Fig. 8

Figure 8. Most of the subjects in the mutton group were Muslims, who had just completed the one month long Ramzan fasting when the investigation was done. This may be the reason for lowered lipid levels of this group.

The vegetarians who consumed only milk also had recorded risk levels of more than 200 mg/dl and 160 mg/dl of total cholesterol and triglyceride respectively. Literature point out that myristic acid and palmitic acid present in milk raises plasma cholesterol. Milk protein casein raises serum total cholesterol and low density lipoprotein cholesterol (Leung et al, 1994, Carroll and Kurowska, 1995 and Noakes et al, 1996). Milk consuming subjects also consumed more butter and ghee which are rich in saturated fats that might have produced higher body mass index and lipid levels.

It is obvious from the present results that including fish in the diet lowers all lipid levels and reduces the risk for heart diseases. The increased percentage consumption of omega-3 fatty acids in fish consumers (Eicosapentaenoic acid, docosapentaenoic acid and docosahexaenoic acid) are probably the factors which might have reduced serum total cholesterol, triglyceride and low density lipoprotein cholesterol levels. These results are analogous to the results of Naber et al (1992), Nordoy et al (1993), Mandal et al (1995) and Bulliyya et al (1997), who have also observed that omega-3 fatty acids from fish oils significanlty lowered plasma total cholesterol, triglyceride, low density lipoprotein cholesterol and very low density lipoprotein cholesterol.

The amount of milk consumed and total serum cholesterol, low density lipoprotein cholesterol and high density lipoprotein cholesterol were positively correlated while triglyceride and very low density lipoprotein cholesterol showed negative correlation. As indicated by Noakes et al (1996) more than myristic acid, palmitic acid present in butter and milk casein are the possible factors that might have raised the total cholesterol and low density lipoprotein cholesterol levels.

For the subjects in the egg group, the amount of egg consumed correlated positively with all the lipid fractions, while HDL-C showed negative correlation.

Among all the animal foods, fish consumption alone showed negative correlation with all the lipid fractions except high density lipoprotein cholesterol for which a positive correlation was shown. Only fish contains long chain polyunsaturated fatty acids among all the other animal foods. These polyunsaturated fatty acids called omega-3 and omega-6 fatty acids might have facilitated reduction in all lipid fractions except high density lipoprotein cholesterol which had increased. Thus consumption of fish has beneficial effect in lowering the plasma cholesterol. As per ICMR (1995) and Oliver (1997) consumption of 100 to 200g fish 2 to 3 times a week helps to prevent heart disease and have also shown an inverse relationship between fish consumption and heart disease.

The amount of animal foods consumed in the case of chicken, mutton, beef and pork showed a positive correlation with lipid profile values. With high density lipoprotein cholesterol though there was positive correlation the 'r' value was only o.3 which was insignificant.

The amount of animal foods consumed and body mass index showed a highly positive correlation. Chen et al (1998) have also pointed out that high fat intake may lead to obesity.

The results of the present study also indicate a high correlation between animal food intake and body mass index.

Table XXII presents the prevalence of fat associated diseases in different animal food consuming subjects.

TABLE XXII

PREVALENCE OF FAT ASSOCIATED DISEASES IN DIFFERENT ANIMAL FOOD CONSUMING SUBJECTS

.Diseases	Group- I Milk	Group-II Egg	Group-III Fish	Group IV Chicken	Group-V Mutton	Group VI Beef	Group VII Pork
Obesity	5	4	3	6	6	3	6
Diabetes mellitus+ obesity	3	2	3	2	4	2	3
Hyper tension	3	2	-	1	3	2	1
Heart disease	1	1	1	-	2	1	1
Stroke	-	1	-	-	-	-	-
Total	11	10	6	9	15	8	11

The incidence of diseases was the highest among the subjects consuming mutton. This was followed by subjects consuming pork, milk, egg, chicken and beef. None of the fish consumers had developed hypertension and the total incidence of diseases was also low in this group. Here again the protective effect of the eicosanoids have been well brought out.

D. Effect of replacement of saturated fats with plant oils

In this part of the study, forty hyperlipidemic adults consuming more than 40g of saturated fats daily were selected and divided into four groups of ten subjects each. The first three groups were requested to stop consuming saturated fats like ghee, butter and vanaspathi and also the other oils normally consumed. Their visible fat intake was replaced with 30g of plant oil namely sun flower oil, gingelly oil and ground nut oil and designated as Group I, II and III respectively. Replacement was carried out for a period of two months. The fourth group did not receive any modification in their fat intake and served as control.

Table XXIII shows the amount of polyunsaturated fatty acid, saturated fatty acid and total fat consumed by the four groups before and during replacement with plant oils.

TABLE XXIII

TOTAL VISIBLE FAT INTAKE OF THE FOUR GROUPS OF SUBJECTS BEFORE AND DURING REPLACEMENT WITH PLANT OILS

	Groups	N	Fats and oils consumption g/day			
			Before replacement			During replacement
			PUFA	SFA	Total	
I	Sunflower oil	10	24	46	70	30
II	Gingelly oil	10	19	51	70	30
III	Ground nut oil	10	18	53	71	30
IV	Control	10	25	45	70	same as before

The fat consumption of all the 40 hyperlipidemics was calculated and they were grouped in such a way that the total fat consumption before replacement was equal to 70g. The subjects in all the four groups consumed 45 to 54g of saturated fatty acids, 18 to 25g of polyunsaturated plant oils as indicated in Table XXIII. During replacement period the subjects in the first three groups consumed only 30g of respective plant oils suggested for replacement while subjects in Group IV (control group) continued with their usual intake of 45g of saturated fats namely ghee, butter and vanaspathi and 25g of plant oils.

Table XXIV presents the mean body mass index of the experimental and control groups before and after replacement with plant oils.

TABLE XXIV

MEAN BODY MASS INDEX OF THE EXPERIMENTAL AND CONTROL GROUPS BEFORE AND AFTER REPLACEMENT WITH PLANT OILS

Groups	N	Mean Body Mass Index Before replacement	 After replacement	't' value
I Sun flower oil	10	27.1 ±2.8	26.9 ±2.6	1.28
II Gingelly oil	10	32.3 ±2.4	32.2 ±2.5	1.84
III Groundnut oil	10	34.7 ±4.3	34.1 ±4.3	2.09*
IV Control	10	29.5 ±4.1	29.4 ±4.0	1.99

* Significant at five per cent level
(Least significant difference)

The body mass index calculated before and after replacement of plant oils showed reduction which was not statistically significant in Groups I, II and IV. Only group III which was replaced with groundnut oil showed least significant reduction at five per cent level.

The lipid profile of all the subjects was studied and the mean values are presented in Table XXV and Figure 9.

TABLE XXV

MEAN LIPID PROFILE VALUES OF THE SUBJECTS BEFORE AND AFTER REPLACEMENT

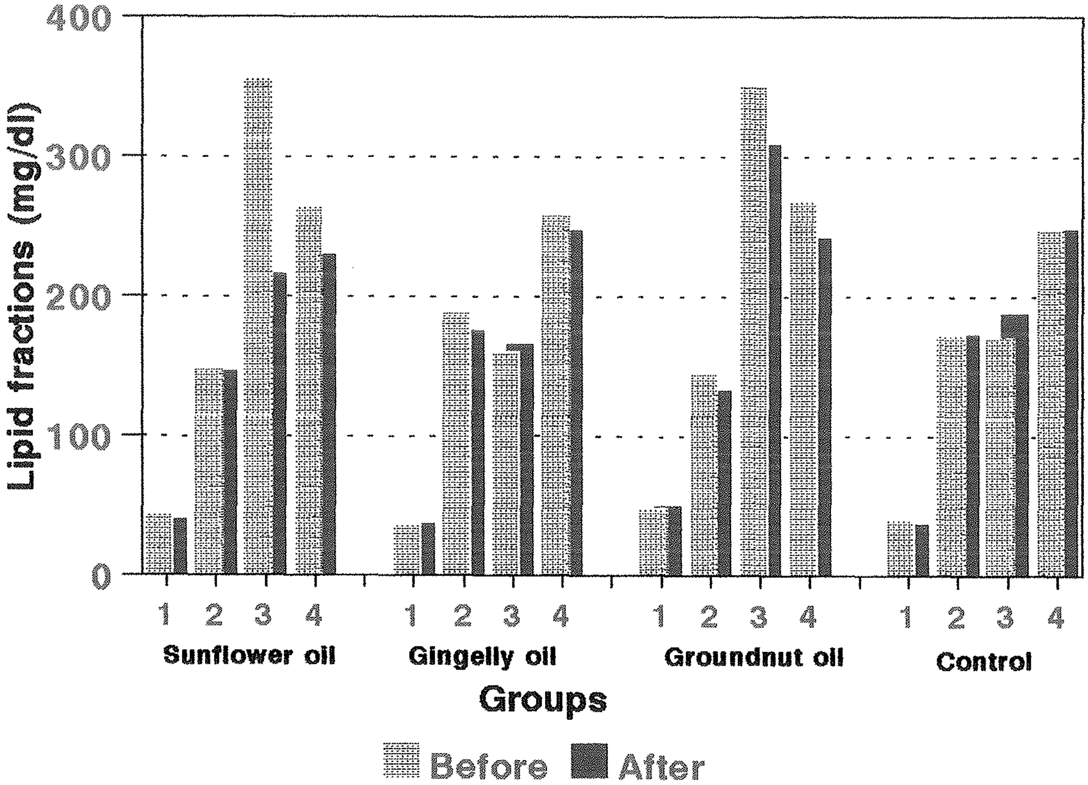
(N= 10 in each group)

Lipid fractions mg/dl	Sun flower oil group			Gingelly oil group			Groundnut oil group			Control group		
	Before	After	't' value	Before	After	't' value	Before	After	't' value	Before	After	't' value
Total cholesterol	264.2 ± 16.5	230.8 ± 14.3	5.99**	259.0 ± 15.3	247.5± 17.2	5.72**	268.5± 33.3	242.3 ± 32.5	6.55*	248.2 ± 13.0	248.8± 15.8	-0.38NS
HDL-C	44.0 ± 8.4	40.3 ± 5.1	1.21NS	37.7 ± 12.23	38.3± 12.6	0.28NS	49.0 ± 13.1	50.7 ± 13.9	0.17NS	41.7 ± 10.6	37.8± 9.8	2.50**
LDL-C	148.7 ± 45.6	147.2± 23.1	0.87NS	189.0± 59.9	176.0 ± 23.9	3.35**	145.7 ± 32.4	133.0 ± 27.9	2.44*	172.3 ± 35.2	173.3± 28.5	-1.14NS
VLDL-C	71.5 ± 47.1	43.3 ± 11.4	1.49NS	32.3 ± 17.3	33.2 ± 11.6	1.33NS	70.1 ± 21.2	61.8 ± 21.2	3.99**	34.2 ± 19.9	37.7 ± 21.8	0.51NS
Triglyceride	357.4 ± 217.6	216.61± 55.3	1.80NS	161.2 ± 42.7	166.2 ± 56.8	-0.43NS	350.7 ± 115.9	309.3 ± 106.0	3.85**	171.0 ± 48.4	188.6 ± 49.0	-1.65NS

* Significant at five per cent level

** Significant at one per cent level

NS Not Significant



MEAN LIPID PROFILE OF THE SUBJECTS BEFORE AND AFTER REPLACEMENT WITH PLANT OILS

Fig. 9

1. HDL-C
2. LDL-C
3. Triglyceride
4. Total cholesterol

Replacement of saturated fats by sunflower oil, gingelly oil and ground nut oil had decreased the total cholesterol levels and the difference was significant at one per cent level. Only ground nut oil group had produced statistically significant reduction in low density lipoprotein cholesterol, very low density lipoprotein cholesterol and triglyceride. These three fractions especially low density lipoprotein cholesterol is normally referred to as bad cholesterol that leads to atherosclerotic deposits. Ground nut oil had reduced the low density lipoprotein cholesterol levels which is conducive to health. Sunflower oil and gingelly oil had reduced low density lipoprotein and very low density lipoprotein fractions but not at statistically significant level. Only Gingelly oil had increased HDL cholesterol values from 37.7 to 38.3 mg/dl..

These results match the results of Wood et al (1994), Biro (1996) and Chanderbhan et al (1997) who have observed significant reduction in serum total cholesterol levels after substitution with oils rich in polyunsaturated fatty acids .

Among the three plant oils replaced, ground nut oil rich in monounsaturated fatty acid was found to be the best in maintaining normal lipid profile followed by gingelly oil and sunflower oil.

Katan et al (1995) and Grundy (1997) have reported that replacement of unsaturated oils for hard fats rich in saturated or trans-fatty acids, provides a more favourable lipid profile than replacement of fat by carbohydrate, when body weight is kept constant.

Nielsen et al (1996) have also indicated that replacement of dietary saturated fat with monounsaturated fat brought about significant positive changes in plasma cholesterol levels.

Yu et al (1995) have reported that monounsaturated fatty acids do not lower high density lipoprotein cholesterol. Oleic acid not only decreases plasma cholesterol and low density lipoprotein cholesterol concentrations, but also increases high density lipoprotein cholesterol. Mattson et al (1985) also showed that monounsaturated fat was as effective as polyunsaturated fat in lowering total cholesterol. Ground nut oil rich in monounsaturated fatty acid has been found to be effective in reducing lipid profile as that of gingelly oil and sunflower oil.

E. Pattern of body mass index and serum lipid profile of patients suffering from fat associated diseases in relation to the intake of fats and oils

Subjects suffering from cardiovascular diseases, hypertension and diabetes mellitus were selected to study the fats and oil consumption, body mass index, waist hip ratio and blood lipid profile of these patients to cross examine the relationship between fat intake and the fat related diseases.

Groups of fifty patients, each suffering from cardiovascular diseases, non-insulin dependent diabetes mellitus and hypertension were selected. The fat intake of these subjects was assessed by 24 hr recall method for three consecutive days. The day's total fat consumption of the selected patients was 45.6g, 45.7g and 43.6g respectively for cardiovascular disease, diabetic and hypertensive patients. This amount is greater than 20 to 40g recommended by ICMR (1995) for fats and oils consumption of adults. Further examination brought out the fact that after the diagnosis of the disease the patients reduced their fat intake. The patients reported that the prior fat intake was much greater than what they consumed during the investigation period as they had reduced the consumption of butter, ghee and vanaspathi and total fat intake on the advice of the doctor.

Table XXVI presents the mean body mass index, waist hip ratio and lipid profile of the patients suffering from the three diseases.

The correlation of body mass index and waist hip ratio with lipid profile of the patients suffering from cardiovascular diseases, diabetes mellitus and hypertension are presented in Table XXVII.

TABLE XXVI

MEAN BMI, WHR AND LIPID PROFILE OF THE SELECTED ADULT MALE PATIENTS SUFFERING FROM CARDIOVASCULAR DISEASES, DIABETES MELLITUS AND HYPERTENSION

Criteria	Cardiovascular diseases	Diabetes mellitus	Hypertension
BMI	25.0 $\pm$2.0	23.0 $\pm$11.4	24.7 $\pm$1.7
WHR	0.94 $\pm$0.03	0.89 $\pm$0.03	0.90 $\pm$0.10
TC	257.0 $\pm$14.4	237.1 $\pm$32.3	258.8 $\pm$22.8
TG	188.8 $\pm$27.7	194.5 $\pm$43.2	211.6 $\pm$38.5
LDL-C	164.0 $\pm$15.4	127.5 $\pm$23.4	131.5 $\pm$12.0
VLDL-C	39.8 $\pm$8.6	31.1 $\pm$12.4	44.1 $\pm$6.4
HDL-C	42.3 $\pm$6.8	35.3 $\pm$8.7	34.3 $\pm$6.8

TABLE XXVII

CORRELATION OF BMI AND WHR WITH LIPID PROFILE OF PATIENTS SUFFERING FROM CARDIOVASCULAR DISEASES, DIABETES MELLITUS AND HYPERTENSION

Lipid fraction	Cardiovascular diseases		Diabetes mellitus		Hypertension	
	BMI	WHR	BMI	WHR	BMI	WHR
TC	0.938	0.805	0.370	0.991	0.895	0.954
TG	0.606	0.742	0.936	0.491	0.825	0.869
LDL-C	0.901	0.607	0.935	0.608	0.523	0.533
HDL-C	-0.829	-0.768	-0.989	-0.453	-0.961	-0.990

From Table XXVI it is evident that the mean body mass index value of cardiovascular disease patients was 25, that of hypertensives and diabetics were 24.7 and 23 respectively. The mean body mass index of the hypertensives and diabetics were within the normal value suggested by Garrow and James (1993) whereas that of cardiovascular disease patients was at the upper limit of the normal value.

Same trend was observed in the case of WHR where cardiovascular disease patients showed the highest value followed by hypertensives and diabetics.

The lipid profile of the selected patients were above the normal value suggested by NCEP (1988). The low density lipoprotein cholesterol levels were normal for diabetics and hypertensives. Other lipids were above the normal value suggested by NCEP (1988). All three groups of patients had registered WHR of <0.95 the normal value suggested by Croft et al (1995).

The correlation of BMI with lipid profile presented in Table XXVII shows that these two factors are well correlated. Increase in the body weight, due to deposition of fat in the body might have been responsible for the increase in the lipid profile. There is high correlation between BMI and TC in the case of cardio vascular diseases and hypertensive patients whereas this is not significant in the case of diabetics. But in diabetics triglycerides and low density lipoprotein cholesterol were highly correlated with body mass index. The same trend was observed with waist hip ratio also. As waist hip ratio increases, total cholesterol, triglyceride and low density lipoprotein cholesterol also increase.

But the high density lipoprotein values showed a highly negative correlation with Body Mass Index (BMI) and Waist hip ratio (WHR).

F. Impact of diet counselling on selected hyperlipidemic adults

The final part of the study consisted of diet counselling of the hyperlipidemic subjects as a means of preventing the onset of degenerative diseases. The knowledge, attitude and practices of the subjects, body mass index and blood lipid profile were assessed before and after diet counselling.

The results of two months of intensive diet counselling had produced changes in the attitudes of the subjects in planning menu for the family. The subjects started to include more boiled and steamed foods rather than including more oil to fry the foods. Instead of including refined cereals and frying them in oil, fibre containing cereals were used avoiding excess oil. Saturated fats like butter and ghee were reduced. Including more fibre containing diets, use of fruits rich in antioxidants and adequate exercise were the steps undertaken by the subjects after diet counselling.

Table XXVIII reveals the mean percentage marks, body mass index and lipid profile of the subjects before and after diet counselling. Figure 10 shows the blood lipid profile of the subjects before and after counselling.

TABLE XXVIII

MEAN PERCENTAGE MARKS, BMI AND SERUM LIPID PROFILE OF SUBJECTS BEFORE AND AFTER DIET COUNSELLING

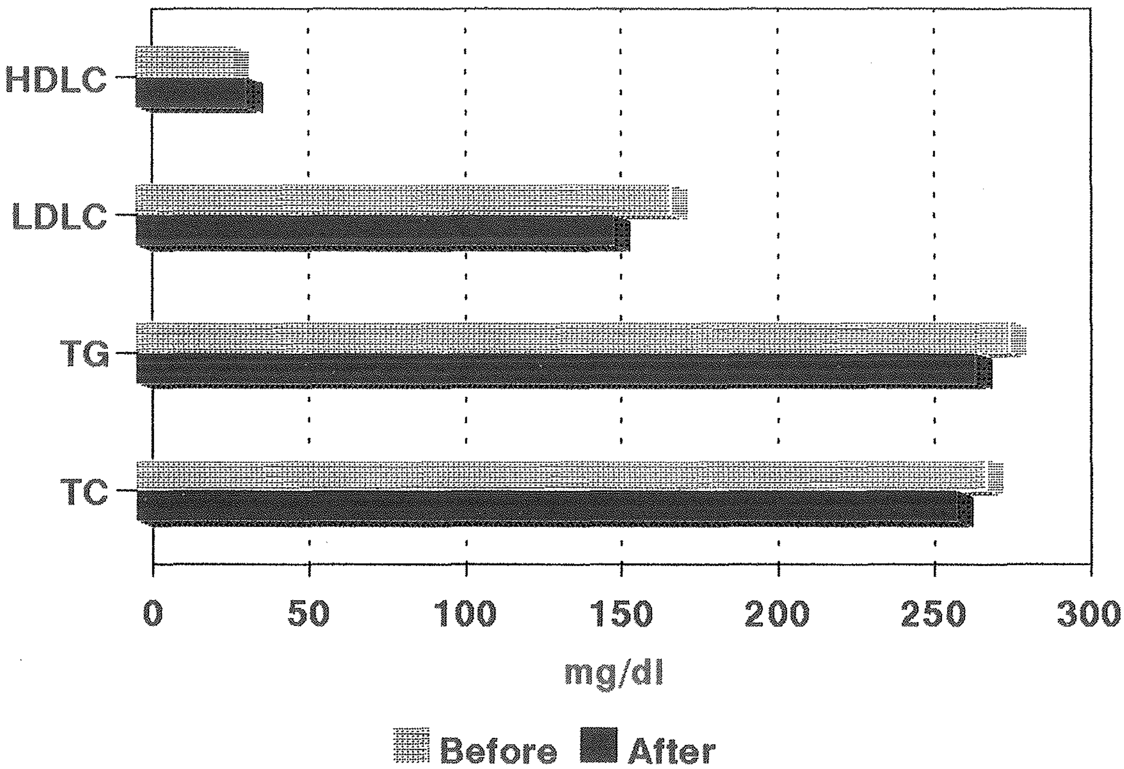
(N=100)

Criteria	Before diet counselling	After diet counselling	't' value
Percentage marks	26.2 ± 7.6	86.5 ± 15.5	5.29**
BMI	27.2 ± 1.3	26.3 ± 1.5	1.97 NS
TC mg/dl	272.3 ± 16.8	262.4 ± 19.5	2.99**
TG mg/dl	279.7 ± 12.7	268.5 ± 15.8	2.91**
LDL-C mg/dl	171.2 ± 27.1	168.8 ± 17.9	1.61 NS
HDL-C mg/dl	31.5 ± 7.7	35.40 ± 10.5	2.40*

* - Significant at five per cent level

** - Significant at one per cent level

NS - Not significant



MEAN SERUM LIPID PROFILE OF SUBJECTS
BEFORE AND AFTER DIET COUNSELLING
Fig.10

The mean scores awarded for knowledge, attitude and practices had increased after diet counselling. The results showed that the scores awarded for the knowledge, attitude and practices had increased by 60 per cent (from 26.2 to 86.5) after diet counselling which was significant at one per cent level.

There was a reduction of 0.9 in the mean BMI of the subjects which was not statistically significant.

The serum lipid levels namely total cholesterol, triglyceride and low density lipoprotein cholesterol had shifted from higher value (272.3 mg/dl) to a more desirable value (262.4 mg/dl). Total cholesterol and triglycerides were significantly ($p<0.01$) reduced while reduction of LDL-C was not statistically significant. There was mean increase of 3.9 mg/dl in the case of HDL-C. This increase was statistically significant at five per cent level. Before diet counselling 80 per cent of the subjects did not know the normal body weight for adults, whereas all of them were aware of this after diet counselling. In the same way the energy values of carbohydrates, proteins and fats, the role of mono, polyunsaturated and saturated fatty acids, dietary fibre and their role in maintenance of health and the ways and means to maintain desirable body weight were taught.

A significant reduction in BMI shows that proper counselling and guidance can make adults keep fit and help to avoid long-term complications.

This result is yet another document in the support of the statement of Laino (1994) and Smith et al (1995) who have also shown positive changes in blood lipid levels after diet counselling. Flemming et al (1996) have also stated that diet counselling is necessary for statistically significant reductions in total cholesterol and triglyceride.

Diet counselling of population groups on the correct dietary practices can provide solution to reduce the incidence of hyperlipidemia and diet related diseases such as cardiovascular diseases, diabetes mellitus and hypertension.

Summary and Conclusion

V SUMMARY AND CONCLUSION

Association of fat quality and quantity with incidence of cardiovascular diseases, hypertension and diabetes mellitus has been extensively studied in developed countries, but there is dearth of information in these lines in India. In order to find out the pattern of fat consumption and the epidemiology of fat associated diseases in the target adults in Coimbatore city, Tamil Nadu, the present investigation was undertaken with the following objectives. To

A. Analyse the incidence of cardiovascular diseases in adult population who attended the selected hospital of Coimbatore city, in 1985 and 1995 by collecting secondary data
B. Select adult population at random and study their socio-economic profile, personal habits, food intake, body mass index and incidence of diseases
C. Examine the association between consumption of fats and oils and body mass index, serum lipid profile and incidence of diseases on a subsample
D. Assess the serum lipid profile of adults consuming single plant oil/ animal foods
E. Find out the effect of replacement of saturated fats with plant oils in hyperlipidemic subjects
F. Cross examine the intake of fats and oils and serum lipid profile of patients suffering from cardiovascular diseases, hypertension and diabetes mellitus and
G. Impart and evaluate the impact of diet counselling on hyperlipidemics

The methodolgy involved in carrying out the current investigation is as follows:

Incidence of cardiovascular diseases in 1985 and 1995 was studied by collecting secondary data from the hospital records of G.Kuppuswamy Naidu Memorial Hospital in Coimbatore city. The data collected included details on the number of patients treated, their age, sex, type of health disorder and treatment given.

Analysis of data over a decade indicated an alarmingly high rate of prevalence of cardiovascular diseases in 1995. Hence the investigator further probed to re-examine the crucially important and highly overlooked diet related aspects of these diseases to formulate guidelines for fat intake , towards the prevention of fat linked diseases.

The target group of 1200 adults between 25 and 55 years of age were selected at random from three prominent residential areas of Coimbatore city. Four hundred adults each from low, middle and high income groups representing 240 males and 160 females were selected.

The socio-economic profile namely, age, educational status, level of activity, income, type of family, prevalence of fat associated diseases and personal habits of all the subjects were assessed using the interview schedule developed by the investigator.

The amount of foods consumed, types of fats and oils consumed were collected by utilising the schedule. Quantification of food intake was carried out through 24 hour food recall survey for three consecutive days.

The anthropometric measurements namely, height and weight of all the subjects were measured using standard procedures. Using height and weight, the body mass index of all the subjects were calculated.

Utilising the check list prepared, the prevalence of fat associated diseases among the target adults was assessed.

To study the association between the consumption of fats and oils, body mass index, serum lipid profile and incidence of diseases a sub sample of 120 subjects representing 25 males and 15 females in each income group was selected.

The serum lipid profile of the subsample of 120 subjects was estimated following standard procedures. Data on the food and nutrient intake, type and quantity of fats and oils consumed, body mass index and prevalence of fat associated diseases were also gathered for these 120 subjects.

To further examine the effect of consuming any one plant oil or any one animal food on health, subjects consuming any one plant oil were picked out from the target 1200 adults. Fifty subjects each consuming either ground nut oil or refined ground nut oil or gingelly oil or sunflower oil or coconut oil were identified. Ten subjects each consuming only milk or egg or fish or chicken or mutton or beef or pork were located. Animal food consumers ate the particular animal food at least four times a week totalling at least one kg per week. Total visible and invisible fat intake, BMI, waist hip ratio, incidence of diseases and serum lipid profile were assessed for all the 270 target adults.

The hyperlipidemic subjects, screened from the 1200 target adults were found to consume saturated fats in the form of butter, ghee and vanaspathi in quantities exceeding the recommended allowances. Hence a total number of forty hyperlipidemics were selected to study the effect of replacement of saturated fats with plant oils. These hyperlipidemics were selected on the basis that their serum total cholesterol values were above the high risk level of more than 240 mg/dl suggested by the NCEP.

The 40 hyperlipidemics were divided into four groups of 10 subjects each. The visible saturated fats and oils present in the diets of the first three groups were replaced with 30 grams each of groundnut oil/gingelly oil/sunflower oil respectively. The fourth group served as control without any oil replacement. The replacement of oils was carried out for a period of two months. The body mass index and serum lipid profile of all the four groups of subjects were estimated before and after replacement.

Three groups of one hundred patients, each suffering from cardiovascular diseases, hypertension and diabetes mellitus respectively were selected at random from one of the reputed hospitals of Coimbatore city.

Fats and oils intake, body mass index, waist hip ratio and serum lipid profile of all the patients were measured. The association of all these parameters with incidence of diseases was studied.

Diet counselling of hyperlipidemic subjects was undertaken as a strategy for preventing the onset of degenerative diseases.

A total number of 100 obese hyperlipidemics were selected from the same hospital using random selection for the purpose of diet counselling. Diet counselling was imparted for a period of two months. Based on the initial knowledge and dietary practices of the subjects, lessons were developed for diet counselling. Individual and group counselling were undertaken at least for two hours in a week for a period of two months.

The knowledge, attitudes and practices were evaluated by conducting tests before and after diet counselling. BMI and serum lipid profile were estimated before and after diet counselling and the results were statistically analysed.

Highlights of the results

A. Incidence of cardiovascular diseases in 1985 and 1995

1. The number of patients registered in the hospital for treatment of cardiovascular diseases was 773 in 1985 as against 2198 in 1995 indicating a three fold increase in the incidence of cardiovascular diseases over a decade.
2. The percentage incidence of cardiovascular diseases was 71 among males and 29 among females in 1985. In 1995 the percentage

incidence in females increased to 36 per cent, indicating that in 1995 more females had been treated and gender bias in availing health facilities had changed over 10 years.

3. The incidence of cardiovascular diseases was the highest between 50 to 60 years in both males and females in 1985 and also in 1995 followed by 40 to 50 in 1985 and 60 to 70 years in 1995. Beyond the age of 40 all the adults should have regular health check-up to avert becoming victims of killer diseases.

B. Association between consumption of fats and oils, body mass index and incidence of diseases among the target adults

1. The distribution of target adults according to age indicates 30 per cent adults to be in 40 to 50 years in all the three income groups as against 8 to 18 per cent in 60 to 70 years.
2. Nuclear family system predominated in all the income groups ranging from 64 to 72 per cent.
3. Literacy level was high among the selected subjects with no illiterates in high and middle income groups. A direct relationship was observed between educational status and income.
4. The subjects in the low income group were employed in occupations requiring heavy activity. In the middle income group 50 per cent of the male subjects were doing moderate activity and 31 per cent were doing heavy activity. Females were engaged in sedentary activity. In high income group none of the subjects performed heavy activity.

Seventy per cent of the subjects were engaged in sedentary activity and 30 per cent in moderate activity.

5. Nature of diet consumed by the target population revealed that 70 per cent were non-vegetarians in low income group as against 50 and 60 per cent in middle and high income groups. There were more (33 per cent) vegetarians in middle income group while 20 per cent were vegetarians in low and high income groups.

6. Food consumption pattern revealed that in low income group the foods containing carbohydrate were consumed in larger proportion compared to pulses, fruits, milk, fats and oils and flesh foods. In middle income group the carbohydrate consumption of subjects was less compared to those in low income group. Consumption of pulses was higher. More than 40g of fats and oils were consumed by the subjects in the middle income group.

   Except cereals the consumption of all the other groups of foods was high by the subjects in high income group and they ate variety of foods. Consumption of milk, fats and oils and flesh foods was high leading to increase in saturated fat consumption.

7. Thirty three and 28 per cent of the subjects consumed alcohol in low and high income groups respectively. Smoking was also high among the subjects in low and high income groups. None of the female subjects had the habit of consuming alcohol or smoking. But tobacco chewing was greater in females than males. Betel leaves were

consumed by 145 (36 per cent) males in low income group followed by 77 (19 per cent) and 47 (12 per cent) females in middle and high income groups.

8. The average BMI of male subjects considering all age groups together in the three income groups ranged between 20.8 to 21.3. Male subjects between 25 to 30 years in low income group had BMI below 18.5 denoting chronic energy deficiency. The highest BMI was registered by female subjects between 55 to 65 years of age in high income group. In the case of females, as income increased there was a gradual increase in the BMI.

   The distribution of subjects according to body mass index classification given by Garrow indicated that 50 per cent of the subjects in each income group fell in the normal BMI range. Obesity was present in 10, 15, and 36 per cent of male subjects from low, middle and high income groups respectively.

9. Prevalence of fat associated diseases indicated that the percentage of obese subjects in the three income groups ranged between 7 to 27, the highest being in the high income group. Totally there were 198 obese subjects out of 1200. Diabetes mellitus ranked second in the prevalence followed by hypertension and cardiovascular

diseases. There were totally 248 subjects with fat associated diseases in high income group followed by 110 subjects in middle and 61 subjects in low income groups. These results indicate a high association between disease prevalence, affluence and type and amount of fat intake. Consumption of excess saturated fats and total fats has kept the subjects in high income group at a greater risk for diseases.

10. The day's mean food intake of subsample of, 120 subjects indicated that the subjects in the low income group consumed inadequate quantities of cereals, pulses, flesh foods, vegetables, visible fat, milk and fruits. The fruit consumed by these subjects was plantain.

    The food consumption of the subsample of middle income group also indicated a deficit in cereals, pulses and vegetables. Intake of fats and oils, flesh foods, sugar, milk and milk products and fruits was upto the recommendations.

    The subjects from high income group met the RDA for all the foods except cereals and pulses and in addition green leafy vegetables in the case of females. The diet of the subjects in high income group indicated variety of vegetables and fruits.

11. Consumption of energy, protein, iron, beta-carotene, riboflavin, niacin and vitamin C was inadequate in the diets of subjects in the

low income group. The percentage deficit was 21 and 8 for energy, 20 and 6 for protein, 21 and 33 for iron, 27 and 53 for beta-carotene and 28 and 38 for vitamin C, for males and females respectively. Calcium and thiamine were consumed in adequate quantities.

In the case of subjects in the middle income group energy, protein, beta-carotene, riboflavin and niacin were deficient by 2 to 19 per cent.

Subjects from high income group consumed more than the recommended quantities of all nutrients except energy and niacin in male subjects and beta carotene in the case of female subjects. The total fat intake of all the three income groups was adequate. Subjects in the high income group consumed more than 100 per cent surplus fat than the recommendation.

12. The type of fats and oils consumption indicated that the subjects from low income group consumed any one oil, while the subjects from higher income groups consumed a combination of many fats and oils including the hydrogenated fats like vanaspathi and fats of animal origin such as butter and ghee. The quantity of oil consumed by the male and females adults in high income group was 79 and 82g which was a very high intake.

13. The mean of the total fat intake was 31.5g, 60g and 80g for low, middle and high income groups, indicating a desirable consumption by the subjects in low income group and an excess intake by the subjects in middle and high income groups.

    The mean energy contribution from fat was 12.4, 24.3 and 29.8 per cent for subjects in low, middle and high income groups respectively. The energy contribution from fat in the case of subjects from high income group exceeded the recommendations.

    The saturated fat intake of high income group was 14g/day which is twice the amount consumed by the subjects in other income groups. This implies that people from high income group should be more cautious in selecting and consuming right type of fats and oils, so that incidence of fat associated diseases can be reduced.

14. Prevalence of fat associated diseases in the subsample indicated that obesity was the most prevalent disorder followed by diabetes mellitus and hypertension. None of the subjects in the low income group had cardiovascular diseases, while two of the 40 subjects from high income group suffered from cardiovascular diseases.

15. With regard to serum lipid profile, the mean total cholesterol values of the subjects from low and middle income groups were184 and 200 mg/dl respectively which were within the normal range suggested by NCEP. Subjects from high income group had registered a mean value of 234 mg/dl which coincided with the high risk level.

The triglyceride levels ranged from 159.7 mg/dl for the subjects in low income group followed by 153.9 mg/dl for the subjects in middle income and 197.9 mg/dl for the subjects in high income group. The subjects in low income group have registered a higher value than the subjects in middle income, indicating that replacement of fat calories by carbohydrate elevates the triglyceride levels.

The low density lipoprotein cholesterol levels of all the three groups of subjects were within the normal value.

The high density lipoprotein cholesterol values of all the three groups of subjects were in the range of 39 to 46 mg/dl indicating a safe level. The point to be stressed here is that the subjects belonging to low income group had higher level of high density lipoprotein cholesterol (45.9 mg/dl) because of the fact that all these subjects were engaged in occupations requiring more physical activity. This may be the factor that has facilitated favourable high density lipoprotein cholesterol values.

C. Impact of consuming single plant oil/animal foods on adults

1. All the plant oil consuming subjects had registered body mass index values within the normal range.
2. Consumption of different plant oils revealed that the adults consuming coconut oil had registered the highest values for total cholesterol (197 mg/dl), triglyceride (151 mg/dl) and very low density lipoprotein cholesterol (25 mg/dl), while the lowest total cholesterol value (172.6 mg/dl) was registered by adults consuming gingelly oil.

   The increased high density lipoprotein cholesterol values for the ground nut oil group is due to the beneficial effect produced by the mono unsaturated fatty acids present in ground nut oil.

   Among the plant oils, gingelly oil ranked first in the maintenance of serum lipid profile. This may be attributed to the high linoleic acid (40g/100g) content of gingelly oil.
3. The incidence of diseases was minimum (14%) in the ground nut oil consuming subjects and maximum (24%) in the coconut oil consuming subjects. Here again the protective effect of ground nut oil can be attributed to the monounsaturated fatty acids present in ground nut oil, which has also raised the HDL-C levels.

   Plant oil consumption upto 30 to 50g per day does not produce adverse effects in the serum lipid levels and BMI. Gingelly oil and ground nut oil were found to be good in maintaining serum lipid levels and in reducing the incidence of diseases.

4. The BMI values of all the animal foods consuming groups were greater than 25 which denotes grade I obesity.

5. The total fat intake of the different animal food consumers was high ranging between 64g to 85g/day. The invisible fat contribution from animal foods was equal to that of visible oils used in cooking.

6. Consumption of different animal foods revealed that fish consumption had negative correlation with all serum lipids and a positive correlation with high density lipoprotein cholesterol. The long chain eicosanoids present in fish oil have contributed to the beneficial effect. The subjects in the beef consuming group had registered the highest serum lipid values, followed by pork, egg, chicken, milk, fish and mutton groups.

7. Obesity, diabetes mellitus and hypertension were prevalent among the animal food consumers. Subjects consuming mutton and pork had developed more health disorders than other animal food consumers.

These results imply that non-vegetarians consuming different animal foods should include about 100-200g of fish once or twice a week to maintain normal serum lipid levels. Vegetarians must be cautious to avoid consuming excess amounts of butter and ghee.

D. Effect of replacement of saturated fats with plant oils

1. The body mass index of the subjects in the four groups before and after replacement of saturated fats showed reduction which was not statistically significant except for the subjects in the ground nut oil group. The ground nut oil consumers had produced reduction in BMI which was statistically significant at one per cent level (P<0.01) indicating that ground nut oil is the most efficient of the three plant oils tested.

2. All the plant oils had reduced the serum lipid profile values after two months of replacement. Sunflower oil and gingelly oil had significantly (P<0.01) reduced the total cholesterol values. Gingelly oil had improved the high density lipoprotein cholesterol levels from 37.7 to 38.3 mg/dl.

   The group replaced with ground nut oil had reduced the total cholesterol (P<0.01), low density lipoprotein cholesterol (P<0.05), very low density lipoprotein cholesterol (P<0.01) and triglyceride (P<0.01) significantly. These results indicate that ground nut oil has been more efficient in altering the serum lipids towards favourable levels.

   The control group did not show any significant change in the lipid profile.

Replacement of saturated fats with plant oils that are rich in polyunsaturated fatty acids and antioxidants has been proved to be beneficial in preventing fat associated diseases.

E. Pattern of body mass index and lipid profile of patients suffering from fat associated diseases in relation to their intake of fats and oils

1. The mean body mass index of the patients suffering from cardiovascular diseases was 25 which is the upper borderline value. Patients with cardiovascular disease showed the highest BMI among subjects having fat associated diseases.

   Hypertensives had registered a body mass index value of 24.7 followed by diabetics with a BMI value of 23. The same trend was observed with values of waist hip ratio though all had registered desirable values.

2. The serum total cholesterol values of all the three groups of patients were above the normal value. The value for diabetics was 237.1 mg/dl which was just below the high risk value of 240 mg/dl. Cardiovascular disease and hypertension have direct relation with fat intake and the total cholesterol values..

   The triglyceride levels showed a value of 211.6 mg/dl for hypertensives followed by diabetics (194.5 mg/dl) and patients with cardiovascular diseases (188.8mg/dl). But the cardiovascular disease patients showed high LDL- cholesterol levels (164 mg/dl) compared to diabetics and hypertensives.

The high density lipoprotein levels were at the high risk level for diabetics and hypertensives while cardiovascular disease subjects showed a slightly high value (42.3 mg/dl).

F. Impact of diet counselling on selected hyperlipidemics

1. The mean scores obtained by the subjects for knowledge, attitudes and practices had increased by 60 per cent showing a highly significant improvement (P<0.01) after diet counselling.
2. The reduction in the mean body mass index was only to the tune of 0.9 after diet counselling, which was not statistically significant.
3. Among the serum lipids, the total cholesterol, triglyceride and HDL-cholesterol values had improved significantly after diet counselling. The mean low density lipoprotein cholesterol levels had decreased from 171.2 to 152.8mg/dl, which was not statistically significant.

   Diet counselling was found to be an effective method of educating the community to keep fit and avoid long-term complications. The health care team of doctors, nurses, nutritionists and dietitians through counselling patients on dietary aspects should take diet much more seriously and strengthen it by making diet prescription as important as drug prescription.

Recommendations

1. Fifty years of age has been found to be the critical age for the onset of fat associated diseases. Hence a package of health care services for the adults be offered by the Central and State governments and should be available at all hospitals and primary health centres at nominal cost.
2. Collaborative research studies directed towards incidence of diseases and fat intake should be carried out by nutrition and health departments of the Central and State governments and universities and colleges with nutrition departments once a decade. From this, dietary guidelines should emerge for population groups to follow, which would keep them fit and healthy.
3. Data base on secular trends in the incidence of diet related diseases in rural and urban areas should be developed and maintained by the nutrition and health departments as well as the hospitals and primary health centres. The salient aspects on diet and disease should be projected and communicated to the masses effectively which would bring in awareness paving way for adopting appropriate preventive measures.

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ANNEXURE - I

INTERVIEW SCHEDULE TO ELICIT SOCIO-ECONOMIC AND FOOD INTAKE PATTERN

Part I - Socio-economic pattern

1. Name of the interviewer :
2. Name and ~~of the~~ address of the interviewee :
3. Age :
4. Educational status :
5. Occupation :
6. Income/month :
7. Type of family : Joint/Nuclear
8. Composition of the family

S. No.	Name	Age	Relation to head of family	Education	Occupation	Income

Part II - Food in take Pattern

1. Vegetarian/Non-vegetarian

2. Type and amount of foods consumed

Sl. No. Foods	Frequency of consumption	Amount consumed/ Day
1. Cereals		
Raw rice		
Boiled rice		
Wheat		
Maida		
Jowar		
Bajra		
Maize		
Ragi		
Sago		
Tapioca		
Others (Specify)		
2. Pulses		
Red gramdhal		
Black gram dhal		
Bengal gram dhal		
Green gram dhal		
Horse gram dhal		
Cow gram		
Others (Specify)		
3. Roots and Tubers		
Potato		
Carrot		
Yam		
Colocasia		
Onion		
Others (Specify)		
4. Green Leafy Vegetables		
Amaranth		
Palak		
Others (Specify)		

Sl. No	Foods	Frequency of consumption	Amount consumed/Day
5.	**Vegetables (Others)** Brinjal Beans Pumpkin Ladies finger Tomato Others (Specify)		
6.	**Fruits** Plantain guava Papaya Others (Specify)		
7.	**Flesh Foods** Mutton Chicken Fish Beef Egg Others (Specify)		
8.	**Milk & Milk Products** Milk Curds Buttermilk Cheese Ghee		
9.	**Sugar & Jaggery** Sugar Jaggery Palm jaggery		

Sl. No	Foods	Frequency of consumption	Amount consumed/Day
10.	**Prepared Foods** Biscuits Pickles Pappads Sweets Ice-creams Chocolates Chips and Others Fried foods		
11.	**Beverages** Tea Coffee Cool drinks Others (Specify)		
12.	**Nuts & Oil Seeds** Cashewnuts Almonds Pistachio Raisins Walnuts Others (Specify)		

3. What type of oil do you use for cooking ?

S.No.	Type of oils	Quantity consumed per/week
1.	Groundnut oils	
2.	Gingelly oil	
3.	Sunflower oil	
4.	Palm oil	
5.	Coconut oil	
6.	Ghee	
7.	Vanaspathi	
8.	Butter	
9.	Others	

4. Daily Meal Pattern :

S.No	On rising	Breakfast	Mid-morning	Lunch	Tea	Supper
1 st day						
IInd day						
IIIrd day						

5. If non-vegetarian, mention the types of food consumed and oil used

S.No.	Items	Type of oil used	Amount in g		
			Daily	Weekly	Occassionally
1.	Egg				
2.	Meat				
3.	Fish				
4.	Chicken				
5.	Others				

6. Do you drink alcohol? Yes [ ] No [ ]
7. If yes, mention how many drinks/day (ie frequency of consumption), quantity consumed and type of alcohol consumed
8. Do you exercise regularly ? Yes [ ] No [ ]
9. If yes, what kind of exercise do you perform?
   Yoga Jogging Walking Aerobics
   Other gymnastic exercises (Specify)

10. Anthropometric measurements

a. Weight (kg)

b. Height (cm)

c. BMI

d. Waist circumference

e. Hip circumference

f. WHR

11. Lipid Profile

Total cholesterol -

High density lipoprotein cholesterol -

Low density lipoprotein cholesterol -

Very low density lipoprotein cholesterol -

Triglycerides -

ANNEXURE - II

CHECK-LIST TO ASSESS THE PREVALENCE OF FAT ASSOCIATED DISEASES

Diseases conditions	Prevalence	
	Yes	No
Cardiovascular diseases		
Heart attack		
Angina pectoris		
Atherosclerosis		
Myocardial infraction		
Stroke		
Hyper tension (B.P)		
Non-insulin dependent diabetes mellitus		
Insulin - dependent diabetes mellitus		
Obesity		
Others (specifly)		

ANNEXURE III

ESTIMATION OF SERUM TOTAL CHOLESTEROL

(Bioclin kit)

PRINCIPLE

Cholesterol esters are hydrolysed by cholesterol esterase to cholesterol and fatty acids. Free and liberated cholesterols are oxidised by cholesterol oxidase to cholestene -3-one and hydrogen peroxide is liberated. The hydrogen peroxide produced couples with 4-aminoantipyrine and phenol in the presence of peroxidase to form a coloured compound. The intensity of the colour developed is proportional to cholesterol concentration. It is measured photometrically at 500 nm.

REAGENTS

1. Enzyme Reagent (Reagent 1)

Phosphate buffer	100mmol/L
4-Aminophenazone	0.25mmol/L
Phenol	25mmol/L
Peroxidase	5KU/L
Cholesterolesterase	>150U/L
Cholesterol oxidase	>100U/L
Sodium azide	0.05%

2. Cholesterol Standard 200mg/dL

PROCEDURE

Pipetted out into test tubes the following:

	Blank (B)	Standard (S)	Test (T)
Working reagent	1.0ml	1.0ml	1.0ml
Standard	-	-	-
Sample	-	-	0.01ml

Mixed and incubated for 10 minutes at 37 °C. Read absorbance of sample (AT) standard (AS) and reagent blank (AB) against distilled water at 500 nm. The colour developed was stable for one hour at room temperature 25± 5 °C, if protected from direct light.

CALCULATIONS

Conc. mg/dl = 553x $(A_T - A_B)$

Conc. mmol/L = 14.3x$(A_{T-}A_B)$

ANNEXUREIV

ESTIMATION OF SERUM HDL CHOLESTEROL

(Bioclin kit)

PRINCIPLE

The chylomicrons, VLDL and LDL are precipitated by addition of phosphotungstic acid and magnesium chloride. After centrifugation the supernatant contains HDL-fraction which is assayed for HDL-cholesterol using cholesterol enzymatic method.

REAGENTS

Precipitation Reagents

Phosphotungstic acid	0.55mmol/L
Magnesium Chloride	25mmol/L

Preparation of working solution

1. Precipitant for macro assay:· Reagent was used undiluted
2. Precipitant for semi-micro assay: Diluted reagent 4:1 with distilled water.

PROCEDURE

Pipetted into centrifuge tubes

	Macro (with Standard)		Micro (With factor only)
	Sample (T)	Standard (S)	Sample(T)
Sample (T)	0.5ml	-	0.2ml
Standard (S)*	-	0.5ml	-
Precipitating reagent : undiluted	1.0ml	1.0ml	-
Precipitating reagent : diluted	-	-	0.5ml

* Standard - 200mg/dl

Mixed well, allowed to stand for 10 minutes at room temperature and centrifuged for 2 minutes at 10,000 g or 10 minutes at 4,000 g. After centrifugation, separated the clear supernatant from the precipitate within one hour and determined the cholesterol concentration as follows:

Pipetted in to centriuge tubes

	Blank (B)	Standard (S)	Test (T)
Distilled water	0.1 ml	-	-
Sample supernatant	-	-	0.1 ml
Standard supernatant	-	0.1 ml	-
Cholesterol reagent	1.0 ml	1.0 ml	1.0 ml

Mixed incubated for 10 minutes at 37 °C. Measured the absorbance of the sample (A_T), standard (A_S) and blank (A_B) against distilled water at 500 nm or 546 nm.

CALCULATIONS

A. With standard (For macro method only).

$$C\ mg/dl = 200 \times \frac{A_T - A_S}{A_S - A_B}$$

B. With Factor

1.	Macroassay	C (mg/dl)	C (mmol/L)
	Wave length		
	Hg 546 nm	$274x\,(A_T-A_B)$	$7.09\ x\,(A_T-A_B)$
	500 nm	$180x(A_T-A_B)$	$4.65x(A_T-A_B)$
2.	Microassay		
	Wavelength		
	Hg 546 nm	$320x(A_T-A_B)$	$8.27x(A_T-A_B)$
	500 nm	$210x(A_T-A_B)$	$5.43x(A_T-A_B)$

ANNEXRUE IV
ESTIMATION OF SERUM TRIGLYCERIDES
(Enzokit, Ranbaxy Diagnostics)

PRINCIPLE

Serum triglycerides are hydrolysed to glycerol and free fatty acids by lipase. In the presence of ATPand glycerokinase, the glycerol is converted to glycerol-3 phosphate. The glycerol-3 phosphate is then oxidised by glycerol -3 phosphate oxidase to yield hydrogen peroxide. Hydrogen peroxide reacts in the presence of peroxidase with ESPAS (N -ethyl-N-sulfopropyl-m-anisidine) and 4-aminoantipyrine to form a coloured complex. The intensity of the colour developed is proportional to triglycerides concentration and is measured photometrically at 546 nm.

REAGENTS

Reagent	1	:	Buffer containing Pipes buffer and ESPAS
Reagent	2	:	Enzymes containing lipoprotein lipase, glycerokinase, glycerol-3phosphate oxidase, peroxidase, 4aminoantipyrene and ATP
Reagent	3	:	Standard triglycerides - 200 mg/dl

Preparation of working solution : Dissolved the contents of one bottle Reagent 2 with contents of one bottle Reagent 1. Mixed well. This is the chromogen reagent.

PROCEDURE

Pipetted into test tubes	Blank (B)	Standard (S)	Test (T)
Chromogen Reagent	1.0ml	1.0ml	1.0ml
Standard	-	0.2ml	-
Sample	-	-	0.2ml
	Mixed and incubated at 37 °C for 10 min		
Distilled water	4.0ml	4.0ml	4.0ml

Mixed and read absorbance of the test (A_T), standard (A_S) and the reagent blank (A_B)against distilled water at 546 nm.

CALCULATION

$$\text{Triglycerides(mg/dl)} = \frac{A_T - A_B}{A_S - A_B} \times 200$$

$$\text{mmol/L} = \text{mg/dl} \times 0.0114$$

ANNEXURE VI

QUESTIONNAIRE TO ELICIT FOOD PRACTICES BFORE AND AFTER DIET COUNSELLING

1. Name :
2. Age :
3. Sex : Male Female
4. What is the normal body weight of an Indian adult man/women
5. What is obesity
6. A calorie means

   a. Unit measure of protein b. Unit measure of energy

   c. Unit measure of fat d. Unit measure of carbohydrate
7. What is your energy requirement
8. How much calories is to be restricted/allowed in your diet
9. Calorific value of carbohydrate/protein/fat is

   a. 4 kcal/4 kcal/9 kcal b. 5 kcal/5 kcal/8 kcal

   c. 10 kcal/5 kcal/10 kcal
10. Which of the following foods can be eaten by you without restriction

Item	Amount
Rice	
Pulses	
Vegetables	
Fruits	
Non-vegetarians items	

11. List the foods high in cholesterol

1	2
3	4
5	6

12. List the foods low in cholesterol

1	2
3	4
5	6

13. What are food groups.

14. What is the use of food groups in menu planning.

15 a. Do you know the foods to be allowed/retricted in CVD

15. What is dietary fibre.

16. **List the foods high in dietary fibre.**

17. What fat is essential in the diet?

Your diet to maintain/reduce the weight?

Yes ☐ No ☐

If yes list the foods

Allowed	Restricted

18. What is PUFA, MUFA and SFA.

19. How much fat showed by included in your diet?

20. What type ofoil you will use in your diet?