

REVIEW OF LITERATURE

The review of literature pertaining to the present study “**Hypolipidemic effect of high fiber and omega 3 rich foods**” is discussed under the following headings:

- A. Global prevalence of cardiovascular diseases**
- B. Non-communicable diseases – Mortality and Morbidity**
- C. Hyperlipidemia and cardiovascular diseases – World public health challenge**
 - a. Types
 - b. Etiology
- D. Management of cardiovascular diseases**
 - a. Dietary management
 - b. Lifestyle – alcohol, smoking, tobacco
 - c. Physical exercise
 - d. Medical therapy
 - e. Nutraceuticals
- E. Cardiac-friendly effects of nuts**
 - a. Flaxseeds
 - b. Almonds
 - c. Walnuts

A. Global prevalence of cardiovascular diseases

Cardiovascular disease is a major cause of disability and premature death throughout the world and contributes substantially to the escalating costs of health care. The underlying pathology is atherosclerosis, which develops over many years

and is usually advanced by the time symptoms occur, generally in middle age. Acute coronary and cerebrovascular events frequently occur suddenly and are often fatal before medical care (WHO, 2011).

Cardiovascular conditions such as myocardial infarction, stroke and angina, coronary heart disease (includes angina and myocardial infarction but not stroke or heart failure) prevalence increases with age and is higher in men than in women. Chronic angina is higher than acute myocardial infarction and stroke. Five and four per cent prevalence is seen in men and women respectively in the United Kingdom (Appelors, 2009).

Barnes *et al.*, (2008) reported that Asian Indian adults (9 per cent) are ≥ 2 fold more likely to have heart disease than Korean adults (4 per cent) based on 2004-2006 data. Heidenreich *et al.*, (2011) reported that by 2030 almost 40.5 per cent of the US population will have some form of cardiovascular disease.

Similarly several studies on densely populated regions like Europe, North America (Morbidity Mortality Weekly Report, 2011) and China have reported significant regional variations in cardiovascular disease mortality, prevalence and incidence and major cardiovascular risk factors.

The association between ischemic heart disease and stroke was smaller than that reported by the Framingham Heart Study, in which ischemic heart disease tripled stroke risk. Ischemic heart disease is frequently associated with other risk factors such as hypertension, diabetes and/ or atrial fibrillation (Bejot *et al.*, 2009).

According to WHO (2009), about 5.71 million people died from stroke in 2004 and it is estimated that this number will climb to 6.3 million in 2015 and 7.8 million in 2030. As observed in the past 20 years by Feigin *et al.*, (2009), there has been a 29 per cent decline in the incidence of all types of stroke, especially in women and a 25 per cent reduction in mortality, except for hemorrhagic stroke in developed countries.

Data from the National Health and Nutrition Examination Survey (NHANES) 2005 - 2008 indicate that 33.5 per cent of US adults' ≥ 20 years of age have hypertension. This amounts to an estimated 76 400 000 US adults with hypertension. The prevalence of hypertension is nearly equal between men and women. Among the highest rates of hypertension in the world, African American adults were at 44 per cent (AHA, 2012).

May *et al.*, (2012) in his study among the US adolescents aged 12-19 years stated that there is no significant change in the prevalence of pre-hypertension / hypertension (17 and 13 per cent) and borderline-high/high LDL cholesterol (23 and 19 per cent) during the survey, but the prevalence of pre-diabetes/diabetes has been increased from 9 to 23 per cent. He also concluded that there is a substantial burden of cardiovascular disease risk factors on those who are overweight or obese.

Once a disease of the affluent, cardiovascular disease has now emerged as the number one killer in India (WHO, 2009). Reddy *et al.*, (2009), also stated that the prevalence of cardiovascular disease in individuals over 35 years currently stands at 10 per cent.

The incidence and prevalence rates of heart failure are rising due to population, epidemiological and health transitions. The rates of heart failure, in India due to coronary heart disease, hypertension, obesity, diabetes and rheumatic heart disease range from 1.3 to 4.6 million, with an annual incidence of 491 600–1.8 million (Huffman and Prabhakaran, 2010). Jones *et al.*, (2010), estimated that the prevalence of heart failure in India remains lower than that in the USA (5.8 million), but the rate for potential increase and subsequent morbidity and mortality strengthens the case for prevention of heart failure in India.

According to WHO (2010), the prevalence of other risk factors of heart failure is also rising in India. In addition to the ageing population, the prevalence of hypertension is projected to increase from 118 million (2000) to 214 million (2025).

A 6-fold increase in the incidence of cardiovascular disease is seen in urban India in the last 5 decades and a doubling in prevalence of cardiovascular disease is seen in rural India in the last 3 decades (Reddy *et al.*, 2009).

Pandey *et al.*, (2013), in his nationwide (India) study among urban women has reported a greater prevalence of multiple cardiovascular disease risk factors. This is similar to previous studies on urban-rural differences in cardiovascular risk factors using uniform protocols and has been reported from Haryana, Delhi, Rajasthan and Tamilnadu (Gupta *et al.*, 2008).

B. Non-communicable diseases - Mortality and Morbidity

Cardiovascular disease, including coronary heart disease and stroke, is the largest cause of mortality in the world and the majority of deaths occur in low and middle-income countries such as India and China (WHO, 2011).

Cardiovascular disease prevalence in India has risen four-fold in the past four decades. Expected to be the leading cause of death and disability by 2020, cardiovascular disease already causes 29 per cent of all deaths in the country. "Indians are succumbing to heart disease and stroke in the most productive years of their lives; about a decade earlier than their western counterparts". It was concluded that in India, cardiovascular disease victims are often the sole breadwinner of a large family. Most healthcare costs are covered out of pocket and hospitalizations drive many families into poverty. According to the World Health Organization, lost productivity due to premature deaths and disability cost India 9 billion dollars in 2005, a loss projected to amount to 237 billion dollars by 2015 (Prabhakaran *et al.*, 2009).

Cardiovascular diseases are the leading cause of death and disability in both developed and developing countries. In developed countries socio-economic mortality differentials have been studied extensively showing that the low socio-economic group suffers the highest mortality. As the epidemiological transition is taking place against a background of economic globalization, cardiovascular disease risk factors among the urban poor and middle class are rapidly increasing

in India. Recent evidences by Jeemon and Reddy (2010), from India also suggest the reversal of social gradient with excess burden of cardiovascular disease morbidity in the low socio-economic group. Understanding the social determinants of environmental and behavioural exposures in determining the risk factors for cardiovascular disease is an important challenge for public health professionals as well as communities. Socio-economic disadvantage is not simply a proxy for poor cardiovascular risk factor status, but also an indication of the likely trajectory that an individual or a community may follow in the course of their life.

Cardiovascular disease comprises major proportions of non-communicable diseases. In 2010, among all the projected worldwide deaths, 23 million deaths are due to cardiovascular diseases. In fact, it is the single largest cause of death in the world accounting for more than one third of all deaths; 7.6 million were attributed to coronary heart disease and 5.7 million to stroke. More than 80 per cent of the deaths occurred in low and middle income countries (WHO, 2011).

Non-communicable diseases, particularly heart diseases, were once associated with the developed and affluent nations while the developing nations were afflicted by infectious and parasitic diseases. However, over the past few decades there has been a change in the landscape of non-communicable diseases across the world. These developing nations are undergoing rapid epidemiological transition where the infection related morbidity and mortality in the countries such as India, the disease burden has been shifted predominantly to non-communicable diseases (Gupta *et al.*, 2011). Almost half the disease burden is in low and middle-income countries (Lopez *et al.*, 2006). At the same time there is an increasing number of people from developing countries suffering from non-communicable diseases. By 2030, four-fifths of all non-communicable disease related mortality will take place in developing nations (ASSOCHAM, 2011).

Cardiovascular disease at present is the largest single contributor to global mortality and will continue to dominate mortality trends in the future (WHO, 2009e). It also reported that almost 23.6 million people will die due to cardiovascular diseases by 2030.

By 2030, researchers project that non-communicable diseases will account for more than three-quarters of deaths worldwide; cardiovascular disease alone will be responsible for more deaths in low income countries than infectious diseases (including HIV/AIDS, tuberculosis and malaria), maternal and perinatal conditions, and nutritional disorders combined (Beaglehole and Bonita, 2008).

The United States Institute of Medicine (2010), reported that non-communicable diseases are epidemic in urban locations of developing countries and are rapidly increasing in rural areas as well. There are also national differences in cardiovascular mortality across the world. The report on cardiovascular disease in low income countries shows that there are substantial national variations. The highest age-adjusted mortality is observed in countries of central Asia, east and central Europe, some countries in Africa, while the lowest rates are observed in west European and North American countries. There are within-country variations also and the report presents data on significant differences in regions and locations within countries and in many large nations such as the United States, Russia and China.

Coronary heart disease mortality trends across countries reveal considerable variability in the shape and magnitude of disease epidemics since 1950s. Trends are not consistent even among countries within the same geographic region (Fuster and Kelly, 2010). Though the connecting trends in the causes of mortality and stage of development can be observed, it is difficult to make generalized observations about coronary heart disease mortality trends for most low and middle income regions. This is due to limited trending data from many low and middle income countries as well as considerable country-to-country variability within regions.

US Center for Disease Control and Prevention (CDCP, 2011), reported that in 2008, the leading causes of death in women ≥ 65 years of age in the order were diseases of the heart, cancer, stroke and Chronic Lower Respiratory Disease (CLRD), whereas in older men, they were diseases of the heart, cancer, CLRD and stroke. About 150 000 Americans died of cardiovascular disease in 2008 who were

≥65 years of age and 33 per cent of deaths attributed to cardiovascular disease occurred before the age of 75 years, which is well below the average life expectancy of 77.9 years.

Coronary heart disease mortality is greater in south India while stroke is more common in the eastern Indian states. The prevalence is higher in urban Indian populations while stroke mortality is similar in urban and rural regions (Mony, 2010).

Mortality rates generally appear to be most closely linked to a country's stage of epidemiological transition. With demographic shifts, epidemiological transition and increasing urbanization associated with increase in cardiovascular disease risk factors (smoking, sedentary lifestyle, obesity, hypertension and hypercholesterolemia) and a lack of policy directives aimed at chronic disease control, cardiovascular diseases are poised to accelerate further (Gupta *et al.*, 2012).

Cardiovascular disease was the largest cause of deaths in males (20.3 per cent) as well as females (16.9 per cent) and led to about 2 million deaths annually. Mortality data from cardiovascular disease in India are also reported by the WHO. According to Global Status on Non-Communicable Diseases Report by WHO (2011), there were more than 2.5 million deaths from cardiovascular disease in India in 2008, two-thirds due to coronary heart disease and one-third due to stroke. These estimates are significantly greater than those reported by the Registrar General of India and shows that cardiovascular disease mortality is increasing rapidly in the country.

World Health Organization has predicted that from years 2000 to 2020 Disability-Adjusted Life Years (DALY) lost from coronary heart disease in India shall double in both men and women from 7.7 and 5.5 million respectively (Gupta, 2009). It has also been reported that cerebrovascular diseases will account for more DALYs than coronary heart disease.

According to the National Center for Health Statistics (NCHS), if all forms of major cardiovascular disease were eliminated, life expectancy could rise by almost 7 years. According to the same study (Anderson, 2011), the probability at birth of eventually dying of major cardiovascular disease is 47 per cent.

C. Hyperlipidemia and cardiovascular diseases – World public health challenge

a. Types

The WHO Global Status Report on non-communicable diseases 2010 (GSR 2010) showed that non-communicable diseases are the biggest cause of death worldwide. More than 36 million people died from non-communicable diseases in 2008, mainly cardiovascular diseases (48 per cent), cancers (21 per cent), chronic respiratory diseases (12 per cent) and diabetes (3 per cent). More than 9 million of these deaths occurred before the age of 60 and could have largely been prevented. Premature deaths from non-communicable diseases range from 22 per cent among men and 35 per cent among women in low-income countries to 8 per cent among men and 10 per cent among women in high-income countries (WHO, 2011).

According to Schiller *et al.*, (2012), the age-adjusted prevalence of cardiovascular diseases estimated from the National Health Interview Survey (NHIS) and National Center for Health Statistics (NCHS) for diagnosed conditions for people ≥ 18 years of age in 2010 is observed in various regions around the World. It is estimated that among Whites, 11.7 per cent had heart disease, 6.4 per cent had coronary heart disease, 23.6 per cent had hypertension and 2.5 per cent had stroke. Among Blacks or African Americans 10.9 per cent had heart disease, 6.3 per cent had coronary heart disease, 33.8 per cent had hypertension and 3.9 per cent had stroke. Hispanics or Latinos have 8.1 per cent heart disease, 5.2 per cent coronary heart disease, 22.5 per cent hypertension and 2.6 per cent stroke whereas Asians had heart disease of 7.2 per cent, coronary heart disease 4.9 per cent, hypertension 20.5 per cent and stroke 2.0 per cent and American Indians or Alaska Natives had 12.5 per cent heart disease, 5.9 per cent coronary heart disease, 30.0 per cent had hypertension and 5.9 per cent had stroke.

In Native Hawaiians or other Pacific Islanders, 20.2 per cent of the population had heart disease, 19.7 per cent had coronary heart disease, 40.8 per cent had hypertension and 10.6 per cent had stroke.

It is well established that non-communicable diseases are the leading cause of death in the world, responsible for 63 per cent of the 57 million deaths that occurred in 2008 (Alwan *et al.*, 2010). The majority of these deaths i.e., 36 million were attributed to cardiovascular disease and diabetes, cancers and chronic respiratory diseases.

Stroke is the second leading cause of death in the world. In the Middle East and North Africa stroke is increasingly becoming a major health problem, with projections that deaths from it will nearly double by 2030. This systematic review aims to bring together age-adjusted epidemiological data of stroke in this region. Several studies reported that the rates from 29.8 per 100 000 people in Saudi Arabia to 57 per 100 000 people in Bahrain. Furthermore, the 28-day case mortality rate also differed among studies, ranging from 10 per cent in Kuwait to 31.5 per cent in Iran. The rates are comparable with those in the Western World; however, the population of the region is younger. The Middle East and North Africa are lacking in data on the epidemiology of stroke. There is an urgent need to develop strategies to prevent and better care for stroke patients in the Middle East and North Africa (Tran *et al.*, 2010).

Coronary heart disease is a major cause of death and disability in developed countries. Although coronary heart disease mortality rates have declined over the past four decades in the United States (and elsewhere), coronary heart disease remains responsible for about one-third of all deaths in individuals over age 35 (Lloyd *et al.*, 2010).

Coronary heart disease incidence is decreasing in Western Europe, the United States and in Australia but is steeply increasing in Central and Eastern Europe, Asia and Africa. The greater cause for concern is the early age of coronary heart disease deaths in the developing countries compared to the developed

countries, which cripple the major work force of the nation. It was also reported an incidence of coronary artery disease of 5 per cent for western population compared to 12-16 per cent in the South-east Asian population.

Congenital heart disease accounts for nearly one-third of all major congenital anomalies. Coronary heart disease birth prevalence worldwide and over time is suggested to vary (Linde *et al.*, 2011).

The INTERSTROKE study by O'Donnell *et al.*, (2010), reported that 10 common risk factors explained more than 90 per cent of incident hemorrhagic and thrombotic strokes. The risk factors were similar to the INTERHEART study (hypertension, smoking, dyslipidemia, diabetes, high waist-hip ratio, sedentary lifestyle, psychosocial stress, poor quality diet and cardiac causes), but the population-attributable risks were different with greater importance of hypertension and lesser importance of diabetes and lipids.

In terms of population, India ranks second only to China. Recent rapid socio-economic changes have led to a concomitant change in people's lifestyle, leading to work-related stress and altered food habits, raising the risk of hypertension. Those factors, coupled with an increase in the average life expectancy, are expected to have an impact on the occurrence of stroke disorder in India (Das and Benerjee, 2008).

Stroke is a clinical syndrome divided into two broad categories that define its pathophysiology. Ischaemic strokes are caused by sudden occlusion of arteries supplying the brain, either due to a thrombus at the site of occlusion or formed in another part of the circulation. It account for 50 to 85 per cent of all strokes worldwide (Feigin *et al.*, 2009). Haemorrhagic strokes are caused by sub-arachnoid haemorrhage bleeding from one of the brain's arteries into the brain tissue or intra-cerebral haemorrhage, arterial bleeding in the space between meninges. This category of stroke accounts for 1 to 7 per cent and 7 to 27 per cent respectively of all strokes worldwide.

Prevalence data for stroke are limited and are confined to studies that suffer from frequent bias, small and variable sample sizes and inconsistent diagnostic criteria as reported by Nagaraja *et al.*, (2009). They also estimated that the crude prevalence rate in India for stroke varies according to region. The crude prevalence rate appears to be higher in urban compared to rural populations. The Parsi population in Mumbai appears particularly at risk, compared with the Indian population.

Ischaemic stroke is the most common sub-type followed by haemorrhagic and embolic stroke and 21-48 per cent of stroke in young is caused by atherosclerotic large artery occlusive disease (Kumar *et al.*, 2011). Interim analysis of 3092 patients in a study (INSPIRE) conducted in India found that approximately 27 per cent (814) of the patients with stroke were below the age of 50 and 30 per cent (935) of patients had a poorer socio-economic status. Thus, suggesting the higher incidence of stroke among younger age group and also among poorer population in India (Xavier *et al.*, 2012)

Puri *et al.*, (2010), opine that atherosclerosis affects the Indian population at a younger age than in other ethnic groups with more advanced lesions. Epidemiological data of the last 5 decades indicate a significant increase in the prevalence of coronary artery disease in urban as well as rural India. In another study on Indian population of Haryana he reported an incidence of 86 per cent atherosclerosis.

Ischemic heart disease following atherosclerosis is a giant killer and the incidence of atherosclerosis in coronary arteries is rapidly increasing among Indians. Thej *et al.*, (2012), conducted a study to find out the prevalence of atherosclerosis between age and sex in the semi-urban population of Kolar, a district in Southern India. He found among the population aged 35-85 years that the incidence of atherosclerotic lesions in aorta was 90 per cent with 40 per cent being advanced atherosclerotic lesions. In the coronaries, the incidence of atherosclerotic lesions was 73 per cent with 33 per cent being advanced lesions using American Heart Association classification. With cardiovascular disease attaining pandemic

proportions, the study of sub-clinical atherosclerosis is the need of the hour to estimate the disease burden in the asymptomatic population. The increased amount of atherosclerosis (advanced and intermediate lesions) found in the young population in the study gives an indication that anti-atherogenic preventive measures need to be implemented in young individuals, so as to prevent coronary artery disease from causing premature death.

In humans, psychological stress and hopelessness can be risk factors for cardiovascular catastrophes such as stroke, coronary ischemia and myocardial infarction, which occur secondary to increased atherosclerosis. The increased stress leads to endothelial dysfunction, which is a major cause for initiation and development of atherosclerosis. Altered hypothalamic pituitary adrenal axis and impaired platelet function of platelets have also been implicated as mechanisms by which chronic psychological stress can cause increased atherosclerosis leading to increased coronary heart disease (Chumaeva *et al.*, 2010 and Lombard, 2010).

According to Chow and Patel (2012), the outcomes in cardiovascular health of women are notably inferior to those in men, especially within the strata of lower socio-economic status and education level. The diversity in Indian population could be a significant factor contributing towards information deficit in prevention and care mechanisms of cardiovascular disease in India.

b. Etiology

Apart from the risk factors said by Gupta *et al.*,(2012), age, gender, low educational status, high fat diet are also considered as the most important determinant factors and has been reported in middle socio-economic status of individuals living in Europe and North America. It is also observed among the middle class individuals in middle-income countries such as Mexico (Villalpando *et al.*, 2010), Latin American countries, Central and Southern European countries and East Asian region (Lee, 2010). These secular trends show that there are divergent trends in risk factors.

Hypertension plays a major role in cardiovascular diseases. It is also a determining factor for the cause of the disease and it is not only affecting the adults

but also teens and children. The prevalence of hypertension has increased in both urban and rural Indian subjects and presently 25 to 40 per cent in urban adults and 10 to 15 per cent among rural adults. A review of epidemiological hypertension studies by Deedwania and Gupta (2012), reported that the prevalence of hypertension was significantly higher in urban populations in India compared with rural populations. However, no consistent trends were observed for regional variations. In rural populations the prevalence of hypertension was higher in Rajasthan while in urban studies prevalence rates were not significantly different in different regions. The prevalence of hypertension was highest in metropolitan cities such as Mumbai and lower in less populated cities. An important finding of the studies is that the prevalence of hypertension in rural populations is now approaching the rates in urban subjects.

Prabhakaran *et al.*, (2009), reported that hypertension prevalence in Hyderabad (Andhra Pradesh) was more than double when compared to prevalence in Nagpur (Maharashtra).

Gupta *et al.*, (2012), opine that multiple cardiovascular risk factors like physical inactivity, high fat intake, low fruits and vegetables intake, smoking, obesity, truncal obesity, hypertension, dyslipidemia and the metabolic syndrome are high in prevalence in an urban Indian middle class population.

The higher prevalence of cardiovascular risk factors in urban areas in India is in contrast to high income countries where the cardiovascular disease risk factors are equal in urban and rural areas (Stuckler, 2008). This is due to advancing disease and epidemiological transition and it is likely that the prevalence of risk factors will change in India with socio-economic development of rural areas. Recent studies in certain states have reported a high prevalence of diabetes and hypertension in some rural locations in south and west India.

The accumulation of risk in later life is especially important, given that, over the past 150 years, life expectancies in most parts of the world have increased dramatically. All indications suggest that this trend will continue through the

21st century, making it likely that most babies born in countries with long life expectancies since 2000 will live to see their 100th birthday (Christensen *et al.*, 2009). Studies of non-agenarians, centenarians and super-centenarians (individuals aged 110 to 119 years) reveal that it is possible to live independently and without significant assistance into the 10th and 11th decades of life; however, minimizing the accumulation of risks throughout the life course through health promotion is critical to this postponement of disability.

This rise in the elderly population is not only occurring in developed countries. Demographers predict that by 2020, 70 per cent of the world's elderly population will be living in developing countries. As more and more people live into old age, an emphasis on delaying the onset of disability due to chronic diseases becomes increasingly important. Research has found that cardiovascular disease is the second leading cause of disability among Americans aged 65 years and older and that even sub-clinical cardiovascular disease can significantly increase frailty, hospitalizations and institutionalizations. However, research also indicates that on-going risk factor-reduction efforts, particularly the promotion of increasing levels of physical activity, can significantly reduce disability and help to prevent adverse cardiovascular outcomes among the elderly (Rich and Mensah, 2010).

The body of evidence suggests that smoking, blood lipids and blood pressure were the three most important risk factors in reducing coronary heart disease mortality and incidence in developed countries, although the numbers from each study differ. In various studies, cholesterol reductions were responsible for between 0.4 and 50 per cent of the reductions and population-level blood pressure reductions were responsible for between 6 and 21 per cent of the reductions (Ford *et al.*, 2007). Smoking reduction alone was responsible for between 6 and 56 per cent of the reductions in various studies.

Proximal risks for cardiovascular disease include those associated with consumption patterns (mainly linked to diets, tobacco and alcohol use), activity patterns and health service use as well as biological risk factors such as increased cholesterol, blood pressure, blood glucose and clinical disease. The Framingham

Study first centred attention on the concept of “risk factors” associated with cardiovascular disease and most recently reported substantial 30-year risk data showing the accumulation of risk over time (Pencina *et al.*, 2009). Importantly, risk factors for the incidence of cardiovascular disease and those associated with cardiovascular disease severity or mortality are not synonymous. Risk factors for incidence become important starting very early in life and accumulate with behavioural, social and economic factors over the life course in biological risks for cardiovascular disease such as increased cholesterol, blood pressure, blood glucose and clinical disease.

The Indian Heart Watch (IHW) study took place over a five-year period (2006–2010) and involved 6,000 men and women from 11 cities across various regions of India. The study assessed the prevalence of different “lifestyle” and biological cardiovascular disease risk factors across the country and results show that these risk factors are now at higher levels in India than in developed countries and regions such as USA and Western Europe. The prevalence of biological and metabolic risk factors was found to be high. Overweight and obesity was reported in 41 per cent of men and 45 per cent of women. High blood pressure was reported in 33 per cent of men and 30 per cent of women, while high cholesterol was found in one-quarter of all men and women. Diabetes (and or metabolic syndrome) was also reported in 34 per cent of men and 37 per cent of women. According to the IHW, urban social development is also playing a role in the development of cardiovascular disease risk factors. Risk factors such as smoking, high fat intake and low fruit/vegetable intake were shown to be more common in less developed cities, while physical inactivity was seen to be more prevalent in highly-developed cities. Accordingly, metabolic risk factors such as obesity, high blood pressure and high cholesterol were seen to be more prevalent in more highly developed cities (Deedwania and Gupta, 2012).

These declines came about when government, health professionals, farmers, food companies, and local non-Governmental organizations invested decades of sustained work implementing efforts to support a more healthful diet (reducing saturated fat and sodium consumption, increasing fruit and vegetable

consumption), reduce smoking prevalence and promote the use of risk factor-reducing medications were indicated. As a result of these comprehensive efforts to reduce cardiovascular disease risk between 1972 and 2007, serum cholesterol declined 21 per cent among men and 23 per cent among women, systolic blood pressure declined by 10.1 mmHg in men and 18.6 mmHg in women and male smoking prevalence declined from 52 to 31 per cent in the North Karelia Province (Puska *et al.*, 2009). These results have implications as a potential model for intervention.

Smoking kills thousands of people every year. Over 400,000 people die from cigarette related illnesses every year. Smoking affects almost every part of the body. It affects lungs, heart and brain and can even affect important numbers such as cholesterol levels. In fact, smoking related cholesterol issues cause approximately 20 per cent of smoking related deaths. Fifty per cent of smoking related deaths are due to heart related diseases which are also related to cholesterol levels (AHA, 2011). Smoking affects the cholesterol levels by dramatically increasing the bad cholesterol (LDL) and decreasing the good cholesterol (HDL). It also increases the triglyceride (fatty lipids) levels in the blood stream. This is largely due to the chemical properties of the ingredients in cigarettes, most notably nicotine.

Smoking is estimated to cause nearly 10 per cent of cardiovascular disease and is the second leading cause of cardiovascular disease after high blood pressure. The impact of tobacco smoke is not confined solely to smokers. Nearly 6 million people die from tobacco use or exposure to second-hand smoke, accounting for 6 per cent of female and 12 per cent of male deaths worldwide, every year. By 2030 tobacco-related deaths are projected to increase to more than 8 million deaths a year (Mendis *et al.*, 2011).

Smoking is a major risk factor for atherosclerotic cerebro and cardiovascular diseases. Smoking affects the blood lipid profile: serum HDL and LDL cholesterol concentrations have been reported to be lower and higher respectively in smokers than in non-smokers. Thus, smoking may exert its atherogenic effects through blood lipid levels.

Cigarette smokers have a higher risk of developing several chronic disorders. These include several types of cancer, chronic obstructive pulmonary disease and atherosclerosis which are chief contributor to the high number of deaths from smoking. Cigarette smoking potentiates the harmful effects of total cholesterol and reduces the cardio-protective properties of high density lipoprotein cholesterol (HDL-C), increasing the risk of coronary heart disease. Decreased serum HDL-C is one of the most common lipid disorders in patients with coronary heart disease. Existing evidence suggests that every 1 mg/dl decrease in serum HDL-C increases the risk of coronary heart disease by 2-3 per cent. HDL-C levels are known to be lower in smokers than in non-smokers. Smoking whether light or heavy equally affect HDL-C level by decreasing its concentration in the serum and hence increase the risk of coronary heart disease (Haydar, 2010).

The causal associations between cigarette smoking and human diseases are irrefutable. Prasad *et al.*, (2009), focused on the epidemiological pattern of cigarette smoking on cardiovascular risk, the underlying mechanistic process of such a causal link, how to prevent premature cardiovascular morbidity and mortality particularly through smoking cessation and the health benefits of such cessation measures. Smoking has been estimated to cause about 11 per cent of all deaths due to cardiovascular disease. It contributes to the pathogenesis of coronary artery disease and sudden death through a variety of mechanisms, including the promotion of atherosclerosis, the triggering of coronary thrombosis, coronary artery spasm and cardiac arrhythmias and through reduced capacity of the blood to deliver oxygen. Smoking cessation also confers substantial benefits on people with serious heart disease. It should be viewed as therapeutic rather than preventive intervention, similar to treating asymptomatic hypertension. Smoking cessation is highly cost-effective relative to other frequently used medical and surgical interventions. Tobacco related illnesses are important public health issues worldwide. It has been estimated that there are 1.1 billion smokers worldwide and 250 million of them live in India.

The mechanisms by which cigarette smoke causes cardiovascular disease are multiple and are synergistic. They include thrombosis, endothelial dysfunction,

atherosclerosis and hemodynamic effects. In addition, tobacco smoke may also cause insulin resistance, a risk factor for diabetes and cardiovascular disease. The same mechanisms responsible for cardiovascular disease in active smokers are nearly as large in passive smokers. Many of these effects occur immediately after a smoker or non-smoker inhales cigarette smoke (Flouris *et al.*, 2010). Smokers also have a higher risk of recurrent ischemia after coronary artery bypass graft surgery and of re-occlusion after an acute myocardial infarction.

Nicotine is a powerful pharmacologic agent with a wide variety of stimulant and depressant effects involving the central and peripheral nervous, cardiovascular, endocrine and other systems. These effects contribute to nicotine's addictive properties.

Tobacco use is responsible for 10 per cent of all global deaths from cardiovascular diseases (WHO, 2012). The percentage of smoking related deaths attributable to cardiovascular disease varies by region and gender. In the year 2004, 15 per cent of cardiovascular deaths were attributable to tobacco in Europe, 9 per cent were attributable to tobacco in South-East Asia and 6 per cent were attributable to tobacco in the Western Pacific. Differences in smoking related deaths attributable to cardiovascular disease are reflective of differences in smoking prevalence rates across countries and by gender. Cardiovascular disease is by far the greatest cause of deaths from secondhand smoke; over 87 per cent of the estimated 430,000 worldwide adult deaths caused by secondhand smoke in 2004 were attributed to be ischaemic heart disease (Oberg *et al.*, 2011).

Tobacco use and secondhand smoke exposure are major causes of cardiovascular disease. Secondhand smoke exposure causes coronary heart disease in adults, increasing the risk of disease by approximately 25–30 per cent (Institute of Medicine, 2010). The implementation of comprehensive smoke-free laws in work and public places reduces the incidence of acute coronary events (Mackay *et al.*, 2010). A review of research studies estimated that implementation of strong smoke-free laws are followed by a 15 per cent reduction in acute myocardial infarctions.

Smokeless tobacco use is increasing in many parts of the world and in some countries (e.g., Bangladesh, India) it is more common than the use of smoked tobacco. The type of smokeless tobacco used and the prevalence of use vary across countries and regions. Examples of smokeless tobacco products include snuff, chewing tobacco and gutkha. Reviews of studies have found associations between smokeless tobacco use and fatal myocardial infarction and stroke (Piano *et al.*, 2010 and Zhang *et al.*, 2010). One study estimated that smokeless tobacco users are 1.13 times more likely than non-users to experience a fatal myocardial infarction and 1.40 times more likely to experience a fatal stroke (Boffetta and Straif, 2009). Measures to reduce smokeless tobacco use should be included in efforts to reduce the effects of tobacco on cardiovascular disease.

India has 285 million smokers and about 138 million don't know that smoking can cause stroke (cerebrovascular accident). As many as 92 million aren't aware that tobacco causes heart disease. According to a report released by the World Heart Federation (WHF) (Kounteya, 2012), half of all Chinese smokers and one-third of Indian smokers are unaware of the risks tobacco pose to the heart. There is even lesser awareness about the dangers of secondhand smoke. According to WHF, cardiovascular disease kills 17.3 million people every year. Around 80 per cent of these deaths occur in low and middle-income countries like India, which are increasingly being targeted by the tobacco industry.

High blood pressure has consistently been associated with an increased risk of myocardial infarction. This risk is associated with systolic and diastolic hypertension. The control of hypertension with appropriate medication has been shown to reduce the risk of myocardial infarction significantly (National Heart, Lung and Blood Institute, 2009).

Hypertension is another cholesterol related smoking problem. As the cholesterol levels rise, so does the blood pressure. The nicotine in cigarette smoke has a profound effect on the arteries. Since nicotine is a powerful stimulant, it can cause the blood vessels in the body to constrict. Constricted blood vessels mean that the heart has to work twice as hard to pump blood through the artery.

This process causes a significant rise in blood pressure. The decreased blood flow can also cause the cholesterol plaque to rupture within the blood vessel. All of these symptoms lead to the eventual onset of heart disease (Lynne, 2011).

A recent review of the global burden of high blood pressure found that approximately 54 per cent of stroke, 47 per cent of ischemic heart disease, 75 per cent of hypertensive disease and 25 per cent of other cardiovascular diseases were attributable to hypertension. This equates to an annual burden of approximately 7.6 million deaths or 13.5 per cent of the total number of annual global deaths, attributable to high blood pressure. He also found that more than 80 per cent of the attributable burden of hypertension in 2001 occurred in low and middle income countries and both another recent review and an analysis commissioned for this report found the prevalence of hypertension to be equally high in developed and developing countries (Gaziano and Kim, 2009).

Among the major underlying risks for hypertension are sodium, body weight and access to treatment (Reuser *et al.*, 2009 and Yang *et al.*, 2008). Primary prevention focused on sodium reduction, fruit and vegetable intake, weight control and avoidance of excessive alcohol intake has been shown to make a difference. Finland's experience has potential applications for low and middle income countries where treatment levels remain extremely low and health systems have yet to adapt to managing chronic diseases like hypertension.

In 2008, age-standardized mean total cholesterol worldwide was 4.64 mmol/l for men and 4.76 mmol/l for women (Farzadfar *et al.*, 2011). The global prevalence of raised total cholesterol in 2008 was 38 per cent. In high-income countries, more than 50 per cent of adults had raised total cholesterol and more than double the level in low-income countries. Further it was reported that in lower-middle-income countries around a third of adults had raised total cholesterol whereas in low-income countries around a quarter of adults had raised total cholesterol level. In the three decades from 1980-2008 global mean total cholesterol levels changed very little, although the prevalence of raised total cholesterol declined in all country income groups except lower-middle-income.

Kurth *et al.*, (2007) evaluated the association between total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), total cholesterol to HDL-C ratio and non-HDL-C with the risk of ischaemic stroke in a large cohort of apparently healthy women. In this cohort study 27,937 US women aged ≥ 45 years participated in the Women's Health Study who provided baseline blood samples. Stroke occurrence was self-reported and confirmed by medical record review and was carried out for 11 years of follow-up. All lipid levels were strongly associated with increased risk of ischaemic stroke in age-adjusted models. The association attenuated particularly for HDL-C after adjustment for potential confounders. In this large cohort of apparently healthy women, total cholesterol, low-density lipoprotein cholesterol, the total cholesterol to high-density lipoprotein cholesterol ratio and non-high-density lipoprotein cholesterol were significantly associated with increased risk of ischaemic stroke.

Sinha *et al.*, (2012) in his randomised observational study in north India on 435 patients of which 218 were in the 'Young Group' (YG) who are ≤ 45 years of age and 235 were in the 'Not So Young Group' (NSYG) who's age is ≥ 55 years. They concluded that dyslipidaemia was more common in YG as evident by significantly higher levels of total cholesterol, triglycerides, low- and very low-density lipoprotein cholesterol as compared to NSYG. Diabetes, hypertension, urban lifestyle and family history of CAD were found to be important determinants of dyslipidaemia in YG.

Low density lipoprotein cholesterol which is known to cause plaque formation in arterial blood vessels is a major contributing factor for hypertension. The prevalence of dyslipidaemia among males between 31 and 40 years was identified early. One such study was carried out in 2006 in Mumbai (Sawant *et al.*, 2008). Close to 9000 members participated in the Health check-up program at P.D. Hinduja National Hospital and Medical Research Centre, Mumbai, India. Researchers advocated increased physical activity and adoption of healthy diet besides clinical interventions for proper management of dyslipidaemia.

The increased levels of LDL cholesterol that result from smoking significantly increases the risk of developing atherosclerosis, as reported in the Tobacco

Related Disease Research Program. The increased level of LDL cholesterol begins to build up along the walls of the arteries. This excess buildup is known as plaque and as the plaque buildup grows, arteries harden, restricting blood flow to heart and brain. This process is known as atherosclerosis.

Smoking can cause HDL cholesterol and LDL cholesterol levels to reach levels that increase the risk of significant health problems. According to the American Heart Association, HDL cholesterol levels less than 40 mg for men and 50 mg for women can increase the risk of stroke and heart attack. Having a LDL cholesterol level above 170 mg increases the risk of developing heart disease or heart attack (American Heart Association, 2010).

Worldwide, obesity trends are causing serious public health concern and in many countries threatening the viability of basic health care delivery. It is an independent risk factor for cardiovascular diseases and significantly increases the risk of morbidity and mortality (Raj and Kumar, 2010).

Obesity is now viewed as a complex disorder and a major risk factor of linked to increase cardiovascular disease, stroke, cancer, hypertension, diabetes and early death (Flegal *et al.*, 2013). More than just a contributing factor, obesity itself increases the risk of heart disease. Those with abdominal obesity are at particularly high risk for cardiovascular disease, diabetes and all-cause mortality (Katzmarzyk *et al.*, 2012).

Cardiovascular disease mortality, especially stroke, is higher in the south-west of the United States (Morbidity Mortality Weekly Report, 2011) associated with a greater prevalence of abnormal lifestyles, obesity and hypertension. In China, cardiovascular disease, especially stroke mortality, is greater in the north-east and this is due to a greater prevalence of obesity and hypertension.

Another troubling gender difference is the increased prevalence of obesity among women. WHO data indicate that although overweight (BMI ≥ 25 kg/m²) is more common among men globally; obesity (BMI ≥ 30 kg/m²) is more common

among women. This trend of increased obesity prevalence among women is consistent around the world, including in Sub-Saharan Africa (Steyn *et al.*, 2006 and Barnighausen *et al.*, 2008), but it is particularly striking in a number of Middle Eastern countries where prevalence among women is more than 40 per cent (WHOSIS, 2009). The trend is of particular concern in part because of the close association between obesity and diabetes.

Obesity recently beat out smoking as the “greatest modifiable risk factor” affecting how long and how well people live. Smoking has long been known as the number one cause of cardiovascular disease, lung cancer, emphysema and variety of other health challenges (Ivan Berkowitz and Winnipeg, 2010).

There is strong correlation among hypertension, obesity and hyperlipidemia which are important risk factor for the cardiovascular disease. Ahmed *et al.*, (2009) conducted a cross-sectional study at medical out-patient Department at Shahina Jamil Teaching Hospital, Abbottabad, revealed that eighty-six patients with mean age of 53.7 ± 12.9 years were included and divided into younger age group (age <46 years) and older age group (age ≥ 46 years) with a mean BMI of 29.7 ± 5.2 and 26.9 ± 4.7 respectively. The mean serum cholesterol levels was 192.2 ± 14.2 mg/dl and 190.9 ± 18.3 mg/dl respectively and mean serum triglyceride level was 170.5 ± 13.7 mg/dl and 166.6 ± 21.4 mg/dl in younger age group and older age group. Overweight and obese patients were 70.9 per cent with its higher prevalence in younger (86.2 per cent) as compared to older patients (63.2 per cent). Hypercholesterolemia was found in 27.9 per cent of the patients, with a frequency of 24.1 per cent in younger patients and 29.8 per cent in the older patients. Hypertriglyceridemia was seen in 66.3 per cent of the patients, with a frequency of 69 per cent in younger patients and 64.9 per cent in the older patients. They conclude that hypercholesterolemia and hypertriglyceridemia are not associated with the age of the hypertensive patients. Increased BMI is more frequent in the young as compared to the old hypertensive patients.

A high sodium intake, especially when combined with a low potassium intake, is associated with significantly increased risk of cardiovascular disease and

all-cause mortality in the general US population, according to a report in the July 11 issue of *Archives of Internal Medicine* (Yang *et al.*, 2011).

Pasquale *et al.*, (2009), performed a systematic review and meta-analysis of prospective studies of habitual dietary salt intake and incidence of stroke and total cardiovascular disease published between 1966 – 2008 revealed that among the 19 independent cohort samples from 13 studies, with 177025 participants (follow-up 3.5-19 years) and 11000 vascular events, higher salt intake was associated with significantly greater risk of stroke and total cardiovascular disease.

Research showed that some forms of margarine-specifically the hard stick margarines-were worse for the heart than butter. This was because they contained large amounts of trans-fats from partially hydrogenated oils. The Nurses' Health Study found that women who ate four teaspoons of stick margarine a day had a 50 per cent greater risk of heart disease than women who ate margarine only rarely (Shai *et al.*, 2008).

One interesting observation is that the exercise lowers plasma cholesterol in general. Inactivity is one of the four major risk factors for coronary artery disease, equally with smoking, unhealthy cholesterol and high blood pressure. Study the effect of physical activity on HDL-C and body mass index among Saudis men and women, reported significant increase in plasma HDL-C levels and moderate reduction in BMI. Common genetic variants that are linked with HDL-C levels are modified by physical activity level; according to the results of a new study (Ahmad *et al.*, 2011). It was hypothesized that smoking status and cholesterol levels would be associated with both early and more advanced atherosclerotic cardiovascular disease, whereas physical activity may improve lipid profile and lowering risk of developing heart disease.

The major risk factors are improper diet, physical activity and smoking. It showed that 55 per cent of deaths are due to non-communicable diseases and this proportion is >60 per cent in middle-aged individuals 25-69 years and >70 per cent among the subjects living in urban locations (Gupta *et al.*, 2012).

An emerging body of evidence suggests that rapid dietary changes associated with nutritional transition, along with a decrease in levels of physical activity in many rapidly urbanizing societies, also play a particularly important role in the rise of cardiovascular disease observed in developing countries. The nutritional transition currently occurring in many low and middle income countries has created a new phenomenon in which it is not uncommon to see both under-nutrition and obesity co-exist in the same populations (Dangour and Uauy, 2006).

Research has shown that women experience poorer outcomes when they have a cardiovascular disease event. Studies in North America and Western Europe have found that women delay longer before seeking medical treatment at the onset of symptoms, wait longer to receive life-saving cardiac interventions and have poorer outcomes following myocardial infarction or stroke (Pilote *et al.*, 2007). Indeed, after a stroke or myocardial infarction, women tend to have longer hospital stays, increased prevalence of depression and anxiety, higher short-term mortality, greater long-term disability and higher rates of reinfarction than men (Reeves *et al.*, 2008).

In addition to traditional cardiovascular disease risk factors, there are also several situations unique to women that can place them at increased cardiovascular disease risk. During pregnancy and the post-partum period, women are at an increased risk of stroke. Indeed, some researchers have found that women in their childbearing years (aged 15–35 years), a stressful period having a higher incidence of stroke than men of the same age. Furthermore, preeclampsia and eclampsia increase this risk of hypertension later in life (Jamieson and Skliut, 2009).

Although there are large regional variations in the prevalence of diabetes Anjana *et al.*, (2011) reported that it has more than quadrupled in the last 20 years from <1-3 per cent to 10-15 per cent in urban areas and 3-5 per cent in rural areas. Diabetes is currently more common in men than women; however, its prevalence is increasing in both sexes and it appears to be a much stronger risk factor for cardiovascular disease in women (Jackson, 2008). Indeed, the presence of

diabetes appears to eliminate any premenopausal protection associated with female gender. The reason most often cited for these gender differences is a protective effect of estrogen on the development of cardiovascular disease risk factors, most notably hypertension and dyslipidemia. Estrogen is thought to contribute to premenopausal women's tendency to have lower systolic blood pressure, higher levels of HDL cholesterol and lower triglyceride levels than men. The specific mechanisms of this protection have not been fully elucidated; however, estrogen is known to affect the atherosclerotic and blood-lipid control process in a number of different ways.

Chronic non-communicable diseases are the greatest world public health challenge of the 21st century (WHO, 2011). The deaths due to non-communicable diseases are approximately 36 million in 2008, of which more than half were due to diabetes and cardiovascular diseases and mostly occurring in developing countries (Alwan *et al.*, 2010).

Setia *et al.*, (2012) by shifting focus on families rather than individuals, have acknowledged the importance of diagnosing familial hypercholesterolemia and its early identification. Whole family focus could result in better health outcomes, specifically life expectancy. Researchers suggest the use of DNA testing and cholesterol assay to achieve required results.

D. Management of hyperlipidemia and cardiovascular disorder

A continuing understanding of how trends in cardiovascular disease change over time is important, as knowledge evolves about the underlying causes of hyperlipidemia and cardiovascular disease and their relative impact. The empirical base for understanding the specific reasons for changes in lipid profile and cardiovascular disease trends over time comes from two different sets of observations and studies. First, there are those that investigate the causes for the increases in cardiovascular disease death and incidence rates being experienced in many developing countries. Second, there are others that have analysed the reasons for the substantive decline experienced in developed countries over the past few decades. The data indicate that poor diet, tobacco use, physical inactivity,

excess fat and alcohol use and psychosocial factors are the major contributors to hyperlipidemia and cardiovascular disease increases (Clarke *et al.*, 2009 and Mayosi *et al.*, 2009).

a. Dietary management

"Dietary changes have powerful effects on cholesterol levels." That's true even if they don't lose weight or exercise more, although it's better to do those things as well. Reducing the amount of unhealthy fats in the diet is a way to lower cholesterol. But it's not all about subtraction. Adding foods to the diet such as oatmeal and nuts as well as olive oil, fatty fish and foods fortified with sterols and stanols can help lower unhealthy LDL levels and triglycerides.

The relationship between hyperlipidemia and cardiovascular disease and diet is one of the most studied relationships in epidemiology. Several key relationships identified decades ago remain valid, while others have evolved in the light of better-quality research. Current evidence does not support the use of general terms like "lipids" or "fats" without qualifying their type and considering the amount used in the diet. Although nutritional research has traditionally focused on the effect of individual food groups or nutrients on cardiovascular disease, there has been a shift in recent years toward comparing how different types of dietary patterns in their entire effect of cardiovascular disease risk (Fuster and Kelly, 2010).

The effect on cardiovascular disease risk of diets rich in whole grains and low in processed foods that are high in fat, sodium and sugars has been increasingly investigated in both developed and developing countries. In parallel with economic development, radical dietary shifts toward Westernized diets that are high in animal products and refined carbohydrates and low in whole grains and other plant-based foods have occurred in many developing countries (Hu, 2008).

Vrablik *et al.*, (2009) stated that there are three levels of evidence documenting the impact of fish omega-3 fatty acids on cardiovascular disease risk. Epidemiological data have shown unequivocally the increased intake of fish is

associated with lower cardiovascular disease morbidity and mortality. Numerous experimental studies have shown (almost always) positive effects of omega-3 fatty acids on lipoprotein metabolism, coagulation and platelet function, endothelial function, arterial stiffness etc. Most importantly, there are a few prospective clinical endpoint trials (DART, JELIS, GISSI Prevenzione and GISSI-HF) that have examined the impact of omega-3 fatty acids supplementation on cardiovascular outcomes in different patient populations.

The adverse effect of omega-3 fatty acids may be mediated mostly by DHA as EPA in moderate dose produced 10 per cent LDL lowering in the JELIS trial. The effects on plasma lipids start to occur at daily doses of EPA and DHA of 2 to 4 g. Very importantly omega-3 fatty acids have synergistic and additive effects on plasma lipids when co-administered with statins. Another practical implication of such studies is the proven safety of omega-3 fatty acids add on therapy to statins (Yokoyama *et al.*, 2007).

National Heart Foundation of Australia (2009) advised patients with elevated TG to take fish oil capsules/liquid and marine n-3 PUFA enriched food and drink by starting with a dose of 1200 mg per day of EPA and DHA. If appropriate, titrate the dose up to 4000 mg per day of EPA and DHA.

A steaming bowl of fresh cooked oatmeal is the perfect way to start off the day, especially trying to prevent or are currently dealing with heart disease or diabetes. Oats, oat bran and oatmeal contain a specific type of fiber known as *beta-glucan*. Since 1963, study after study has proven the beneficial effects of this special fiber on cholesterol levels. Studies show that in individuals with high cholesterol (above 220 mg/dl), consuming just 3 grams of soluble oat fiber per day (an amount found in one bowl of oatmeal) typically lowers total cholesterol by 8-23 per cent. This is highly significant since each 1 per cent drop in serum cholesterol translates to a 2 per cent decrease in the risk of developing heart disease. (WH Foods: Oats, 2012)

A study published in the *Archives of Internal Medicine* confirms that eating high fiber foods, such as oats, helps prevent heart disease. Almost 10,000

American adults participated in this study and were followed for 19 years. People eating the most fiber, 21 grams per day had 12 per cent less coronary heart disease and 11 per cent less cardiovascular disease compared to those eating the least, 5 grams daily. Those eating the most water-soluble dietary fiber fared even better with a 15 per cent reduction in risk of CHD and a 10 per cent risk reduction in cardiovascular disease (Djoussé and Gaziano, 2007).

National Heart Foundation of Australia (2009) recommended to replace saturated fatty acids with monounsaturated fatty acids and polyunsaturated fatty acids, consumption of 2–3 g of phytosterols per day from margarine, breakfast cereal, reduced fat yoghurt or reduced fat milk enriched with phytosterols (approximately 2–3 serves per day of these enriched foods) helps in the reduction of coronary heart disease. It also advised 1 g of combined EPA and DHA per day through a combination of oily fish (2–3 150 g serves per week), fish oil capsules or liquid and food and drinks enriched with marine n-3 polyunsaturated fatty acids (PUFA), >2 g ALA per day by including canola or soybean-based oils and margarine spreads, seeds (especially linseeds), nuts (particularly walnuts), legumes (including soybeans), eggs and green leafy vegetables to adopt a healthy eating pattern among the individuals.

The exponential growth in the use of tropical oils (specifically palm oil) and partially hydrogenated soybean oil in low and middle income countries is troubling because both these oils contain high levels of fatty acids that are atherogenic and linked to an increased risk of myocardial infarction. Palm oil has a saturated fatty acid content of 45 per cent, and partially hydrogenated soybean oil, although much lower in saturated fat, contains trans-fatty acids introduced as a by-product of hydrogenation (Khan and Mensah, 2009).

In the INTERHEART study, three major dietary patterns were identified: Oriental (high intake of tofu and soy); Western (high in fried foods, salty snacks, eggs, and meat); and prudent (high in fruits and vegetables). The Western dietary pattern was associated with an increased risk of coronary heart disease in all

regions of the world, whereas the prudent pattern was associated with a lower risk (Iqbal *et al.*, 2008).

Substantial evidence has accumulated to support the notion that the traditional Mediterranean dietary pattern is protective against cardiovascular disease (Fung *et al.*, 2009 and Martinez-Gonzalez *et al.*, 2009). This pattern is characterized by an abundance of fruits, vegetables, whole grain cereals, nuts and legumes; olive oil as the principal source of fat; moderate consumption of fish; lower consumption of red meat and moderate consumption of alcohol. It is important to note, however, that the dominance in research on the Mediterranean diet has come at the cost of research on other diets commonly consumed around the world that may also have heart health benefits.

Tuna, salmon, trout, sardines, herring and other fatty fish don't seem to have an impact on bad LDL cholesterol. They do lower triglycerides, another form of fat in the blood that's measured by cholesterol tests by 20 to 50 per cent. They also seem to boost good HDL cholesterol slightly and lower the risk of heart disease.

Many nuts such as almonds, walnuts, hazelnuts, pecans and pistachios seem to help lower triglycerides. Like fatty fish, they contain substances that are converted to the omega-3 fatty acids known as EPA and DHA. They're also a source of fiber. According to the FDA, eating 1.5 ounces of nuts daily is associated with a lower risk of heart disease. Nuts are a great snack or topping for salads, cereal and yogurt. Stick to a handful because they are high in calories (Brunilda, 2010).

Substantial evidence shows that the soluble fiber in oatmeal and oat bran helps lower cholesterol levels. Although any whole grain is good for cholesterol, oats have the highest levels of soluble fiber. One cup of oatmeal typically contains four grams of fiber about 15 per cent of the fiber most women need and 10 per cent of the fiber most men need. Consider a bowl of oatmeal for breakfast and then sprinkle oatmeal onto other foods throughout the day.

Olive oil which is high in monounsaturated fat seems to help lower bad LDL cholesterol levels without affecting good HDL cholesterol. Diets rich in olive oil, fruits, vegetables, beans and whole grains are associated with lower risks of heart disease and stroke. Olive oil is also rich in healthy vitamin-E, an antioxidant. Other healthy oils include canola and flaxseed. The key is not just to add olive oil to the diet. But need to use it instead of less healthy oils higher in saturated and unsaturated fat. The FDA recommends using two tablespoons daily as a replacement for less healthy oils (Miller, 2010).

A 2010 study modelling a 3 g reduction in salt intake across the population of USA estimated an annual reduction in myocardial infarction by 54 000 - 99 000, stroke by 32 000–66 000 and overall mortality by 44 000–92 000 (Domingo *et al.*, 2010).

b. Lifestyle – alcohol, smoking, tobacco

As emphasized before, making lifestyle changes that improve the risk factors is one important part of management. Eating well, getting regular physical activity and maintaining a healthy weight will help to lessen the severity of the condition. If smoking, they need to quit. Reducing stress and limiting alcohol use can also improve the heart health. People with diabetes along with CVD risk needs extra care to manage it.

Tobacco use has been the most reliably documented and historical trends in cardiovascular disease mortality and tobacco use in the United States from 1900 to 1990 closely mirror each other, with both rates increasing through the 1950s, followed by a precipitous fall beginning in the 1960s. In the United Kingdom, a 38-year follow-up of men showed that baseline differences in tobacco use, high blood pressure and cholesterol were associated with a 10 to 15year shorter life expectancy from age 50 (Clarke *et al.*, 2009). The study has significance for developing countries since many of the baseline levels of risk common in the late 1960s in the United Kingdom are the norm in many developing countries today.

Another likely contributor is a rise in smoking. There has been a steady rise in global cigarette consumption since the 1970s, which is expected to continue over

the next decade if current trends continue. In 2010, researchers estimate that 6.3 trillion cigarettes or more than 900 cigarettes for every person on the earth will be consumed. This increase in the total number of smokers around the world is driven predominantly by global population growth and is expected to continue unless smoking rates are drastically reduced. By 2020, if current smoking and population growth trends continue, the global annual cigarette consumption could rise to between 6.7 and 6.8 trillion cigarettes (Shafey *et al.*, 2009). This growing burden of tobacco is increasingly falling on low and middle income countries. In fact, three of the top five cigarette consuming countries are low or middle income countries (China, the Russian Federation and Indonesia). China alone consumes approximately 2.163 trillion cigarettes every year i.e., 37 per cent of the world's annual consumption.

By 2030, WHO projects that more than 80 per cent of tobacco-related deaths will occur in developing countries (WHO, 2008c). In addition to increasing consumption trends, the amount of tobacco produced globally has nearly doubled since 1960, with production increasing more than 300 per cent in low and middle income countries, where by 2007, approximately 85 per cent of tobacco was grown.

In addition as tobacco use has declined in rich countries, transnational tobacco companies have increasingly focused on expanding markets for their products in low and middle income countries (Bump *et al.*, 2009).

Although rates of smoking, dyslipidemia and hypertension are generally lower among women than men, women tend to have less favourable profiles for other key cardiovascular disease risk factors. Worldwide, women are more likely to be sedentary than men (Guthold *et al.*, 2008). Some researchers have suggested that women's subservient social status in many cultures and their lack of leisure time due to childcare and other familial responsibilities likely contribute to their lower levels of physical activity.

It has long been known that excessive alcohol intake is associated with increased risk for hypertension, stroke, coronary artery disease and other forms of

cardiovascular disease; however, there is also a robust body of evidence in a range of populations that suggests that light to moderate intake of alcohol may reduce the risk of coronary heart disease. Indeed, research suggests that the relationship between alcohol intake and cardiovascular disease outcomes follows a “J” curve, with the lowest rates being associated with low to moderate intakes of alcohol (Beilin and Puddey, 2006). It is important to recognize that, as with any discussion of alcohol and health, the key issues are the quantity of alcohol consumed and the risk or benefit conferred by consumption. Although evidence indicates that low to moderate alcohol use can reduce the risk of coronary heart disease, excessive and harmful use clearly increases cardiovascular disease risk.

Alcohol may also contribute to overweight and obesity as it is a significant source of daily calories in many countries. It is also important to consider the demonstrated negative health effects of excessive and harmful alcohol use on other diseases such as neuropsychiatric disorders, cirrhosis of the liver and various cancers. Taking into account these factors, it is important that approaches to reduce the burden of cardiovascular disease not neglect the importance of reducing excessive alcohol consumption. World health organization has proposed interventions for alcohol that are being considered in developing a global strategy for alcohol control. These include pricing policies, restricting the sale of alcohol, drunk-driving counter measures, restrictions on marketing, awareness and education and effective treatment (WHO, 2009d).

Quitting smoking reduces smokers’ risk of myocardial infarction and stroke (U.S. Department of Health and Human Services, 2010). In patients with coronary heart disease who smoke, quitting smoking has been found to reduce the risk of mortality by approximately 36 per cent and the risk of a non-fatal myocardial infarction by 32 per cent. The risk of stroke for smokers is approximately 1.5 times higher than non-smokers; smokers’ risk of stroke has been found to reach non-smokers’ level of risk approximately 5 years after quitting.

Tobacco control policies are extremely cost-effective for preventing deaths from non-communicable diseases, including hyperlipidemia and cardiovascular

disease. A recent report on cost-effective measures for reducing non-communicable diseases identified four very cost-effective policies to reduce the burden of tobacco on health at the population level (World Economic Forum, 2011). These four keys to cost-effective policies include –

- Tax increases on tobacco products,
- Smoke-free indoor workplaces and public places,
- Health information and warnings about tobacco and
- Bans on tobacco advertising and promotion.

Although these four measures are cost-effective, tax increases on tobacco products have been consistently identified as the most cost-effective policy to reduce tobacco use because it leads to increases in revenue at the same time as it lowers consumption and prevalence. In a recent WHO analysis of the cost-effectiveness of measures that could be used to reduce non-communicable diseases, offering counselling to smokers was identified as a “quite cost-effective” measure (WHO, 2011).

Warning people about the dangers of tobacco is one of the key measures recommended by the WHO for reducing the demand for tobacco. Additionally, concerns about the health effects of smoking are one of the primary reasons that smokers think about quitting and say they quit (Jiang *et al.*, 2010 and Yang *et al.*, 2010).

To test the impact of smoking on cholesterol levels more vigorously and in a realistic setting, Gepner and his colleagues recruited more than 1,500 smokers representative of the current U.S. population, including its high proportion of overweight and obese individuals. The average participant smoked about 21 cigarettes per day prior to the start of the study. After a year on one of five smoking cessation programs, 334 (36 per cent) had succeeded in quitting. The researchers found that those who stopped smoking experienced an average rise of about 5 per cent, or 2.4 milligrams per decilitre (mg/dl) in HDL cholesterol. Abstainers also experienced an increase in large HDL particles, which are

important for lowering heart disease risk as well and reported in the American Heart Journal (Lynne, 2011).

c. Physical exercise

World Health Organization and FAO highlighted the importance of physical activity as a key determinant of obesity, cardiovascular disease and diabetes. For decades, evidence of the relationship between physical activity and cardiovascular disease, independent of effects on weight and obesity, has strengthened. Increasing physical activity including through brisk walking has been shown to decrease the risk of chronic diseases such as coronary heart disease, stroke, some cancers (e.g., colorectal and breast cancer), Type 2 diabetes, osteoporosis, high blood pressure and high cholesterol (Physical Activity Guidelines Advisory Committee, 2008). Physical activity is also important for weight control and maintenance. In addition, regular physical activity is associated with a decreased risk of depression and improved cognitive function. Moreover, people who are physically active have improved quality of life and reduced risk of premature death. Despite this powerful evidence, measurement weaknesses have contributed to the generally poor quality and availability of data on worldwide physical activity trends and impacts.

Further, adults over 50 years of age were more likely to be inactive than younger adults and city dwellers were more likely to be inactive than those who lived in rural areas. Guthold *et al.*, (2008) found that more than 40 per cent of women in Namibia, Swaziland and South Africa were physically inactive. Despite the heterogeneity of the data, the study indicated that levels of physical inactivity in a number of low and middle income countries and among certain sub-groups, particularly women aged 60–69 years are disconcertingly high.

Few studies have explored the reasons why levels of physical activity are declining in developing countries. Therefore, the recent work by Ng *et al.*, (2009) from China estimate that, between 1991 and 2006, average weekly physical activity among adults fell by 32 per cent. This period was associated with rapid urbanization (especially improved housing and transport infrastructure) and

industrialization leading to profound shifts in how people in China, eat, move and work. Meanwhile, sedentary behaviours such as prolonged television watching have increased dramatically. Many aspects of improving quality of life (such as better educational and sanitation facilities) were strongly associated with declines in physical activity, suggesting that multi-sectoral approaches involving workplace, transit, school and leisure time need to be tackled if the trends are to be reversed. For this to happen, health professionals and policy makers need to fully appreciate the value of physical activity, both as a means to address energy balance and as an important avoidable cause of the global burden of chronic diseases. Currently this is not the case in most countries.

In another study, differences in the response of plasma total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides were investigated in a sample of (902) subjects of whom 412 were current smokers and 490 were following aerobic exercise. In both sexes, the results indicated higher levels of plasma total cholesterol, LDL-C and triglycerides for smokers in comparison to non-smokers, whereas HDL-C follow the negative stepwise correlation with smoking. For all parameters tested, the results showed significant results for the people who smoke more than nine cigarettes a day and slight effect for those who smoke less than ten cigarettes a day and a regular physical activity improved plasma lipid profile (total cholesterol, LDL-C and TG). The above three parameters were reducing proportionally depending deeply upon frequency intensive time (FIT) scoring of physical activity, considerable decrease showed only with the people who followed a regular aerobic exercise, whereas plasma HDL-C levels followed a positive correlation with (FIT) physical activity scoring and showed significant increase only for those who followed an active lifestyle (Babiker and Elsayir, 2012).

Exercise improves bone strength, builds muscles, and it is the best for cardiovascular health, especially in women (Sattelmair *et al.*, 2011). Wen *et al.*, (2011), assessed the health benefits of a range of volumes of physical activity among Taiwan population and categorized into five groups of physical activity: inactive, low, medium, high and very high activity. The individuals when compared

with the inactive group, those in the low-volume activity group, who exercised for an average of 92 min. per week (95 per cent CI 71-112) or 15 min. a day (SD 1·8), had 14 per cent reduced risk of all-cause mortality (0·86, 0·81-0·91) and had a 3 year longer life expectancy. Every additional 15 min. of daily exercise beyond the minimum amount of 15 min. a day further reduced all-cause mortality by 4 per cent (95 per cent CI 2·5-7·0). These benefits were applicable to all age groups and both sexes and to those with cardiovascular disease risks. Individuals who were inactive had 17 per cent (HR 1·17, 95 per cent CI 1·10-1·24) increased risk of mortality compared with individuals in the low-volume group. The study clearly states that the physical activity of 15 min. a day or 90 min. a week of moderate-intensity might be of benefit even for individuals at risk of cardiovascular disease.

Marwaha *et al.*, (2011), observed the effect of sports training on bone mineral density in young Indian healthy females carries the key public health message for the authorities to take note of in preventing escalation of non-communicable disease risk factors in the younger age group in India. Vitamin-D deficiency seems to be universal and outdoor physical activity, in this study, doubles its blood levels.

d. Medical therapy

The causes of the decline in CVD in developed countries offer potential lessons for achieving similar results in developing countries. Taken together, studies examining the causes of the decline in CHD mortality and incidence observed in developed countries since the mid-1960s suggest that risk-factor reductions and treatment each account for between 40 and 60 per cent of the reduction in CVD mortality, with undetermined causes accounting for between zero and 10 per cent of additional reduction.

In one of the study conducted by Davies *et al.*, (2007), in the United Kingdom identified the contribution of improved treatment options in that country to be responsible for 40 per cent of the reduction in mortality, with a concurrent reduction in risk factors accounting for the majority of the decline. In contrast, reports from WHO's Multinational Monitoring of Trends and Determinants in

Cardiovascular Disease study have suggested the role of treatment was significantly higher accounting for the majority of the decline.

In the United States, some studies have attributed a slightly higher percentage to treatment than to risk-factor reductions, although a number of other studies found that risk-factor reduction and treatment strategies contribute evenly (approximately 50 per cent each) to the decline in cardiovascular disease mortality rates (Hardoon *et al.*, 2008). Importantly, with each decade, the relative impact of treatment versus prevention has increased (Ford *et al.*, 2007). This effect could be due to the increasing availability of more effective diagnostics and treatment, higher population uptake of treatment or the relative failure to fully implement effective prevention programs at a population level.

Nicotine replacement therapy can be used safely in smokers with stable cardiovascular disease, but should be used with caution within two weeks of a myocardial infarction and in patients with unstable angina, severe arrhythmias or a recent cerebrovascular event (Zwar *et al.*, 2007).

In all patients who continue to smoke, pharmacotherapy should be offered (National Heart Foundation of Australia, 2010). If pharmacotherapy is used, it is aimed to combine with behavioral and psychosocial support.

Modern medicine is comparatively new in its approach to cardiovascular disease, having built up its understanding over the last 200 years in comparison to Ayurveda, which dates back over 5,000 years. Over the last 2,000 years further medicines have been developed in Ayurveda using herbs, minerals and metals some of which are considered controversial by modern medicine today, although they have a long proven record of success when used by indigenous Ayurvedic practitioners in their place of origin (John, 2007).

In the United States, studies have attributed a slightly higher percentage to treatment than to risk-factor reductions, although a number of other studies found that risk-factor reduction and treatment strategies contribute evenly (approximately 50 per cent each) to the decline in CVD mortality rates (Hardoon *et al.*, 2008).

The use of aspirin has been shown to reduce mortality from myocardial infarction. Aspirin in a dose of 325 mg should be administered immediately on recognition of myocardial infarction signs and symptoms (National Heart, Lung and Blood Institute, 2009 and American Heart Association, 2009). Within minutes, aspirin prevents additional platelet activation and interferes with platelet adhesion and cohesion. This effect benefits all patients with acute coronary syndromes, including those with myocardial infarction. Aspirin alone has one of the greatest impacts on the reduction of myocardial infarction mortality. Its beneficial effect is observed early in therapy and persists for years with continued use. The long-term benefit is sustained, even at doses as low as 75 mg/day.

Chew *et al.*, (2011) recommended a daily dose of 75-150 mg of aspirin to all coronary heart disease patients unless contraindicated. If aspirin is contraindicated clopidogrel is recommended as an alternative. This clopidogrel should be considered in combination with aspirin in patients who have recurrent cardiac ischemic events.

Statins are the lipid lowering drugs with the strongest evidence of benefit but some medications, like ezetimibe, have yet to be shown to improve patient outcomes. Statins reduce risk across the spectrum of LDL values. The first generation drugs reduce risk about 20 per cent and the higher potency and high dose statins reduce it by about another 15 per cent (Harlan and Krumholz, 2012).

In nationwide cohort study by Schjerning *et al.*, (2011) revealed that prescribing NSAIDs (excluding aspirin), should be avoided even for short-term use for patients with a history of coronary heart disease, because of the increased risk of recurrent myocardial infarction and death.

Calcium channel blockers of the non-dihydropyridine group (e.g. diltiazem, verapamil) may be used as anti-anginal agents for patients in whom beta-blocker therapy is contraindicated, provided there is no evidence of coronary heart failure (National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand, 2011).

Controlled-release verapamil has been shown to reduce the incidence of cardiovascular events in patients with stable angina. It may decrease the risk of re-infarction and death after myocardial infarction (Rossi, 2012).

Ezetimibe reduces the concentration of LDL-C by 15–20 per cent as monotherapy or when added to a statin. Long-term safety data is satisfactory (Baigent *et al.*, 2011).

e. Nutraceuticals

The terms nutraceuticals and functional foods have been used to describe extracts and whole foods that have the characteristics of providing protective, preventive and possibly curative effects in the pathogens chronic disease progression. The term “Nutraceuticals” which is combination of nutrition and pharmaceutical originated by Stephen De Felice in 1989 (Sumeet *et al.*, 2010). According to him, nutraceutical can be defined as a food or part of a food that provides medical or health benefits, including the prevention and/or treatment of a disease. While functional food is similar in appearance to conventional foods, is consumed as a part of a normal diet and has demonstrated physiological benefits and/or reduces the risk of chronic disease beyond basic nutritional function, but both nutraceuticals and functional food groups provide benefits beyond what is rendered by their nutrient components.

Nutraceuticals are natural and commonly found in bioactive foods or whole plants to keep energy balance in the body and promise substantial therapeutic value in cardio-protection. Major cardio-protective bioactive foods and nutraceuticals are now part of nutrition supplements at non-prescription counters and their self-prescription is increased at large scale (Rakesh and Ram, 2010).

- Growing use of new bioactive foods and nutraceuticals in cardio-protection and management
- Use of fish oils, nutraceuticals in vegetable fat-free diets and restricted life style to enhance cardio-protection

- Need and benefits of newly introduced bioactive foods and revisits the cardio-protective mechanisms of bioactive foods and nutraceuticals
- Cardio-protective nutraceuticals are polyunsaturated fatty acids, antioxidants, omega-3 fatty acids, vitamins, minerals and dietary fibres

Bioactive foods are designed basically meeting four consumer demands: taste, convenience, simple proposition and price. A successful bioactive food product's bioactive role needs its perceptible health benefit. If a health benefit is clearly understandable or if the health benefit is clearly perceptible - such as weight loss or stress reduction or can be easily measured - such as a product that reduces cholesterol, then the product is much more likely to succeed. Now interest is growing for use of bioactive foods in cardiovascular prevention. Recently JIVA™ a bioactive food made of resveratrol combined with garlic has been advocated as potential cardiovascular prevention formula (Condori *et al.*, 2009).

Nutraceuticals may act as essential nutrient, as drug, as regulatory biochemical metabolite and as phytohormone in the body. Most of the side effects of nutraceuticals remain undocumented and unnoticed. Recently, some prominent evidences are reported in favour of cardiovascular disease inhibitory metabolic activity of nutraceuticals in the human body. Navas *et al.*, (2008) opined that nutraceuticals may act as essential amino acid drug like essential nutrients. For example, tryptophan is needed for protein synthesis at low dose in humans. Juan *et al.*, (2008) reported that the nutraceutical preparations containing phytosterols are effective in lowering LDL cholesterol.

The phytonutrients prevent myocardial cell proliferation and play significant role in the prevention of chronic degenerative diseases. Notable examples are ginseng, spirulina, ginkgo biloba, amino acids, glucosamine, chondroitin and aeglemarmelos. Herbal and medicinal plants have shown significant inhibition of cell inflammation (Hamblin *et al.*, 2007). Phytoestrogens play role in reducing myocardial necrosis. Vitamin-C, vitamin-E, beta-carotene, lycopene (carotenoids), lipoic acid, glutathione (thiols) play role in cardiovascular disease prevention and

inhibition of necrosis; co-enzyme Q-10, super oxide dismutase (enzyme), selenium, copper, manganese, zinc (minerals) act as anti-cardiovascular disease in cardiac cells (Novgorodtseva *et al.*, 2007).

In randomized controlled intervention trials, Singh *et al.*,(2008) administered 400 g/day of fruits, vegetables and nuts (almonds and walnuts) and another 400 g/day of whole grains including legumes in conjunction with 25-50 g/day of mustard oils (ALA 2.9 g/day) in patients with high risk of vascular disease, which showed significant benefit. They also found a beneficial effect of fruit, vegetables, nuts and omega 3 fatty acids (EPA+DHA 1.8 g/day) rich foods to patients on risk of coronary artery disease. A randomized double blind placebo controlled trial on 300 patients after myocardial infarction supplemented with EPA+DHA (3.4-3.5 g/day) or corn oil showed no change. Increased intake of monounsaturated fatty acid and omega 3 fatty acids have been suggested to be protective against diabetes and metabolic syndrome whereas increased consumption of trans-fatty acids, saturated fat and refined starches can predispose cardiovascular disease. India has a rapid economic development causing increased consumption of salt, tobacco, fat, sugar and energy in the last four decades. There is increase in per capita income, gross domestic product, food production and automobile production in the last four decades.

Wheat, rice, millets, barley, oat, buckwheat, corn, sorghum, flaxseed psyllium, brown rice and products are notify the most common cereal based functional foods and nutraceuticals. Chaturvedi and co-workers (2011), identified the nutrients in the cereals have prospective for reducing the risk of coronary heart disease, diabetes, tumour incidence, cancer risk, blood pressure, reduces the rate of cholesterol and fat absorption, delaying gastrointestinal emptying and providing gastrointestinal health. Thus, the regular inclusion of cereals and their processed products can make a payment to health endorsement and disease avoidance.

E. Cardiac-friendly effects of nuts

There is emerging evidence that many kinds of nuts have beneficial effects. Nuts have been shown to have beneficial effects on human health due to the

healthy fat content. Nut consumption has been shown to lower total blood cholesterol as well as LDL-cholesterol and has been associated with decreased risk of cardiovascular disease.

Sabate *et al.*, (2010), pooled individual primary data from 25 nut consumption trials conducted in 7 countries among 583 men and women with normo-lipidemia and hypercholesterolemia who were not taking lipid-lowering medications. With a mean daily consumption of 67 g of nuts, the following estimated mean reductions were achieved in total cholesterol concentration, low-density lipoprotein cholesterol concentration (LDL-C), ratio of LDL-C to HDL-C and ratio of total cholesterol concentration to HDL-C. On the whole nut consumption improves blood lipid levels in a dose-related manner, particularly among subjects with higher LDL-C or with lower BMI.

Kelly and Sabate (2006) concluded that epidemiological investigations have consistently shown that frequent nut consumption reduces coronary heart disease risk. In a summary estimate of four major epidemiological studies, the mean coronary heart disease risk was 37 per cent lower among subjects who consumed four or more servings of nuts a week compared with those who seldom or never ate nuts, with a mean reduction of 8.3 per cent for each incremental serving per week of nuts consumed.

Chiuve *et al.*, (2011), conducted a prospective cohort study among 81,722 US women from the Nurses' Health Study, from June 1984 to June 2010. Lifestyle factors were assessed via questionnaires every 2-4 years. A low-risk lifestyle was defined as not smoking, BMI <25 kg/m², exercise ≥30 minutes/day and top 40 per cent of the Alternate Mediterranean Diet Score, which emphasizes high intake of vegetables, fruits, nuts, legumes, whole grains, fish and moderate intake of alcohol. All these four low-risk lifestyle factors were significantly and independently associated with lower risk of sudden cardiac death and may be an effective strategy for the prevention of sudden cardiac death in the general population.

In a randomized crossover study by Tey *et al.*, (2011), with three phases, 48 mildly hypercholesterolemic participants were asked to consume 30 g of ground, sliced or whole hazelnuts for 4 weeks. There were no significant differences in any outcome variable between the different forms of nuts. However, compared with baseline, mean values at the end of each hazelnut intervention were significantly higher for HDL-C and alpha-tocopherol and significantly lower for TC, LDL-C, TC:HDL-C ratio, apo B100 and apo B100:apo A1 ratio, with no significant difference in body weight. Hazelnuts can therefore be incorporated into the usual diet as a means of reducing cardiovascular disease risk.

“Eat a handful, not a can full!” Increasing nut consumption works best at lowering cholesterol if they are consumed in place of saturated fat in the diet. After combining the results from four major epidemiological trials on nutrition and the risk of heart disease, regular nut consumption reduced the risk by an average of 37 per cent (Sabate and Ang, 2009).

Omega-3 fatty acids are considered essential fatty acids. The most essential omega-3 fatty acids are alpha-linolenic acid or ALA, docosahexaenoic acid or DHA and eicosapentaenoic acid or EPA. They are necessary for human health and are not made in the body and need to get them through food. Omega-3 fatty acids can be found in fish, such as salmon, tuna and halibut, other seafood including algae and krill, some plants and nut oils. Also known as polyunsaturated fatty acids (PUFAs), omega-3 fatty acids play a crucial role in brain function as well as normal growth and development. They have also become popular because they may reduce the risk of heart disease (<http://umm.edu/health/medical/altmed/supplement/omega3-fatty-acids>).

Defilippis *et al.*, (2010) opined that the major dietary sources of omega-3 fatty acids are fish containing eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), as well as nuts, seeds and vegetable oils containing alpha-linolenic acid (ALA). These omega-3 fatty acids, especially those derived from marine sources, may be a useful tool for the primary and secondary prevention of cardiovascular disease. They recommend one serving (200-400 g) of fatty fish two

times per week and a diet that includes foods rich in ALA for the primary prevention of cardiovascular disease and one serving (200-400 g) of fatty fish or a fish oil supplement containing 900 mg of EPA + DHA every day and a diet rich in ALA for patients with known cardiovascular disease or congestive heart failure.

Phytosterols and omega-3 fatty acids are natural compounds with potential cardiovascular benefits. Phytosterols inhibit cholesterol absorption, thereby reducing total and LDL cholesterol. A number of clinical trials have established that the consumption of 1.5–2.0 g/day of phytosterols can result in a 10–15 per cent reduction in LDL cholesterol in as short as a 3-week period in hyperlipidemic populations. On the other hand, omega-3 fatty acid supplementation has been associated with significant hypotriglyceridemic effects with concurrent modifications of other risk factors associated with cardiovascular disease, including platelet function and pro-inflammatory mediators. Recent studies have provided evidence that the combination of phytosterols and omega-3 fatty acids may reduce cardiovascular risk in a complementary and synergistic way (Micallef and Garg, 2009).

Valdivielso *et al.*, (2009), recruited patients with Type 2 diabetes and mixed hyperlipidemia. Fasting lipid profile was taken when patients were treated with diet, diet plus 80 mg of fluvastatin and diet plus fluvastatin 80 mg and 4 g of prescription omega 3 fatty acids. The results show that there are significant reductions in the levels of triglycerides, VLDL and the triglyceride/HDL cholesterol ratio and an increase in HDL cholesterol.

a. Flaxseeds

Flaxseeds are known as *Linum usitatissimum* with its species name meaning “most useful”. That would definitely describe the versatility and nutritional value of this tiny little seed. Flaxseeds are nutritionally unique and offer various health benefits not found across the board within the seeds food group. The nutritional uniqueness of flaxseeds features three nutrient aspects and all three play a key role in the outstanding health benefits of this food. Two of the most popular sources

for omega 3's are found in flaxseed. Flaxseed is regarded as a functional food or nutraceutical because it contains three powerful health components: the omega 3 fatty acid, alpha-linolenic acid (ALA); lignans, a major class of estrogen-like compounds and soluble fiber.

Flax is rich in fat, protein and dietary fibre. The composition of flax can vary with genetics, growing environment, seed processing and method of analysis. The protein content of the seed decreases as the oil content increases. The nutritive value of the flaxseeds is given in Table I.

Flaxseeds are an excellent source of omega 3 essential fatty acids and ALA. They are a very good source of dietary fiber and manganese. They are also a good source of folate and vitamin-B6 as well as the minerals magnesium, phosphorus, and copper. In addition, flax seeds are concentrated in lignan phytonutrients.

The study by the Patade *et al.*, (2008) indicates that Native American postmenopausal women benefit from regular consumption of 30 g of whole ground flaxseed by reducing their risk of cardiovascular disease which lowered total cholesterol and low-density lipoprotein cholesterol by approximately 7 per cent and 10 per cent respectively. However, the levels of high-density lipoprotein and triglyceride remained unaltered. No changes were observed in other clinical and hematological parameters.

A study published in the *Archives of Internal Medicine* confirms that eating high fibre foods, such as flaxseed, helps prevent heart disease. Almost 10,000 American adults participated in this study and were followed for 19 years. People eating the most fibre, 21 g per day had 12 per cent less CHD and 11 per cent less CVD compared to those eating the least 5 g daily. Those eating the most water-soluble fibre fared even better with a 15 per cent reduction in risk of CHD and a 10 per cent risk reduction in CVD. (<http://www.whfoods.com/genpage.php?tname=foodspice&dbid=81>).

a. Almonds

Almonds are one of the most nutritious of all nuts. As more and more consumers become dedicated to healthy lifestyles, experts have found that adding natural foods, such as almonds, to the diet may be the prescription for physical wellness in the 21st century.

It may look like a humble nut, but almonds are an effective weapon in the battle against heart disease (<http://www.nutsforalmonds.com/nutrition.htm>). The facts are in and they're fabulous! This impressive list shows you exactly how many great nutrients almonds have to offer (Table I).

According to a research conducted by Loma Linda School of Public Health people who consume almonds 5 times a week showed a reduction in heart attack risk up to 50 per cent. Almonds are enriched with heart-healthy monounsaturated fats such as palmetoelic and oleic acids. A quarter cup contains almost 18 g of total fat out of which 11 g are the heart healthy monounsaturated ones. Vitamin-E present in almonds acts as an antioxidant and improves heart health. Magnesium contents reduce the risk of heart attacks. Not only the almonds are free of cholesterol they also have a favourable impact on the cholesterol levels in the blood. Research conducted by Spiller, proves that almonds help to reduce the bad cholesterol. A regular consumption of these nuts also increases HDL levels (<http://myhealthlist.net/2013/03/health-benefits-of-almonds/>).

Jalalli *et al.*, (2010) demonstrated that almond supplementation among 30 healthy volunteer men (age 45.57 ± 7.14 years and body mass index 24.29 ± 2.15 kg/m²) with mild hyperlipidemia who received 60 g almond daily for 4 weeks showed significantly decreased low-density lipoprotein cholesterol, total cholesterol (TC) and apo-lipoprotein B100 (apo-B100). They concluded that apart from the lowering effects on serum levels of coronary heart disease lipid risk factors, they may also contribute to a dramatic change in the relation of lipid risk factors and susceptibility of serum lipids to oxidative modification. This may be due to the distribution of different almond phenolic antioxidants in different components of serum including non-lipoprotein molecules such as serum albumin.

The dose-response effects of whole almonds, taken as snacks, were compared with low-saturated fat (<5 per cent energy) whole-wheat muffins (control) in the therapeutic diets of hyperlipidemic subjects (Jenkins *et al.*, 2008). In a randomized crossover study, 27 hyperlipidemic men and women consumed 3 isoenergetic (mean 423 kcal/d or 1770 kJ/d) supplements each for one month. Supplements consisted of full-dose almonds (73 ± 3 g/d), half-dose almonds plus half-dose muffins (half-dose almonds), and full-dose muffins (control) and were assessed at week 0, 2 and 4, found that the mean body weights differed ≤ 300 g between treatments, although the weight loss on the half-dose almond treatment was greater than on the control. At four week, the full-dose almonds reduced serum concentrations of malondialdehyde and creatinine-adjusted urinary isoprostane output compared with the control. Antioxidant activity provides an additional possible mechanism, in addition to lowering cholesterol that may account for the reduction in coronary heart disease risk with nut consumption.

Almonds contain soluble fibre but a larger proportion is insoluble fibre, also linked with CVD protection. For those consuming whole almonds as a snack, the fibrous coat may play a role in nutrient release, satiety and possibly also weight control (Hollis and Mattes, 2007 and Mandalari *et al.*, 2008). Current recommendations are to increase dietary fibre and as nuts rank after cereals in their fibre content, they make a valuable contribution to the diet (USDA, 2007).

The amount of vitamin-E in almonds is higher than other nuts and may potentially contribute to the reduced risk of atherosclerosis development. Studies have also documented elevated levels of vitamin-E and increased total plasma antioxidant capacity following consumption of just one handful of almonds.

b. Walnuts

Walnuts are a delicious way to add extra nutrition, flavour and crunch to a meal. It is no surprise that the regal and delicious walnut comes from an ornamental tree that is highly prized for its beauty. Walnuts not only taste great but are a rich source of heart-healthy monounsaturated fats and an excellent source of those hard to find omega-3 fatty acids.

All types and varieties of walnuts can have unique nutrient composition. Sometimes within a particular type of walnut - for example, English walnut - there is a surprising amount of nutritional variety. The bottom line is to not to get caught up in thinking that one main type of walnut (for example, English versus black) is best, but to take advantage of the nutritional variety offered by walnuts overall (WHFoods: Walnuts, 2012). The nutritive value of the walnuts is given in Table I.

TABLE I NUTRITIVE VALUE OF NUTS PER 100g

Nutrient	Flaxseed*	Almond	Walnut
Energy (kcal)	534	655	687
Carbohydrates (g)	28.88	10.5	11
Fat (g)	42.16	58.9	64.5
Protein (g)	18.29	20.8	15.6
Dietary fibre (g)	27.3	12.2*	6.7*
Sugars (g)	1.6	3.9*	2.6*
Thiamine (mg)	1.6	0.24	0.45
Riboflavin (mg)	0.2	0.57	0.4
Niacin (mg)	3.1	4.4	1.0
Pantothenic acid (mg)	1.0	0.5*	0.6
Vitamin B6 (mg)	0.5	0.1*	0.5*
Vitamin C (mg)	0.6	0	0
Folate(µg)	0	50*	98*
Calcium (mg)	255	230	100
Iron (mg)	5.73	5.09	2.64
Phosphorus (mg)	642	490	380
Magnesium (mg)	392	373	302
Potassium (mg)	813	705*	441*
Zinc (mg)	4.34	3.57	2.32
Sodium (mg)	-	-	2.0*

*USDA SR-21, 2008

Walnuts are unique from other nut family members as walnuts contain high amounts of polyunsaturated fatty acids such as linoleic acid and alpha-linolenic acid. Polyunsaturated fatty acids are thought to decrease serum LDL levels and thus exhibit cardio-protective effects by decreasing risk of atherosclerosis.

Consumption of nuts has been associated with a decreased risk of cardiovascular disease events and death. Walnuts in particular have a unique profile. They are rich in polyunsaturated fatty acids, which may improve blood lipids and other cardiovascular disease risk factors (Banel and Hu, 2009). Thirteen studies representing 365 participants were included in the analysis. Diets lasted 4-24 week with walnuts providing 10-24 per cent of total calories. Overall, high-walnut-enriched diets significantly decreased total and LDL cholesterol for the duration of the short-term trials. Larger and longer-term trials are needed to address the effects of walnut consumption on cardiovascular risk and body weight.

In addition to effects on lipids, certain nuts have other desirable vascular effects. In two diet intervention studies, patients randomized to walnuts had improved endothelial function as measured by brachial artery flow mediated vasodilation. In both of these studies, patients in the intervention group were given 40-65 g of walnuts, which is about 8-13 walnuts per day (Ros *et al.*, 2004, Cortes *et al.*, 2006).

Since nuts are calorie-dense, they should be recommended with specific instruction, especially to overweight and obese patients. In general, it was recommended to consume unroasted, unsalted (plain) raw nuts since the beneficial effects of nuts are likely diluted or counter balanced by roasting in oils, coating with sugars or salting. Eating a small handful of nuts every day is a healthy snack that improves cardiovascular health and can be used to replace less healthy snacks.

Nuts have favourable fatty acid and nutrient profiles, so there is growing interest in evaluating their role in a healthy diet. While fat accounts for 50–75 per cent of the weight of the nuts, the amount of saturated fatty acids is quite low ranging from 4–15 per cent. Among the nuts, walnuts have the highest weight per

cent of PUFA and also the highest per cent 18:2 (n-6) and the highest per cent 18:3 (n-3) was 47, 38 and 9 per cent respectively (USDA, 2011).

When consuming the high-energy dense nuts, there is a satiety effect and low metabolizable energy. In addition, nut consumption increases elevated resting energy expenditure and elicits a thermogenic effect of feeding (Mattes and Dreher, 2010). These mechanisms provide the rationale for the fact that clinical studies showed that nuts are not associated with weight gain (Salas *et al.*, 2008). In fact in a Spanish study those who ate nuts twice a week were 31 per cent less likely to gain weight than those who did not eat any nuts (Bes *et al.*, 2009).

Rajaram *et al.*, (2009), in a randomized crossover feeding trial, conducted the study on 25 normal to mildly hyperlipidemic adults who consumed 3 isoenergetic diets (approximately 30 per cent total fat and <10 per cent saturated fat) for 4 week each: a control diet (no nuts or fish), a walnut diet (42.5 g walnuts/10.1 mJ), or a fish diet (113 g salmon, twice/week). Fasting blood was drawn at baseline and at the end of each diet period and analysed for serum lipids. They observed that serum total cholesterol and LDL cholesterol concentrations in adults who followed the walnut diet were lower than in those who followed the control diet and those who followed the fish diet. So including walnuts and fatty fish in a healthy diet lowered serum cholesterol and triglyceride concentrations respectively, which affects coronary heart disease risk favourably.

Consumption of whole walnuts or their extracted oil can reduce cardiovascular risk through a mechanism other than simply lowering cholesterol, according to a team of Penn State, Tufts University and University of Pennsylvania researchers (Penn state, ScienceDaily, 2013). In a randomized-controlled trial, the researchers gave 15 participants with elevated blood cholesterol one of four treatments – either 85 g of whole walnuts, 6 g of skin and 34 g of defatted nutmeat or 51 g of oil and showed that a one-time consumption of the oil component in walnuts favourably affected vascular health. In addition, consumption of whole walnuts helped HDL - good cholesterol to perform more effectively in transporting and removing excess cholesterol from the body.

Katz *et al.*, (2012), conducted randomized controlled crossover trial to investigate the effects of daily walnut consumption on endothelial function and other biomarkers of cardiac risk in a population of overweight individuals with visceral adiposity. Forty-six overweight adults with elevated waist circumference and one or more additional signs of metabolic syndrome were randomly assigned to two 8-week sequences of walnut-enriched *ad libitum* diet and *ad libitum* diet without walnuts, which were separated by a 4-week washout period. They found significant difference from baseline when subjects consumed a walnut-enriched diet as compared with the control diet. Beneficial trends in systolic blood pressure reduction were also seen. They also concluded that the results provide evidence that walnuts can play a role in protecting against heart disease in at-risk individuals.