Review of Literature

REVIEW OF LITERATURE

II

The literature pertaining to the study on **"Development and Evaluation of Functional Food Mixes on Adults with Cardiovascular Diseases and Impact of Diet Counselling"** has been reviewed under the following headings.

A. Cardiovascular disease

a. Prevalence
   i. Global
   ii. Asia
   iii. India
b. Etiology
   i. Modifiable risk factors
      a. Physical inactivity
      b. Overweight/obesity
      c. Diabetes mellitus
      d. Smoking/alcohol
      e. Dyslipidemia
      f. Metabolic syndrome
   ii. Non modifiable risk factors
      a. Age
      b. Gender
      c. Ethnicity/race
      d. Family history

B. Role of selected functional foods and antioxidants

i. Sprouted green gram
ii. Carrot
iii. Amla
iv. Drumstick leaves
v. Wheat germ
vi. Flax seed

C. Dietary management of cardiovascular disease and

D. Significance of nutrition and diet counselling

A. Cardiovascular disease

Our body is like a clock; if one wheel be amiss, all the rest are disordered, and the whole fabric suffers: with such admirable art and harmony is a man composed.

—Robert Burton

The heart is one of the most vital and complex organs of the human body. Any abnormality in its functioning results in a wide range of associated life threatening disorders. Cardiovascular disease comprises especially the major disorders of the heart and the arterial circulation supplying the heart, brain, and peripheral tissues. Williamson (2010) defines cardiovascular disease as the various conditions that result from the deterioration of the heart and blood vessels. The epidemiology and prevention of these diseases involve the understanding of their causes, identification of the means of prevention, and monitoring of populations to assess the changing burden of these diseases and the measurable impact of interventions to control them.

a. Prevalence

Prevalence is an estimate of how many people have a disease at a given point or period in time. Burden of disease information is an important component of health information required for health planning as it can be used to identify the health gaps in the population that need to be addressed to improve health status (Labarthe, 2010).

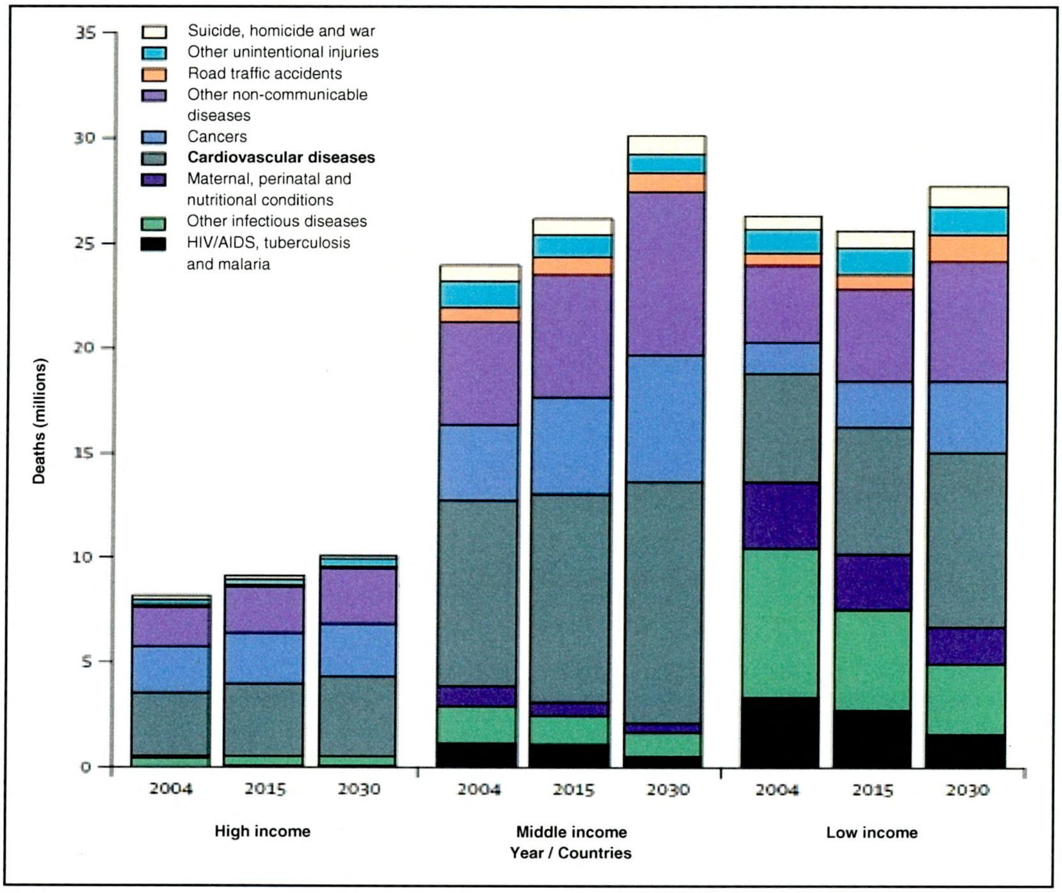
i. Global

Cardiovascular disease is a leading cause of mortality in many countries worldwide and is estimated that it will be the single largest cause of disease burden globally by the year 2020 (WHO, 1999). The American Heart Association (2008) has declared that cardiovascular disease is the leading cause of death and disability in the western world and contributes substantially to healthcare budgets. It has further been stated by World Health Organization (2008) that diabetes and cardiovascular disease together with cancer and chronic respiratory disease as the world's biggest killers, causing an estimated 35 million deaths each year, 80 per cent of which are in low and middle income countries.

Once considered a problem only in high income countries, the prevalence of cardiovascular disease risk factors is dramatically increasing even in low and middle income African countries, particularly in urban areas (Christensen *et al.*, 2008). Projections of Global Mortality and Burden of Disease from 2002 to 2030 by Mathers and Lonkar (2006) had shown that global cardiovascular deaths increased from 16.7 million in 2002 to 23.3 million in 2030. According to Gaziano *et al* (2010), between 35 and 65 per cent of all deaths at the global level can be traced to cardiovascular disease. Typically, the rate of death from coronary heart disease exceeds that of stroke by a ratio of 2:1 to 3:1. During this period, average life expectancy surpasses 50 years and roughly 35 per cent of the world's population falls into this category.

Projected global deaths by cause

(Beaglehole and Bonita, 2008)



ii. Asia

Over 80 per cent of deaths and 85 per cent of disabilities from cardiovascular diseases occur in low and middle income countries (Reddy, 2004). The Indian subcontinent including India, Pakistan, Bangladesh, Sri Lanka and Nepal has among the highest rates of cardiovascular disease globally (Eapen *et al.,* 2009). Cardiovascular disease prevention in Asia is an important issue for world health, because half of the world's population lives in Asia. Central Asian countries have the highest stroke and coronary heart disease mortality rates among all Asian countries, followed by other Middle east Asian and south Asian countries (Ueshima *et al.,* 2008).

According to Lawes *et al* (2006), blood pressure and hypertension are more prevalent in east Asia. The Asia-Pacific Cohort Studies Collaboration (Matriniuk *et al.,* 2007) stated that the population-attributable fraction of hypertension for cardiovascular disease is as high as 60 per cent in Asian countries. In addition, the total number of individuals with hypertension in China and India is expected to increase to more than 500 million by 2025 (Perkovic *et al.*, 2007).

Bainey and Jugdutt (2009) have also opined that south Asians show an increased risk of atherosclerosis and have the highest mortality rates from coronary artery disease than any other ethnic group. The greater susceptibility of south Asians to coronary artery disease are due to conventional risk factors alone and other factors such as genetic predisposition and high prevalence of metabolic syndrome and type-2 diabetes. Coronary artery disease is more severe, extensive and malignant among south Asians.

Cardiovascular disease risk in south Asians increases as the number of traditional risk factors such as smoking, lack of exercise, and decreased intake of fresh fruits and vegetables increase. The landmark INTERHEART study (Eapen *et al.*, 2009) demonstrated that the population-attributable risk for acute myocardial infarction based on the combined presence of potentially modifiable risk factors in native south Asians equalled 85.8 per cent.

iii.India

India is experiencing a rapid health transition by carrying an increasing burden of non communicable diseases with more than 30 million people with chronic heart disease and 118 million people with high blood pressure. This figure is expected to go up to 214 million people with high blood pressure by the year 2025 if preventive measures are not taken (Goenka *et al.*, 2009). In the year 2003, the prevalence of coronary heart disease in rural and urban areas of India was estimated to be 3-4 and 8-10 per cent which was two and six folds respectively higher when compared to the prevalence 40 years ago (Goyal and Yusuj, 2006). According to WHO (2004), by the year 2020, India will have the largest cardiovascular death burden in the world which would account for one third of all deaths. Epidemiologists in India and international agencies have therefore been sounding an alarm on the rapidly rising burden of cardiovascular disease for the past fifteen years.

In India, cardiovascular disease is projected to be the largest cause of deaths and disability with 2.6 million Indians predicted to die due to coronary heart disease by 2020 which constitutes 54.1 per cent of all cardiovascular deaths. Nearly half of these deaths are likely to occur among young and middle aged individuals (WHO, 2002a). This is because Indians experience cardiovascular disease deaths at least a decade earlier than their counterparts in developed countries (Prabhakaran *et al.*, 2005). Heart attack ranks second in the ten selected diseases which are responsible for deaths in India. It is reported by Gupta *et al* (2010) that in every one minute, five people die of heart attack in India and it is expected that 60 per cent of the world's cardiac patients would be Indians by the year 2010. The prevalence of dyslipidemia and diabetes are also in particularly high proportions and by 2020, it is expected that India will have more than 50 per cent of the cardiovascular disease cases in the world (Ramachandran *et al.*, 2008). It is a paradox that in India most people are vegetarians but have an increased risk perhaps due to the presence of new risk factors: higher lipoprotein(a), hyperhomocysteinemia, insulin resistance, low high-density lipoprotein cholesterol, and poor nutrition during foetal life, infancy, and childhood (Singh *et al.*, 2010a).

WHO (2004) has stated that by the year 2020, India will have the largest cardiovascular death burden in the world which could account for one third of all deaths and Indians succumb to heart attacks, strokes, and diabetes in their most productive years, when they are 40 to 50 years, when they are rising in their jobs, when they are peaking in their careers. Such premature heart attacks, strokes and diabetes will lead to loss of productive years and also huge economic burden on the country (Mohan *et al.*, 2008). In 2005, it is estimated that India lost nine billion dollars in national income from premature deaths due to heart disease, stroke and diabetes. These losses are expected to be cumulatively upto 237 billion dollars over the next ten years (Goenka *et al.*, 2009).

Seventy two per cent of India resides in the villages. Recently, there is also evidence that cardiovascular disease is becoming the leading cause of death even in rural India (Joshi et.al, 2006). Not only are the large and growing numbers a matter of grave concern but early onset of these chronic diseases will destroy the productive potential of India (Goenka *et al.*, 2009).

Coronary heart disease prevalence studies report three to four per cent in rural areas and eight to ten per cent in urban areas and mortality of coronary heart disease in India accounts to 29 per cent (Reddy *et al.,* 2005). Park *et al* (1998) have reported higher prevalence rates of cardiovascular disease in southern India compared to northern India. Reddy (2008) opined that the reported prevalence of coronary heart disease in adult surveys has risen four-fold in 40 years and even in rural areas the prevalence has doubled over the past thirty years.

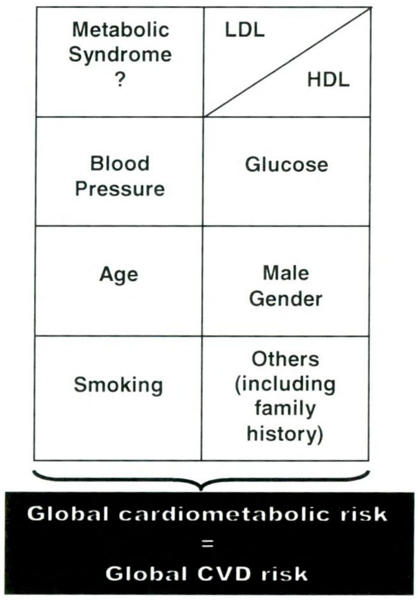
The country already has more than 118 million people with hypertension, which is expected to increase to 213 million by 2025 (Kearney et al., 2005). Moreover, in India about 70 per cent of coronary heart disease related deaths occur in people younger than 70 years compared with 22 per cent in the west (Gaziano *et al.*, 2010).

A recent report by Ganda and Fonseca (2010) revealed that the public health challenges of increasing prevalence of obesity, diabetes, and cardio metabolic syndrome is seen in India where, according to recent estimates, approximately 60 per cent of the world's cases of cardiovascular disease occur and the salt consumption is the highest in any large population. Epidemiologic data from rural south India in 2005 revealed that 32 per cent of all deaths were due to cardiovascular disease, outranking infectious disease which was responsible for 13 per cent of deaths (Joshi *et al.*, 2006).

b. Etiology

WHO (2002b) defines the term 'risk' as a probability of an adverse health outcome, whereas 'risk factor' refers to an attribute or characteristic or exposure of an individual whose presence or absence raises the probability of an adverse outcome. Williamson (2010) explains risk factor as a characteristic or behaviour that increases a person's likelihood of developing a disease and the probability of developing cardiovascular disease correlates with the number of risk factors present and to the length of time that they have existed. The greater the number of risk factors, the stronger the chance of developing cardiovascular disease. WHO (2002a) identified top 20 leading risk factors in terms of the burden of disease according to the mortality status in the population. Ezzati *et al* (2003) estimated that in 2000, 47 per cent of premature deaths and 39 per cent of total disease burden resulted from the combined effects of the risk factors studied.

"Building blocks" of cardio metabolic risk (Després et al., 2008)



Marma *et al* (2010) reported that the wide distribution of isolated risk factors indicates that no single risk factor is responsible for determining the lifetime risk stratification. By lowering the prevalence of risk factors, there will be an anticipated reduction in both cardiovascular disease events and cardiovascular mortality of striking proportions (Heidenreich *et al.*, 2011). With longer the exposure and greater intensity of the risk factors involved, the atherosclerotic burden becomes higher (Shah *et al.*, 2009). Modifiable risk factors comprise smoking, dyslipidemia, hypertension, and diabetes, with obesity and metabolic syndrome while non modifiable risk factors include age, genetics, and gender (Heidenreich *et al.*, 2011).

i. Modifiable risk factors

Modifiable risk factors are those that can be reduced or prevented by lifestyle behaviours or by medical treatment (Kokkinos, 2010). Although part of an individual's risk of cardiovascular disease is determined by factors that cannot be changed, attention to the major modifiable risk factors can appreciably reduce the risk of experiencing a major cardiovascular event (Killewo *et al.*, 2010). Traditionally smoking, blood lipids and recently physical inactivity dominate these major modifiable risk factors. Specific lifetime risk estimates help to enhance risk communication and motivate patients and assist policy makers and researchers seeking to understand the current or project the future cardiovascular disease burden (Marma *et al.*, 2010).

a. Physical inactivity

Physical activity is defined as movement that requires any form of skeletal muscle contraction and results in energy expenditure beyond resting levels (Kokkinos, 2010). In 2008, the Physical Activity Guidelines for Americans Advisory Committee concluded that adults should accumulate 150 minutes of moderate intensity physical activity, or 75 minutes of vigorous intensity physical activity, or a combination of both, each week (U.S. Department of Health and Human Services, 2008). Research has also shown that meeting these guidelines is associated with better cardiovascular disease risk profiles, as well as reduced risk of mortality (Warren *et al.*, 2010).

Studies by Bowtell and Weissbort (2010) concluded that endurance exercise increases endogenous antioxidant capacity, mitochondrial volume, oxidative capacity of muscles and insulin sensitivity. The reason has been reported by Lenz (2007) that exercise results in decreased total peripheral resistance which is in turn associated with increased blood vessel diameter and thereby decrease in blood pressure. Lindegaard *et al* (2008) have also confirmed that endurance training resulted in significant reductions in total cholesterol, LDL cholesterol and free fatty acids and significant increase in

HDL cholesterol, whereas resistance training resulted in significant reductions in triglyceride and free fatty acids as well as significant increase in HDL cholesterol.

The Inter99 study by Aadahl *et al* (2009) reported that five-year changes in physical activity level were significantly associated with relevant changes in weight, waist circumference, diastolic blood pressure and serum lipids in a population-based Cohort of adult men and women though changes in physical activity levels induced a significant change in HDL cholesterol concentration. Vepsalainen *et al* (2011) proposed that physical activity reduced cardiovascular and total mortality in middle aged type II diabetic subjects suggesting that this may reflect an anti-inflammatory effect of exercise independent of traditional cardiovascular disease risk factors.

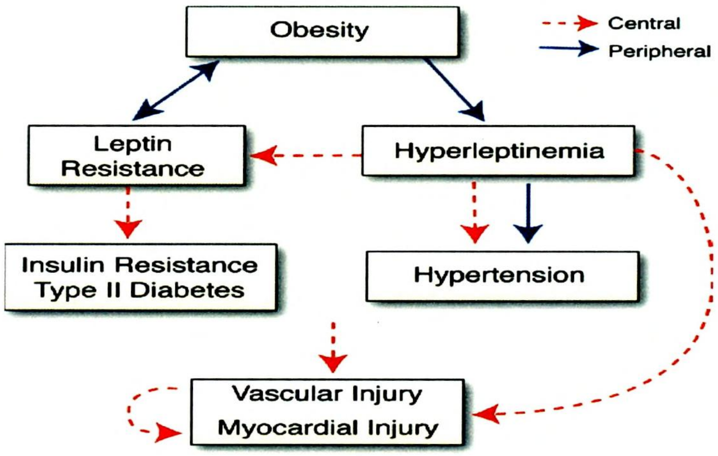
b. Overweight/obesity

Owing to its maladaptive effects on various cardiovascular risk factors and its adverse effects on cardiovascular structure and function, obesity has a major impact on cardiovascular disease, such as heart failure, coronary heart disease, sudden cardiac death, and atrial fibrillation, and is associated with reduced overall survival (Lavie *et al.*, 2009). According to Evans (2009), obesity clearly increases cardiovascular disease risk through a number of different routes. Obesity is thought to initiate a cascade of events leading to systemic inflammation and increase in circulating C-reactive protein, insulin resistance, and dyslipidemia (Lin *et al.*, 2008). Data from Framingham (Fox *et al.*, 2008) show that over 30 years, the lifetime risk of cardiovascular disease was greater among obese men and women against those with normal body weight.

Investigations by Tibazarwa *et al* (2009) revealed a positive association of measures of adiposity with cholesterol, triglycerides, and LDL cholesterol. Njelekela *et al* (2009) observed a positive association between measure of obesity and components of the lipid profile and a particular association between lower body mass index and lower HDL cholesterol among men in Tanzania. However, Després *et al* (2008) suggested that physicians should first pay attention to the classical risk factors while also considering the additional risk resulting from the presence of abdominal obesity and metabolic syndrome.

Task of obesity as a risk factor for cardiovascular disease

(Martin *et al.*, 2008)



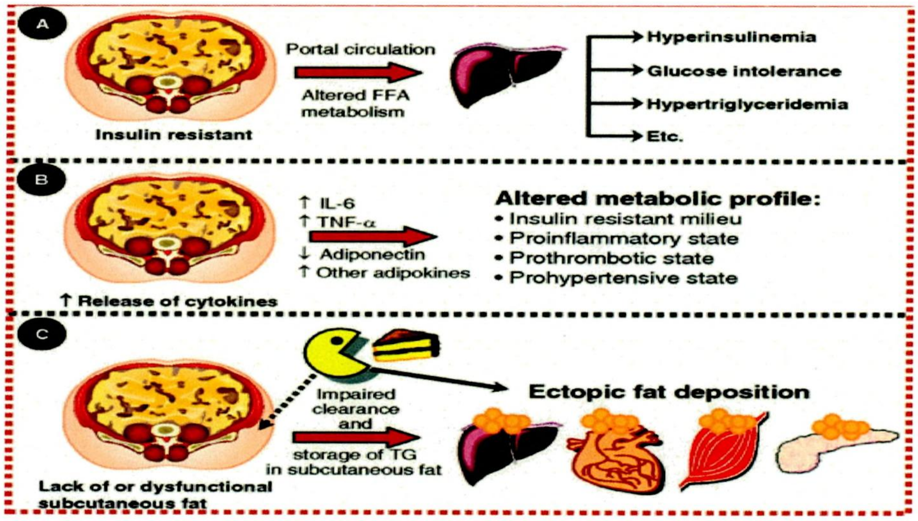
From the point of view of prevention of non communicable diseases, weight control is an important priority in both men and women. Interventions to reduce weight gain must be warranted, and should address social, cultural, and gender-specific aspects of weight gain (Njelekela *et al.*, 2009).

c. Diabetes mellitus

Diabetes mellitus, known to be an independent, significant risk factor for cardiovascular disease and a predictor of acute myocardial infarction (Patel *et al.*, 2008). Although the exact date of diabetes mellitus onset can be difficult to determine, duration of diabetes mellitus appears to affect cardiovascular disease risk (Lloyd-Jones *et al.*, 2009). According to Evans (2009) men with diabetes have two to three fold greater cardiovascular disease mortality risk and in women it is even greater. He further opines that, twice as many type II diabetics as nondiabetics show clinical evidence of atherosclerosis, and death rates following myocardial infarction are two to three times higher where diabetes is present. An observational study of patients in modern everyday clinical practice carried out by Eeg-Olofsson (2010) demonstrated progressively increasing risks for coronary heart and cardiovascular diseases with higher HbA1C levels independently of traditional risk factors.

Tran *et al* (2011) advocated that the ratio between cardiovascular disease prevalence for individuals with and without diabetes was 4.8 for ethnic Norwegians and 2.6 for the pooled ethnic minority groups. Borg *et al* (2011) documented that average glucose and HbA1C levels showed strong associations with cardiovascular risk factors.

Proposed link between insulin resistance and atherosclerosis



(Després *et al.*, 2008)

d. Smoking/alcohol

Smoking remains an important risk factor for hypertension and cardiovascular disease and more prevention/cessation programs are warranted (Njelekela *et al.*, 2009). The population attributable fraction of smoking for cardiovascular disease is 30 per cent, second only to high blood pressure (Matriniuk *et al.*, 2007) and quitting smoking, especially among men, could greatly reduce the prevalence of cardiovascular disease in Asia (Ueshima *et al.*, 2008).

Mathers and Lonkar (2006) divided the projected 2015 global mortality due to smoking into leading causes namely cancers which are responsible for one-third of the deaths, followed by cardiovascular disease and chronic respiratory diseases, each responsible for 30 per cent of the deaths. They further project that smoking will kill 50 per cent more people in 2015 than HIV/AIDS, and will be responsible for ten per cent of all deaths globally.

A recent study by Honjo *et al* (2010) confirmed the association between smoking and mortality from cardiovascular disease in both males and females adding that smoking cessation is a crucial preventive measure against death from cardiovascular disease. The American Heart Association (2011b) adds cessation of smoking as one of the aspects in its guidelines for the prevention of cardiovascular disease in women.

The net effect of alcohol consumption on health is detrimental, with an estimated 3.8 per cent of all global deaths and 4.6 per cent of global disability adjusted life years attributable to alcohol. Disease burden is closely related to average volume of alcohol consumption and for every unit of exposure, the burden is strongest in poor people and in those who are marginalised from society (Rehm *et al.*, 2009).

e. Dyslipidemia

The Heart Disease and Stroke Statistics by American Heart Association, (2010) associates cardiovascular disease with a dyslipidemic profile that includes increased LDL cholesterol and decreased HDL cholesterol and may include high triglycerides. Dyslipidemia by definition is a combination of increased blood lipid levels and lipoprotein concentrations and can be caused by environmental, genetic, and pathologic risk factors (McKenney and Hawkins, 2001). Shi *et al* (2011) identified dyslipidemia as a major risk factor for premature coronary artery disease.

Hyperlipidemia is a major health problem throughout the world because of its important and vital role in the pathogenesis of atherosclerosis. The concept of hyperlipidemia is based on the biochemical changes in the blood, i,e. disturbed lipid metabolism and as a result thereof, increased concentration of lipids in the blood (Kamal and Aleem, 2009).

Worldwide, high cholesterol levels are estimated to cause 56 per cent of ischemic heart disease and 18 per cent of strokes amounting to 4.4 million deaths annually (Gaziano *et al.*, 2010). Hypertriglyceridaemia results if triglyceride-rich lipoproteins accumulate either due to defective clearance, overproduction or a combination of both mechanisms. The most common environmental contributors for this include diabetes, diet, alcohol and medications (Blom, 2010).

Hypertriglyceridemia is associated with small, dense, and cholesteryl ester depleted LDL particles that may be more susceptible to oxidative modification and catabolism via macrophage scavenger receptors (AHA, 2011a). Experimental studies suggest that these small, dense LDL particles and an increased number of atherogenic particles may adversely influence cardiovascular disease risk (Ip *et al.*, 2009).

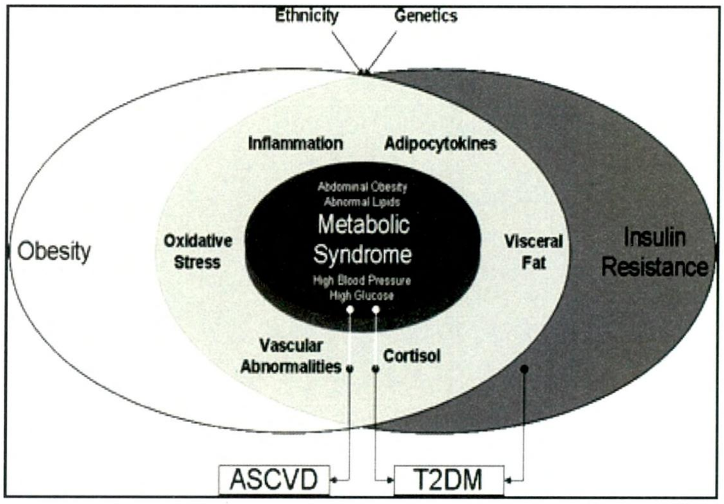
f. Metabolic syndrome

The metabolic syndrome, defined by the presence of three or more of the component factors, increases a person's short-term risk of developing diabetes and coronary artery disease by three to five fold (Mathavan *et al.*, 2009). Several terms such as syndrome X, the deadly quartet, insulin resistance syndrome, and metabolic syndrome have been proposed to describe the connection between obesity, insulin resistance, hypertension, dyslipidemia, type 2 diabetes mellitus and atherosclerotic cardiovascular disease (AHA, 2009). The National Cholesterol Education Program's Adult Treatment Panel III report (2002) has added the metabolic syndrome, a multidimensional risk factor for cardiovascular disease, as a coequal partner of elevated low-density lipoprotein (LDL) cholesterol for risk reduction therapies.

Simmons *et al* (2010) suggested that the metabolic syndrome has been advocated as both a simple clinical tool for predicting diabetes and cardiovascular disease, and the conceptual basis for understanding at least part of the pathophysiological link between metabolic risk, future diabetes and cardiovascular disease. Liu *et al* (2011a) compared stroke victims with and without metabolic syndrome and found that the risk of cardiovascular disease events increased by 44 per cent and the risk increased with the number of metabolic syndrome components.

The Cardiovascular Risk in Young Finns Study (Koivistoinen *et al.*, 2011) identified that metabolic syndrome in childhood predicted increased arterial stiffness in adulthood. A prospective population-based study, with a nine year follow-up in Finland (Salminen *et al.*, 2011) suggested that metabolic syndrome predicted cardiovascular events in late life.

Schematic representation of components of metabolic syndrome (AHA, 2009)



ii. Non modifiable risk factors

Non-modifiable risk factors are factors that are outside a person's control and cannot be reduced or altered (Kokkinos, 2010). These include age, gender, race and family history.

a. Age

Cardiovascular disease death rates are very much higher for successively older age groups in adulthood. When the average person attains age 61 or 62 years, cardiovascular diseases are expected to predominate over infectious diseases as a cause of death (Labarthe, 2010). According to Jimmy *et al* (2011), the prevalence of multiple risk factors increases with age. The AHA (2009) estimated that more than 150 000 Americans killed by cardiovascular disease in 2005 were less than 65 years of age.

Anuurad *et al* (2011) reported an increase in the systemic inflammatory burden with age underscoring the importance of age in evaluating inflammatory markers to assess cardiovascular risk. Mortality was higher in individuals over 85 years of age with even lower blood pressure levels (Kalpan and Victor, 2009).

b. Gender

Marma *et al* (2010) identified that at older ages, a much larger group of women aged between 60 and 79 years were found to be having a higher lifetime risk of cardiovascular disease as compared with men. These sex differences may be attributable to smaller baseline calf muscle area among women with peripheral artery disease (McDermott *et al.,* 2011).

Women with peripheral artery disease had faster functional decline and greater mobility loss than men with peripheral artery disease. Inflammation and the various risk factors such as obesity, type II diabetes mellitus, and metabolic syndrome, appear to play a more predominant role in the development of coronary atherosclerosis in women than in men (Braunwald, 2010). The Multi-Ethnic Study of Atherosclerosis (Winston *et al.*, 2009) conducted in order to examine the cardiovascular risk factor treatment and control among individuals with diabetes revealed that women with diabetes had a more unfavourable cardiovascular risk factor profiles against men.

c. Ethnicity/race

The varying incidence, prevalence, and mortality rates reflect the different levels of risk factors, other competing causes of death, availability of resources to combat cardiovascular disease, and the stage of epidemiologic transition that each country or region finds itself (Gaziano et al., 2010).

The prevalence of diabetes was more than twice as high for Asian Indian adults as for Chinese or Japanese adults (Barnes *et al.,* 2008). Asian populations tend to have higher body fat percentages at a given BMI level and possible higher risks (Flegal *et al.*, 2010). Race/ethnicity was seen to be associated with risk factor control and treatment intensification among cardiovascular disease patients in northern California (Traylor *et al.,* 2010).

Previous studies of five ethnic groups in the Oslo Immigrant Health Study (Kumar *et al.*, 2009) revealed significant group differences in levels of serum triglycerides, HDL cholesterol, blood pressure, and smoking prevalence. Furthermore, ethnic groups from Asia had a high prevalence of diabetes and coronary heart disease, and socioeconomic position differed between and within the various ethnic groups (Kumar *et al.*, 2008).

d. Family History

Familial clustering is common in many forms of heart disease (Braunwald, 2010). The Heart Disease and Stroke Statistics (Lloyd-Jones *et al.,* 2009) update confirmed that there was consistent evidence from multiple large-scale prospective epidemiology studies for a strong and significant association of a reported family history of premature parental coronary heart disease with incident myocardial infarction or coronary heart disease in offspring.

Kullo and Ding (2007) further acknowledged that genes and gene environment interactions play important roles in the causation, pathogenesis, and prognosis of cardiovascular disease. Knowledge of the spectrum of inherited susceptibilities to cardiovascular disease and elucidation of the patterns of inheritance for specific genetic abnormalities may provide improvements in early detection, risk stratification, and prevention of cardiovascular disease in individual patients and their family members. Studies by Paynter *et al* (2009) revealed that genetic variation at the chromosome 9p21.3 region has consistently been associated with total cardiovascular disease, coronary heart disease, myocardial infarction, and stroke.

B. Role of selected functional foods and antioxidants

There are a number of basic capabilities that no society can afford to ignore: nutrition, health, literacy, self-respect and political participation.

- Amartya Sen

Functional foods are defined by the Institute of Medicine of the US National Academy of Sciences (Thomas and Earl, 1994) as foods that encompass potentially healthful products, including any modified foods or food ingredients that may provide a health benefit beyond the nutrients it contains. The Functional Foods Center at USA has defined that a functional food as a natural or processed food that contains known or unknown biologically active compounds which in defined quantitative and qualitative amounts provides a clinically proven and documented health benefit, and thus, an important source in prevention, management and treatment of chronic diseases of the modern age.

The role of functional foods in chronic disease risk reduction has been given increasing attention over the past 10 years by researchers. Media promotions have heightened consumer awareness about the cardiovascular benefits of some foods such as whole grains, nuts, fish, and flax seed. Several recent reviews have highlighted the positive effects of legumes or dry beans in improving serum lipid profiles in patients with coronary heart disease (Winham *et al.*, 2007).

Certain bioactive compounds in food plants have been known for a long time for their beneficial effects, whereas others have been recognised more recently. Such antioxidant rich diets have been associated with a lower incidence of atherosclerotic heart diseases and certain types of cancers which is hypothesised to be related to a reduction in the oxidative polymerization of low density lipoproteins and consequent lesion formation and plaque build up in key coronary arteries (Terry, 2011).

i. Sprouted green gram

Pulses contain a number of bioactive substances including enzyme inhibitors, lectins, phytates, oligosaccharides, and phenolic compounds which may have protective effects. Phytic acid exhibits antioxidant activity and protects DNA damage, phenolic compounds have antioxidant and other important physiological and biological properties, and galacto-oligosaccharides may elicit prebiotic activity. These compounds can have complementary and overlapping mechanisms of action, including modulation of detoxifying enzymes, stimulation of the immune system, regulation of lipid and hormone metabolism, antioxidant, antimutagen, and anti-angiogenic effects, reduction of tumour initiation, and promotion and induction of apoptosis, simultaneously conferring health benefits and are currently marketed as functional foods and nutraceutical ingredients (Campos-Vega *et al.*, 2010).

Green gram (*Phasleolus aureus*) is low in fat, high in protein and fibre and easy to digest (Vandenberg, 2009). A recent study by Jisha and Padmaja (2011) revealed that muffins and biscuits made from composite flour prepared from malted green gram increased the functional properties of the products making them suitable for chronic diseases. Green gram is often praised as a 'green pearl' because of its richness in nutrients and use in traditional medicines. In traditional Chinese medicine, parts of the green gram plant are used for treating various ailments such as hepatitis, gastric ulcer, uraemia, toxicosis, red dysentery, cholera, corneal opacity and macula (Zia-Ul-Haq, 2008). The seeds are used externally and internally for paralysis, rheumatism, liver complaints and cough syrups. The roots are considered to be narcotic.

ii. Carrot

Carrot (*Daucus carota*) is one of the commonly used vegetables of human nutrition. It is rich in β carotene, ascorbic acid and tocopherol and classified as vitaminized food (Hashimoto and Nagayamma, 2004). Amid common fruits and vegetables, carrots are one of the richest vegetables in fiber, carotenoids and contain other antioxidants such as vitamins E and C, and polyphenols such as *p*-coumaric, chlorogenic, and caffeic acids (Terry, 2011). These phenolic compounds are dietary antioxidants found in plants that are shown to inhibit LDL oxidation, platelet aggregation and adhesion, decrease total and LDL cholesterol, and induce endothelium-dependent vaso-relaxation (Potter *et al.*, 2011). Carrot is widely consumed as an aphrodisiac and nervine tonic and its scraped root is used as a local stimulant for indolent ulcers (Singh *et al.*, 2010b). Agudo *et al* (2007) observed that a high intake of carrots was associated with reduced mortality, probably as a result of their high content of vitamin C, provitamin A carotenoids and lycopene.

Anthocyanins, phenolic acids and carotenoids are the predominant phytochemicals present in carrots. These phytochemicals could be useful in the treatment of metabolic syndrome since anthocyanins improve dyslipidaemia, glucose tolerance, hypertension and insulin resistance. The phenolic acids may also protect against cardiovascular disease and β carotene may protect against oxidative processes (Poudyal *et al.*, 2010). According to Purup *et al* (2009) extracts of carrots, containing different amounts of falcarinol, falcarindiol, and falcarindiol 3-acetate had significant inhibitory effects on both normal and cancer cell proliferation demonstrating that the aliphatic C_{17}-polyacetylenes are potential anticancer principles of carrots.

According to Kawashima *et al* (2007), supplementation with carrots and carrot juice concentrate capsules proved to be a highly bioavailable source of phytonutrients. Important antioxidants were elevated to desirable levels associated with decreased risk of disease while markers of oxidative stress were reduced, and folate status improved with a concomitant decrease in homocysteine. A recent study by Potter *et al* (2011) reported that drinking 16 fl oz of fresh carrot juice daily significantly increased antioxidant status and suppressed lipid peroxidation. Human cross-over studies by Soltoft *et al* (2011) found significant increase in plasma carotenoid status upon regular carrot consumption.

Supplementation of ethanolic extract of carrot to normal rats resulted in significant reduction in the total cholesterol, triglyceride, HDL and VLDL cholesterol suggesting that the antioxidant potential of carrot might have contributed to the reduction of oxidative stress and lipid levels (Singh *et al.*, 2010b). The availability of high carotene carrots could readily increase consumption of β carotene and potentially impact the serum vitamin A status (Tanumihardjo *et al.*, 2009).

iii. Amla

Amla (*Emblica officinalis)* enjoys an important position in Ayurvedic medicine. According to ancient Indian mythology, it is the first tree to be created in the universe. It belongs to family Euphorbiaceae and named as Amla, *Phyllanthus Emblica or* Indian gooseberry. The species is native to India and also grows in tropical and subtropical regions including Pakistan, Uzbekistan, Srilanka, south east Asia, China and Malaysia.

Amla is believed to increase defence against diseases. It has its beneficial role in cancer, diabetes, liver treatment, heart disease, ulcer, anaemia and various other diseases. It has application as antioxidant, immunomodulatory, antipyretic, analgesic, cytoprotective, antitussive and gastroprotective agent. Additionally, it is useful in memory enhancing, treating ophthalmic disorders and lowering cholesterol levels. It is also helpful in neutralizing snake venom and as an antimicrobial agent (Khan, 2009).

A combination of amla incorporated in equal proportions along with fruits of black myrobalan and belleric myrobalan in an ayurvedic herbal formulation called 'Triphala' has been reported to exibit chemopreventive potential and significantly increased the antioxidant status in rats (Madhuri *et al.*, 2011). Veena *et al* (2006) reported that when a modified Siddha preparation containing amla were fed to animals suffering with cancer, the elevated levels of free cholesterol, total cholesterol, triglycerides, phospholipids and free fatty acids were reverted back to near normal levels.

Suryanarayan *et al* (2007) reported that amla and an enriched fraction of its tannoids were effective in delaying the development of diabetic cataract in rats. Amla would be a very useful antioxidant for the prevention of age-related renal disease (Yokozawa *et al.*, 2007). Vitamin C in amla accounts for approximately 45 to 70 per cent of its antioxidant activity (Scartezzini *et al.*, 2006).

Flavonoids of amla were found to decrease the activity of enzyme HMG-CoA reductase and increase the degradation and elimination of cholesterol from the body (Han *et al.*, 2005). Kamal and Aleem (2009) found that supplementation of a combination of amla for six days exhibited a significant decrease in the level of serum total cholesterol, triglyceides, LDL cholesterol, VLDL cholesterol and increase in the level of serum HDL cholesterol in patients of hyperlipidemia.

Antony *et al* (2008) reported that supplementation trials of a purified, standardized, dried extract of amla which contained about 35 per cent galloellagi tannins along with other hydrolysable tannins on human volunteers for 6 months showed reduction in total and LDL cholesterols and enhancement of beneficial HDL cholesterol and in addition, a significant reduction in blood C- Reactive Protein levels, a marker for inflammation.

iv. Drumstick leaves

Drumstick (*Moringa oleifera*, horseradish) tree is indigenous to north western India and is often cultivated in hedges and home yards. This tree is valued mainly for the tender pods, which are esteemed as a vegetable. It is considered as one of the world's most useful trees, as almost every part of the drumstick tree can be used for food, medication and industrial purposes (Khalafalla *et al.*, 2010). It is commonly said that drumstick leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, and more potassium than bananas, and that the protein quality of drumstick leaves rivals that of milk and eggs. Numerous studies have indicated that drumstick leaves with their high β carotene content have a great potential to combat micronutrient deficiencies such as vitamin A and can be easily incorporated into our traditional diets and could be recommended for overall health improvement (Nambiar *et al.*, 2010).

The leaves are highly nutritious, being a significant source of β carotene, vitamin C, protein, iron, and potassium. The leaves are cooked and used like spinach. Its leaves are commonly dried and crushed into a powder, and used in soups and sauces (Joshi and Mehta, 2010). Drumstick leaves are reported to contain alkaloids, flavonoids, anthocyanins, proanthocyanidins and cinnamates and is highly reputed in folklore and traditional system of medicine as a remedy for variety of ailments (Anwar *et al.*, 2007).

Recently, a high degree of renewed interest was placed on the nutritional properties of drumstick in most countries where it was not native (Oduro *et al.*, 2008). These studies indicated that the leaves had immense nutritional value such as vitamins, minerals and amino acids (Anwar *et al.*, 2007). Nutritional composition of the plant plays a significant role in nutritional, medicinal and therapeutic values (Al-Kharusi *et al.*, 2009). Moyo *et al* (2011) reported that drying of drumstick leaves assists to concentrate the nutrients, facilitate conservation and makes it suitable for consumption in powder form.

Studies by Nambiar *et al* (2010) found that supplementation of drumstick leaves tablets, with a high amount of β carotene, polyphenols as well as fibre had a positive impact on the lipid profile of hyperlipidemic subjects. Joshi and Mehta (2010) revealed that dehydration was one of the most possible strategies for preservation of green leafy vegetables and drumstick leaves samples after dehydration became a concentrated source of all the nutrients.

It was observed by Luqman and Kumar (2011) that drumstick extract scavenges hydroxyl radical at lower concentrations and suppresses scavenging activity of the hydroxyl radical at increased concentrations thereby suggesting that drumstick extract has strong antioxidant property as assessed by its property of scavenging hydroxyl radical formation. Research works by Giridhari *et al* (2011) indicated that drumstick leaves in the form of dehydrated tablets were effective in reducing the diabetic complications in diabetic patients.

v. Wheat germ

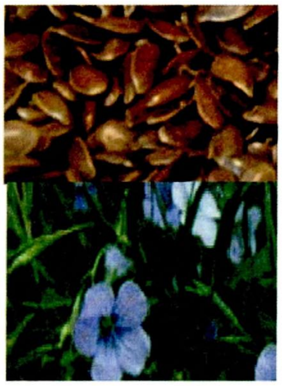
Wheat germ (*Triticum aestivum*), a by-product of the flour milling industry and the oil extracted from wheat germ are the richest known natural dietary source of vitamin E (tocopherols) of plant origin. The germ is the plant embryo which contains concentrated source of minerals such as iron and zinc plus vitamin E that provide defence system against reactive oxygen species (Lang and Jebb, 2009). Wheat germ is considered to be one of the food items reported to be of high nutritional and health values (Roy *et al.*, 2010).

Studies by Leenhardt *et al* (2008) suggested that frequent consumption of wheat germ appeared to be the most natural way to meet vitamin E requirement and to ensure moderate vitamin E intake and antioxidant protection by limiting the risk linked to pharmaceutical supplementation. Moreover, wheat germ is known to be a source of α- linolenic rich PUFA and minerals and some micronutrients that enhance its health value.

Iyer and Brown (2011) reported that fermented wheat germ extract had a potential role in attenuating chronic hypertension, diabetes or metabolic syndrome-induced cardiovascular symptoms along with metabolic abnormalities such as glucose tolerance and obesity in rats. Rezq and Mahmoud (2011) also reported that wheat germ could prevent or decrease the incidence of hypercholesterolemia and atherosclerosis in rat model.

Studies by Liu *et al* (2011b) stated that wheat germ was a widely accepted ingredient in many low glycemic index foods due to its active compounds which were potent α-glucosidase inhibitory compounds namely phosphatidic acids, 1,2-dilinoleoylglycero-3-phosphate and 1- palmitoyl - 2 - linoleoyl – glycerol – 3 - phosphate. Barakat *et al* (2011) also clearly indicated that wheat germ oil had a significant potential to protect cellular system from radiation induced damage without any toxicity.

vi. Flax seed



Flax seed or linseed (*Linum usitatissimum*) is derived from the flax plant, an annual herb with blue flowers believed to have originated in Egypt. It is a versatile plant that is grown both for industrial and culinary applications, as well as for aesthetic purposes. Flax seed in its various forms have become standard in the diets of those who are looking for a healthier lifestyle.

Flax seed is a rich source of 3 components with demonstrated cardioprotective effects: the omega-3 fatty acid α-linolenic acid, dietary fibre, and phytoestrogen lignans (Bassett *et al.*, 2009). The omega-3 fatty (α-linolenic) acid found in the flax seed oil fraction also contributes to the antiatherogenic effects of flax seed via anti-inflammatory and antiproliferative mechanisms (Geleijnse *et al.*, 2010). The amount of omega 3-fatty acids is more than two times as in fishes (Moghaddasi, 2011). Evidences suggest that the dietary fibre and (or) lignan content of flax seed provides the hypocholesterimic action.

Peterson *et al* (2010) reported that intervention studies using flax seed lignan supplements indicated beneficial associations with C-reactive protein, and a meta-analysis that included these studies also suggested lignans have a lowering effect on plasma total and LDL cholesterol levels. Studies by Bassett *et al* (2011) also acknowledged the idea that dietary flax seed protects against atherosclerotic development induced by trans fatty acids and cholesterol feeding through its content of α-linolenic acid.

Studies by Prasad (2009) provided additional evidence that flax lignan complex contained 34 to 38 per cent of the plant lignan secoisolariciresinol diglucoside as well as other potential bioactive components such as 3-hydroxy-3-methylglutaric acid and cinnamic acids that rendered flax seed effective in protecting against atherosclerosis. Addition of ground flax seed to the cholesterol-supplemented diet ameliorated the atherogenic effects of cholesterol, significantly reducing lesions to 28 per cent of the aortic lumen (McCullough *et al.*, 2011). Flax seed diet supplementation in rats showed a 47 per cent increase in HDL cholesterol, a 22 per cent reduction in LDL cholesterol, a 23 per cent reduction in triacylglycerides, and an increased vasodilator response to acetylcholine, in relation to the control group (Daleprane *et al.*, 2010).

C. Dietary management of cardiovascular disease

Whosoever was the father of disease,
An ill diet was its mother

- Anonymous.

Clinical trials have shown that strategies aimed at the appropriate detection and modification of risk factors can slow progression of atherosclerosis, diabetes mellitus, and hypertension and reduce the occurrence of clinical cardiovascular events in both primary and secondary prevention settings. More recently, it has been shown that atherosclerosis can be stabilized or even modestly reversed through primary and secondary prevention strategies (Merz *et al.*, 2009). A basic knowledge of the structure and function of the arterial wall, its interactions with components of the circulating blood, and key pathologic processes such as oxidation, inflammation, thrombosis, and remodelling are important to the application of strategies for the detection, evaluation, and prevention of atherosclerotic cardiovascular disease (Mensah, 2007). Forrester and Libby (2007) reported that mechanisms of atherosclerosis-specific targeted interventions in combination with medications can be used to slow progression and reverse the process of atherosclerosis.

Diet changes remain the cornerstone for prevention and treatment of cardiovascular disease (Ros, 2009). Experimental animal models suggested that early obesity on a high-calorie, high-fat diet was characterized by increased vascular oxidative stress and endothelial dysfunction, insulin resistance and systemic oxidative stress (Galili *et al.*, 2007).

In a meta-analysis of prospective Cohort studies by Mellen *et al* (2008), greater whole grain intake was associated with a 21 per cent lower risk of cardiovascular disease events, with similar estimates for specific cardiovascular disease outcomes like heart disease, stroke, and fatal cardiovascular disease. In contrast, refined grain intake was not associated with lower risk of cardiovascular disease. Meta-analysis of a randomised control trial documented that vitamin D supplementation lowered systolic blood pressure by two to six mm Hg (Wu *et al.*, 2010).

In a Cohort study, greater versus lower adherence to a mediterranean dietary pattern, characterized by higher intakes of vegetables, legumes, nuts, fruits, whole grains, fish, and unsaturated fat and lower intakes of red and processed meat, was associated with a 22 per cent lower cardiovascular mortality (Mitrou *et al.*, 2007). In a similar Cohort study among female nurses, a dietary pattern characterized by higher intakes of vegetables, fruits, legumes, fish, poultry, and whole grains was associated with a 28 per cent lower cardiovascular mortality, whereas a dietary pattern characterized by higher intakes of processed meat, red meat, refined grains, french fries, and sweets/desserts was associated with 22 per cent higher cardiovascular mortality (Heidemann, 2008). A meta-analysis carried out by Bazzano *et al* (2011) reviewed randomised controlled trials evaluating the effects of non-soy legume consumption on blood lipids and concluded that diets rich in legumes other than soya decreased total cholesterol and LDL cholesterol.

D. Significance of nutrition and diet counselling

The real wealth of a nation is its people. The purpose of development is to create an enabling environment for people to enjoy long, healthy and creative lives -Opening lines of First Human Development Report (1990).

Awareness of hypertension in Asia is more than 50 per cent in China and India, and these rates are far lower than in western countries. In addition, the treatment rate is lower in Asia, especially in low income countries (Perkovic *et al.*, 2007). In spite of the several barriers to this goal, including drug cost, there is a need for a primary healthcare system to identify high-risk individuals, and policy barriers that prevent implementation of programs to lower blood pressure. Efforts must be taken to increase awareness of hypertension and implement all possible policies to reduce and prevent it (Perkovic *et al.*, 2007). According to the statement from the ACCF/AHA/ACP (Merz *et al.*, 2009), prevention of cardiovascular morbidity and mortality is a shared responsibility among all health professionals involved in the care of people at risk of developing cardiovascular disease.

Cholesterol levels in the American population fell before the widespread use of cholesterol lowering medications, as the result of a combination of regulatory, public health, and individual approaches. The large and growing burden of hypertension, despite improved medical therapies, and increased awareness that dietary salt reduction can help prevent and treat hypertension reinforced the urgent need for dietary change (Domingo *et al.*, 2010). Studies by Jiménez *et al* (2011) supported the fact that health education was a cost-effective method and had a positive impact on knowledge of risk factors and warning signs of ischemic stroke.

According to Lin *et al* (2010) three intensive salt restriction counselling interventions reduce systolic and diastolic blood pressures by approximately 1.8 and 1.1 mm Hg in 12 months. Medium and high intensity diet and lifestyle interventions decreased systolic and diastolic blood pressures by 0.9 to 1.4 and 0.7 mm Hg along with decreased total cholesterol and LDL cholesterol levels.