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INTRODUCTION

Proper nutrition and exercise are widely known to prevent and reverse the ubiquitous national degenerative disease, but social connectivity plays a major role in protecting the mega-important organ – Heart and health by nature. Health which was deeply related to lifestyle will always remains a mirage, because everything in life is subject to change. Health may be described as a potentiality - the ability of an individual or a social group to modify himself or itself continually in the face of changing conditions of life not only in order to function better in the present but also to prepare for the future.

Living life in a healthier manner will help to create a strong body, strong mind and higher self-esteem which needs regular physical activity, lots of fruits and vegetables and protein in the diet and good amount of water. Do not smoke, drink or consume food additives or chemicals that would cause harm to the body.

Hyperlipidemia is an elevation in atherogenic lipoprotein particles including cholesterol, cholesterol esters and triglycerides and low HDL-cholesterol level. The causes of hyperlipidemia are lifestyle habits and heredity along with diabetes, kidney disease and an under active thyroid gland.

Hyperlipidemia is one of the major underlying causes for the several chronic diseases including coronary artery disease and thus leading to cardiovascular diseases. Hyperlipidemia has emerged as major contributors to the global burden of diseases and leading cause of death worldwide, particularly affecting most of the younger population in developing countries. The causes range from structural defects to infection, inflammation, environmental and heredity. Diet and exercise plays an important role in these chronic diseases.

Hypercholesterolemia, the other name for hyperlipidemia is the most common factor in causing coronary heart disease. Lipid metabolism can be

disturbed in different ways. It is leading to changes in plasma lipoprotein function and/or levels. This by itself and through interaction with other cardiovascular risk factors may affect the development of atherosclerosis. Therefore, dyslipidaemias cover a broad spectrum of lipid abnormalities, some of which are of great importance in coronary heart disease prevention. Dyslipidaemias may be related to other diseases (secondary dyslipidaemias) or to the interaction between genetic predisposition and environmental factors, since overweight, obesity and central obesity often contribute to dyslipidaemia. Overweight is defined as a BMI of 25 to 30 kg/m^2 and obesity as a BMI of 30 kg/m^2. Elevation of total cholesterol and low-density lipoprotein-cholesterol has received most attention, particularly because it can be modified by lifestyle changes and drug therapies (Sevket *et al.,* 2012).

According to National Commission on Macroeconomics and Health (NCMH), 62 million individuals would have coronary artery disease by 2015, of these 23 million would be younger than 40 years (Satyanarayana and Ramanarayana, 2011).

Globally, cardiovascular diseases are increasing substantially and will reach almost 23.6 million deaths by 2030 mainly from heart disease and stroke. Recent estimates of WHO says that 17.3 million people died of cardiovascular diseases in 2008, representing 30 per cent of all global deaths and over 80 per cent of deaths took place in low and middle income countries and occur equally in men and women (WHO, 2011).

In modern times, cardiac disease has emerged as the leading cause of death worldwide, particularly in developed countries. The World Health Organization (2008) reported that 16.7 million deaths in 2003 (29.2 per cent of total global deaths) were caused by some form of cardiovascular disease and is also on the rise comprising a major portion of non-communicable diseases. In 2010, of all projected worldwide deaths, 23 million are expected to be because of cardiovascular diseases. In fact, cardiovascular diseases would be the single largest cause of death in the world accounting for more than a third of all deaths.

Cardiovascular disease in India has quadrupled in the last 40 years and WHO estimates that by 2020 close to 60 per cent of cardiac patients worldwide will be Indian. The established risk factors of cardiovascular disease include lack of exercise, poor diet, hyperlipidemia and smoking (A new look at the cardiovascular crisis in India, Online, 2009).

Cardiovascular diseases are major contributors to the global burden of chronic diseases and in present scenario and as per the epidemiologists in India and International agencies such as WHO have been sounding an alarm on the rapidly rising burden of cardiovascular disease for the past 15 years (Gupta *et al.,* 2008). Mortality data from Global Burden of Diseases studies had revealed that cardiovascular diseases especially coronary heart disease is an important cause of death in India. Worldwide, of the 17.5 million deaths from cardiovascular diseases, 20 per cent deaths occurred in high income countries, 8 per cent in upper-middle income countries, 37 per cent in lower-middle income countries and 35 per cent in low income countries including India (Gupta and Gupta, 2009). Cardiovascular disease is currently the leading cause of death in India and its prevalence is projected to rise. In 2000, there were an estimated 30 million people with coronary heart disease alone in India (NCP, 2010 and Gupta *et al.,* 2012).

Coronary heart disease has risen from one per cent in 1960 to 11 per cent in 2003 and 14 per cent in 2011 in India's urban population. "To be an Indian is a risk for premature coronary artery disease" because of genetic predisposition and faulty lifestyle. Coronary heart disease is more extensive, diffuse, multi-vessel and is more premature in Indians as compared to their counterparts in the Western and European world. Timely drastic steps in lifestyle optimization, heart wellness programs and timely and effective medical and interventional management may help in curbing the rising menace of coronary heart disease in India. These diseases not only impact the wellbeing but can also hold back the economic growth of the country due to increased healthcare expenditure and diminished productivity. India is projected to lose approximately USD 237 billion between 2005-2015 due to cardiovascular diseases and diabetes (WHO, 2010 and International Heart Protection Summit, ASSOCHAM, 2011).

To date cardiovascular disease remains one of the leading causes of morbidity and mortality worldwide and the majority of deaths occur in low and middle-income countries such as India and China (WHO, 2011). Although genetic factors and age are important in determining the risk, the result is an increasing number of cases with intermediate risk factors and comorbidities - hypertension, hypercholesterolemia, dyslipidemia, insulin resistance, diabetes, obesity and lifestyle factors such as smoking and diet are also major in overall risk factors associated with the disease. India is not just the diabetic capital of the world with more than 50 million patients; it also has the highest prevalence of metabolic syndrome and obesity. Today 20 million Indians are obese with 70 million projected by 2025; 20 per cent of Indians suffer from hypertension (Joshi and Parikh, 2007).

Globally, almost 2 per cent of deaths from cardiovascular diseases are related to rheumatic heart disease, while 42 per cent to ischaemic heart disease and 34 per cent to cerebrovascular disease (WHO, 2010).

At the turn of the century, it was reported that coronary artery disease mortality was expected to increase approximately 29 per cent in women and 48 per cent in men in developed countries between 1990 and 2020. The corresponding estimated increases in developing countries were 120 per cent in women and 137 per cent in men. Coronary artery disease is the number one cause of death in adults from both low and middle income countries as well as from high-income countries (Lopez *et al.,* 2006).

The early half of the 20th century witnessed a rapidly growing epidemic of cardiovascular disease as a result of industrialization, urbanization, increased prosperity, consumption of fat rich junk foods and social upheaval in the higher income countries followed by an impressive decline in mortality during the latter half of the 20thcentury (Gersh *et al.,* 2010).

Similar situation was observed by Ebrahim *et al., (*2011) in India which faced rapid urbanization due to globalization and higher income levels, 31.8 per cent of them are living in urban areas which induced a nutritional shift resulting in the rise

of unhealthy food and decreased intake of fruits and vegetables and also led to a number of issues like reduced physical activity, unhygienic and overcrowded living conditions, growing levels of stress and higher exposure to pollution (Gupta *et al.,* 2011) thus leading to the increase in cardiovascular disease risk factors.

Improved healthcare in India has increased the average life expectancy from 48.8 years in 1970 to 64.1 years in 2009, resulting in a growing ageing population which faces an increased risk of heart diseases (World Bank, 2010).

According to Goyal and Yusuf (2006) it was estimated that 9.2 million productive years of life were lost in India in 2000, with an expected increase of 17.9 million years in 2030 (ten times the projected loss of productive life in the United States). The huge burden of cardiovascular diseases in the Indian subcontinent is the consequence of the large population and the high prevalence of cardiovascular disease risk factors.

The major cause for this burden is the rising rates of hypertension, dyslipidemia, diabetes, overweight, obesity, physical activity and tobacco use (WHO, 2012). These are the risk factors for cardiovascular diseases which are modifiable and are called intermediate risk factors or metabolic risk factors.

Yadav *et al.,* (2008) noted that pre-hypertension and hypertension were more prevalent in affluent urban North India and were associated with increasing age, body mass index, central obesity and impaired glucose tolerance and also with cardiovascular disease risk factors. Hypertension even more prevalent among urban (20-40 per cent) and rural adults (12-17 per cent) was affecting an estimated 118 million inhabitants in India in 2000; this number is projected to almost double to 214 million in 2025.

Many epidemiological studies indicated that along with the traditional Mediterranean lifestyle patterns - with diets rich in fruits and vegetables, olive oil, fish, nuts, complex grains and carbohydrates and red wine along with physical activity had a protective role against the development and progression of

cardiovascular disease which is one of the leading causes of morbidity and mortality worldwide. The other reasons are physical inactivity and unhealthy eating conditions (Sofi *et al.,* 2010).

Deng (2009) reported that imbalance of cholesterol level as a result of environmental and genetic factors leads to hypercholesterolemia, a predominant risk factor for atherosclerosis and associated coronary and cerebrovascular diseases.

Mathur and Shah (2011), revealed that the poor, the uneducated and marginalized sections of the society are the dominant victims of the adverse socio-economic and health consequences of tobacco. There is also preliminary evidence that the burden of cardiovascular disease in rural areas is increasing because of the consumption of tobacco.

Experimental and clinical studies conducted by Fernandez and Webb (2008) have shown that the amount of cholesterol transported in the VLDL, IDL and LDL classes of lipoproteins, known as pro-atherogenic cholesterol, is a risk factor for the occurrence of cardiovascular disease. In contrast, cholesterol transported in HDL particles known as anti-atherogenic cholesterol has protective effect on cardiovascular disease (Nicholls *et al.,* 2007).

Proper ranges of cholesterol are important in the prevention of heart attack or stroke. Total blood cholesterol above 200 mg/dl, LDL cholesterol above 130 mg/dl, HDL cholesterol below 35 mg/dl and lipoprotein (a) level greater than 30 mg/dl are indicators of problematic cholesterol. Cholesterol is not actually a damage mechanism but is more an indicator of compromised liver function and increased risk of heart attack (US Center for Disease Control, 2010).

According to Highlander and Shaw (2010) cardiovascular disease is often linked to obesity and diabetes mellitus and as a history of chronic kidney disease and hypercholesterolemia. In fact, cardiovascular diseases is the most life threatening of the diabetic complications and are two to four-fold more likely to die of cardiovascular related causes than non-diabetics (Kvan *et al.,* 2007).

According to one Online Medical Library, people who drink a moderate amount of alcohol have lower risk of coronary artery disease than do people who drink too much or do not drink at all. Alcohol increases the level of good cholesterol (HDL) and also decreases the risk of blood clots and inflammation and helps to protect the body from the by-products of cell activity. However, more than moderate alcohol consumption > 14 drinks per week for men and > 9 drinks per week for women can cause significant health problems and increase the risk of death (Booyse *et al.,* 2007).

Unlike many other chronic medical conditions, cardiovascular disease is treatable and reversible even after a long history of disease. Treatment is primarily focused on diet and stress reduction. Statins, a class of cholesterol-lowering drugs inhibiting cholesterol synthesis, have been most widely prescribed for treating hypercholesterolemia and reducing cardiovascular diseases as revealed by several workers (Ray *et al.,* 2006).

Combination of active ingredients certainly further enhances the therapeutic or preventive value of the food supplements (Micallef and Garg, 2008), which provide patients with a relatively cheap, safe and effective way to manage their cholesterol levels and subsequently reduce the cardiovascular risk. Further Deng (2009) opines that herbal remedies or food supplements have increasingly become attractive alternatives to prevent or treat hypercholesterolemia, especially for those with cholesterol at the borderline levels. Excellent safety profile, cost effectiveness and multiple beneficial effects on improving well-being all contribute to the emerging trend of increasing usage of dietary or herbal supplement in United States and around the world.

As the diet plays an important role in many of the lifestyle diseases, it is more important to emphasize on this in every individual's life. Hyperlipidemia is a potentially modifiable risk factor for cardiovascular morbidity (Filler *et al.,* 2012). Thus, the risk of cardiovascular diseases can be reduced by making modifications in the dietary habits and lifestyle pattern. At the present situation food based approaches are gaining importance in every individual's life. Hyperlipidemia is the

one that is affecting all the ages and the need to prevent it, is very much essential at this hour of time. Regular exercise also plays an important role in reducing the risk for heart disease by increasing good cholesterol.

Nutrition is a key factor in the living of a healthy lifestyle. One need to look at the quantity and quality they eat, lower the calories, make healthier choices and get educated. Diet plays a major role in many of the degenerative diseases. In particular, omega-3 fatty acids and dietary fibre are two important nutrient factors which have many health benefits.

Daily consumption of 5g of soy protein for 2 months reduced total serum cholesterol levels by 16.4 per cent, 7.8 per cent and 2.4 per cent in subjects with high, medium and low pre-treatment cholesterol levels, respectively.

Kris-Etherton *et al.,* (2008) review on nuts and cardiovascular disease, pooled data from four large epidemiological studies showed that people who ate a lot of nuts reduced their risk of heart disease by more than a third. Clinical studies that measured the effect of nuts on lipids, lipoproteins and various heart disease risk factors including oxidation, inflammation and vascular reactivity showed a beneficial effect but the cholesterol-lowering response seen was, “greater than expected on the basis of blood cholesterol-lowering equations that are derived from changes in the fatty acid profile of the diet.” In other words, nuts do more good things than explained by simply being ‘good fats.’ They also concluded that nuts and peanuts contain other bioactive compounds that explain their multiple cardiovascular benefits. Other macronutrients include plant protein and fiber; micronutrients including potassium, calcium, magnesium and tocopherols and phytochemicals such as phytosterols, phenolic compounds, resveratrol and arginine.

Omega-3 fatty acids are a group of polyunsaturated fatty acids that are important for a number of functions in the body. They cannot be synthesized in the body. Omega-3 fatty acids have also been linked directly to cardiovascular health benefits. The major sources of omega-3 essential fatty acids (linolenic acid [LNA]), are flax seed, soybean, canola, wheat germ and walnut oils (Medscape General

Medicine, 2005). Some types of omega-3s are found in foods such as fatty fish and shellfish.

Nuts such as macadamia nuts, brazil nuts, almonds, pecans and walnuts possess fibre and other nutrients that interfere with the absorption of fats, thereby keeping physically fit. Nuts and seeds offer protein, healthy fats, fiber, vitamin-E, magnesium and many other nutrients. The fact that a plant grows from a nut or seed indicates it is life sustaining. Many nuts and seeds offer alpha-linoleic acid, also known as ALA (a plant-based omega-3 fat), a type of health-protective omega-3 polyunsaturated fat. While ALA from plants is not as potent as the type of omega-3s found in fish, any omega-3 fat is better than none. Several studies over the past several years have shown the health benefits of nuts - which contain monounsaturated fat, vitamin-E, folic acid, magnesium, copper, protein and fibre and are rich in antioxidant phytochemicals. Nuts are high in fibre, including soluble fibre which can assist with reducing blood cholesterol levels by lowering cholesterol reabsorption from the gut (Ros, 2010).

Nuts are high in fat but are rich in the healthy fats – monounsaturated and polyunsaturated fats which are important for cholesterol lowering. Walnuts are also a rich source of alpha-linolenic acid. Research has shown that ALA from walnuts can reduce inflammation, similar to omega-3 fats from fish.

Nuts are a powerhouse of good nutrition that can dramatically reduce the risk of heart disease. It also has been shown to play an important role in helping to lower "bad" cholesterol levels and raise "good" cholesterol levels. In addition, they can help dilate blood vessels and prevent hardening of the arteries (www.webmd.com/diet/features/go-nuts-on-your-diet).

Omega-3 fatty acids are a group of polyunsaturated fats that have three double bonds between different carbon atoms and the bond is represented by the Greek letter omega. Animals, including humans, do not have the enzyme necessary to create double bonds naturally and must acquire the molecules from food. Linolenic acid and eicosapentaenoic acid are two members of the omega-3

fatty acid series. These are very essential for the body as they are unable to manufacture them on its own and play a fundamental role in several physiological functions. Eicosapentaenoic Acid (EPA) is believed to play a role in the prevention of cardiovascular disease, while Docosahexaenoic Acid (DHA) is necessary for proper brain and nerve development.

A generous intake of dietary fiber reduces the risk for developing the following diseases: coronary heart disease, stroke, hypertension, diabetes, obesity and certain gastrointestinal disorders. Furthermore, increased consumption of dietary fiber improves serum lipid concentrations, lowers blood pressure, improves blood glucose control in diabetes, promotes regularity, aids in weight loss and appears to improve immune function (Anderson *et al.,* 2009). Optimal intake of whole-grain foods, vegetables, fruits, legumes and nuts increases the daily intake of dietary fibre levels. By modulating food ingestion, digestion, absorption and metabolism, dietary fibres reduce the risk of hyperlipidemia, hypercholesterolemia and hyperglycemia (Kaczmarczyk *et al.,* 2012).

There is a burning need to understand the above modifiable factors through food based approaches (Ros, 2009). In a clinical study conducted on 16 subjects who had consumed a fiber enriched food supplement (46.2 per cent fiber, 16.5 per cent soluble and 29.7 per cent insoluble) for 21 days showed a decrease in total cholesterol levels by 5 to 7.5 per cent in 7 subjects and 8 to 11 per cent in 6 participants with no significant change in 3 subjects.

Epidemiological studies noted that the regular consumption of fibre-rich foods can protect the body against coronary heart disease and its major risk factors such as hypertension, obesity, diabetes and dyslipidemia. Soluble fibre is significantly effective in lowering the serum concentration of total and LDL cholesterol as well as regulating the blood sugar swings in the body (Fereshteh, 2013).

A wealth of epidemiologic studies have assessed associations between dietary exposures and coronary heart disease (Mente *et al.,* 2009), while many

clinical trials have shown the impact of dietary changes on cardiovascular risk factors, including hypercholesterolemia.

Flaxseed is a good source of dietary fiber and omega-3 fatty acids. The fiber in flaxseed is found primarily in the seed coat. Researchers believe this fiber binds with cholesterol in the intestine and prevents it from being absorbed. Flaxseed also seems to make platelets, the blood cells involved in clotting, less sticky. Overall, flaxseed's effects on cholesterol and blood clotting may lower the risk of "hardening of the arteries" (atherosclerosis). Each tablespoon of ground flaxseed contains about 1.8 g of plant omega-3s (http://www.mayoclinic.com/health/flaxseed/AN01258).

A study from Iowa State University's Nutrition and Wellness Research Center (NWRC) led by Suzanne *et al.,* (2010), examined the effects of flaxseed lignan in 90 people diagnosed with high cholesterol. The results showed that consuming 150 milligrams of flaxseed lignans per day (about three tablespoons) decreased cholesterol. It's the flaxseed lignans - a group of chemical compounds found in plants that are known for their protective health effects - that may help lower cholesterol. These compounds are converted to their bioactive forms by gut microbes. It was reported that healthy conversion among the subjects will not have any adverse health consequences (Fukumitsu *et al.,* 2010).

Peterson *et al.,* (2010) reported that five out of 11 studies reported increased dietary intake of lignans, which is a rich source of flaxseed, reduces the risk of cardiovascular disease.

A handful of nuts (30g) at least five times a week may reduce the risk of developing heart disease by 30-50 per cent (Blomhoff *et al.,* 2007) and Type-2 diabetes by 27 per cent. This is due to the wide range of heart healthy nutrients that nuts contain - healthy fats, fibre, antioxidants, vitamins such as vitamin-E and folate, minerals such as magnesium, selenium and zinc, plant sterols and arginine. This was even supported by the Iowa Women's Health Study and The Physicians Health Study. It also contains a low Glycemic Index effect and they play a role in improving insulin sensitivity (Casas *et al.,* 2011).

Sabate *et al.,* (2010), signifies that two handfuls of nuts a day (67g on average) significantly lowers blood cholesterol by 5 per cent particularly LDL cholesterol by 7 per cent. The healthy fats, fibre and plant sterols that nuts contain may help to regulate cholesterol production.

On an average, 85 per cent of the fat in nuts is from heart-healthy mono- and polyunsaturated fats, with walnuts having a unique profile in that they are rich in n-6 (linoleate) and n-3 (linolenate) polyunsaturated fatty acids. Nuts are also natural cholesterol and *trans* fat-free and many are low in saturated fat as reported by Nutrition Update (2007).

Polyunsaturated Fatty Acids (PUFA) have beneficial effects on cardiovascular risk, although the mechanisms are incompletely understood, there showed significant reductions in low-density lipoprotein cholesterol and several markers of inflammation with increasing intake of alpha-linolenic acid from walnuts and flax (West *et al.,* 2010).

Fulgoni *et al*., (2010) recommend that by adding nuts to the diet not only improves the quality of diet but also helps to meet the daily nutrient intake as they are nutrient dense. Nuts are nature's own vitamin pill with small packages that contain more than 28 different nutrients. Each nut variety has a unique combination of nutrients.

Nuts are rich sources of plant protein, dietary fiber, antioxidant, vitamins, minerals and numerous bioactive substances that may have health benefits. Omega-3s are most abundant in seafood and certain nuts and seeds such as flaxseeds and walnuts. Eating nuts reduces the risk of developing blood clots and also improves the health of the lining of arteries.

Based on the above studies and the natural way of cardio-protective effect of nuts and fibre on hyperlipidemia, health risks of cardiovascular diseases, the present study entitled **"Hypolipidemic effect of high fiber and omega 3 rich foods"** is carried out with the following objectives

- Elicit information on demographic profile, dietary and lifestyle pattern of hyperlipidemics.
- Assess the nutritional status - such as anthropometric measurements, dietary assessment and biochemical parameters.
- Evaluate the hypolipidemic effect of underexploited foods rich in omega - 3 fatty acids and high fiber.
- Analyze correlation between the economic status and cardiovascular disease.

Hope that this little effort will give the hyperlipidemics about the importance of various nuts like almond, walnut and flaxseed and its health benefits in reducing the risk factor of cardiovascular diseases and complications. This may help the hyperlipidemics to control and manage their cholesterol levels through food based approach without any side effects.