
SUMMARY AND CONCLUSION

Hyperlipidemia is one of the leading causes of various chronic degenerative diseases. It is a major risk factor of coronary heart disease and other cardiovascular diseases. Cardiovascular diseases are an important cause of morbidity and mortality in developed and developing countries. Apart from hyperlipidemia the other risk factors includes cigarette smoking, hypertension, diabetes mellitus, obesity, age, sex and genetics, lifestyle disorders have been recognized as contributing to the risk of developing cardiovascular disease.

A substantial proportion of population in India is exhibiting increasing prevalence of cardiovascular disease and associated risk factors. Precious life is snatched away when person is in the most productive stage of life, when the social and family responsibilities are the greatest.

Therapeutic medicine is not the only solution and there is strong reason to support that environmental factors are of major importance in the chronic diseases and therefore the prevailing epidemic of cardiovascular disease is not an unavoidable consequence of economic development. The importance of a healthy lifestyle in the prevention of disease is widely understood and most people know that lifestyle changes and choices can be critical in determining their health and lifespan.

The relationship between dietary factors and cardiovascular diseases has been a major focus of health research for almost half a century. Nuts are particularly nutrient dense food, comprising of a range of nutrients which can contribute to a reduced risk of cardiovascular diseases and maintaining heart health. These include healthy fats, dietary fibre, arginine, plant sterols and range of vitamins and minerals known to be important for heart health, including folate, magnesium, potassium, zinc, copper and vitamin-E.

Therefore nuts contribute an indispensable part of the hyperlipidemia management though it is cost effective, it is easy to access, provides various health benefits which mainly helps in weight reduction, lower the blood cholesterol levels, blood glucose levels, increases the HDL cholesterol, provides satiety with fewer calories, maintains healthy blood vessels and nervous system, boost blood circulation, supports immune system, promotes and strengthens bone health, regulates fat metabolism, hormones and central nervous system and other beneficial antioxidant properties.

Keeping this in mind the investigator has taken up the study entitled “Hypolipidemic effect of high fiber and omega 3 rich foods” 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.
- ❖ Analyse correlation between the economic status and cardiovascular disease.

One thousand hyperlipidemic subjects from “Care Hospitals” in Hyderabad city was selected for the study. The selected hyperlipidemics were from both the sexes and in the age group of 35-75 years. A questionnaire was framed to obtain information from the selected hyperlipidemics regarding the demographic profile, occupation, activity pattern, type and income of the family. Dietary pattern, food consumption pattern, type of oils used for cooking, lifestyle pattern such as exercise, coffee and alcohol consumption, smoking pattern, personal and family history of the hyperlipidemic subjects were also collected. Data on anthropometric measurements, biochemical parameters such as blood lipid profile were recorded.

Of the selected one thousand hyperlipidemic subjects, 150 subjects from age group of 40-60years and total cholesterol level >240 mg/dl were chosen for the dietary intervention study. Out of whom 150 hyperlipidemic subjects were included in the four experimental groups (N=30 per group) and the remaining 30 were in the control group. Ethical clearance was obtained by the Institutional Human Ethical Committee of Avinashilingam University, Coimbatore (HEC.2011.30). Written consent was obtained from all the hyperlipidemics before the initiation of the dietary intervention.

For the selected hyperlipidemics in the FAW group, 20g of flaxseed, almond and walnut powder was supplemented. Selected hyperlipidemics of thirty subjects in the AW group, almond and walnut (20 g) are used as such for the intervention. In another group FG, flaxseed and garlic (20 g) was supplemented. Flaxseed powder of 20 g was given to the thirty selected hyperlipidemics in the FS group. Selected ingredients for the group are roasted, powdered, packed and distributed to the hyperlipidemic subjects in person and they were asked to consume along with their daily meals for a period of 90 days. The control group (N=30) did not receive any supplementation during the intervention period. Anthropometric measurements and blood lipid profile was done for the experimental and control group before and after the intervention period of 90 days.

The research findings arising out of the study were summarized as follows

- Among the 1000 subjects selected, 441 were male and 559 were female hyperlipidemic subjects in the age group of 35-70 years, with the maximum percentage of 29.1 and the minimum percentage of 14.6 hyperlipidemics belonged to the age group of 46-55 years and 66-75 years respectively.
- It was heart-warming to note that there are no illiterates and a very few per cent of both male (1.4) and female (3.2) were educated upto primary school level. All others were educated upto high school and college level.
- The data regarding the occupational status showed that out of one thousand hyperlipidemics, a lowest of only 2.9 per cent was agriculturist and

a highest of 24.6 per cent were professionals. With regard to females, 15.6 per cent were housewives, 16 per cent were doing business, 18.4 per cent were holding Government/private jobs and 22.5 per cent were retired.

- Of the male hyperlipidemics, maximum (67.1 per cent) of them were doing sedentary activity, minimum (10.2 per cent) of them were doing heavy activity and 22.7 per cent were of moderate activity group. Among the female hyperlipidemics, a maximum (57.6 per cent) of them were doing sedentary activity, a lower percentage of 28.8 per cent were of moderate activity and 13.6 per cent were doing heavy activity.
- Among the hyperlipidemics, three fourth of the hyperlipidemics (75 per cent) belong to the nuclear family where as one fourth (25 per cent) of them belong to the joint family system.
- The data collected on income level of the hyperlipidemics showed that almost fifty per cent of the hyperlipidemics belongs to the high income group and few of nine per cent belongs to the low income group.
- Out of the selected hyperlipidemics, 48.6 per cent were non-vegetarians, 37.5 were vegetarians and only 13.9 per cent were ova-vegetarians.
- The data on food consumption pattern reveals that 73 per cent of male and 74 per cent of female hyperlipidemics respectively consumed 6-8 servings of cereals. Whereas the pulse consumption was less than four servings per day in both male and female hyperlipidemics respectively.
- The percentage of vegetable consumption was high among the female (68 per cent) hyperlipidemics when compared with the male (27 per cent) hyperlipidemics who had 3-5 servings per day. The fruit consumption among the male hyperlipidemics was 53 per cent whereas females consumed only 37 per cent who had 2-4 servings per day.
- With regard to the consumption of flesh foods male (46 per cent) hyperlipidemics were consuming twice a week whereas female (72 per cent) hyperlipidemics consumed these foods once in a week.

- At the time of the survey, majority of the hyperlipidemics subjects reported that they were using sunflower oil and keep changing the oil every month. The other oils used in the order of preference were rice bran oil, olive oil, groundnut oil and coconut oil.
- With respect to the frequency of consumption of alcohol, 17.5 per cent were found to be taking occasionally, 12.2 per cent were found to be taking twice a week and only 9 per cent were taking on daily basis of 100 ml. Thirty six hyperlipidemic subjects were found to be consuming 150 ml occasionally. Among the 96 hyperlipidemic individuals 15.2 per cent were found to be consuming twice a week and only 6.6 per cent were found to be consuming 200 ml once a week. It is very heart-warming to note that none of the female subjects had a habit of alcohol consumption or smoking. Data reveals that only forty subjects stopped the habit of drinking after the onset of this disorder. Seventy per cent of the male hyperlipidemics was continued to consume alcohol and could not give up the habit of drinking. This reveals that 'Habits die hard'.
- The coffee consumption among the male and female hyperlipidemics was 41 and 20.2 per cent respectively and was taking 150 ml daily.
- Among the 54 per cent of the male hyperlipidemics who smoke, 34.5 per cent smoke 3-5 times per day, 11.6 per cent smoke more than five cigarettes per day and only 8.1 per cent smoke cigarettes occasionally.
- Data revealed that most of the male and female hyperlipidemics adopted mild and moderate exercise pattern. Majority of the subjects of 62 per cent were engaged in mild exercise which includes normal walking, household work and gardening. Thirty four per cent were engaged in moderate exercise which involves brisk walking, jogging and yoga.
- From the data, both male (43 per cent) and female (28 per cent) subjects had the incidence of the elevated levels of total serum cholesterol for the past five years.

- With regard to the mode of treatment majority of the hyperlipidemics adopted allopathy medicine for immediate relief and recovery. Among others 23 and 32 per cent of male and female hyperlipidemics respectively adopted homeopathic treatment.
- The sign and symptoms observed among the selected hyperlipidemics were weakness, shortness of breath, anxiety, fatigue and memory loss.
- Data on anthropometry, the mean height of the male hyperlipidemics shows that only one-fourth were in comparison with the reference standard height for man (174 cm) and 44 per cent of the female hyperlipidemics were in comparison with reference standard height for woman (163.8 cm).
- Among the selected male hyperlipidemics only 8 per cent were meeting the reference standard weight for man (60 kg) and the remaining hyperlipidemics were above the standard weight. In case of female hyperlipidemics one-fourth of them were found to be on par with the reference standard weight for woman (55 kg).
- Alarming fact recorded in the study about BMI was that 46 and 32 per cent of male and female hyperlipidemics were found to have BMI of more than 25 and less than 30, which is considered as pre-obese or overweight category. Thirty one per cent of male hyperlipidemics and 37 per cent of female hyperlipidemics are in the normal category. Of the selected hyperlipidemics, two and six per cent of male and female hyperlipidemics fall in the underweight category.
- With regard to the waist hip ratio, 52 per cent of the male hyperlipidemics were having normal waist hip ratio and the remaining 48 per cent were obese. In the case of female hyperlipidemics, 63 per cent were found to have normal waist hip ratio whereas 37 per cent were found to be in the obese category.
- Data on lipid profile recorded for the selected 1000 hyperlipidemics, total cholesterol, LDL cholesterol, triglycerides and VLDL cholesterol levels was

comparatively higher than the desirable values except for the HDL cholesterol which is less than the desirable value. Results revealed that the mean total cholesterol levels of the male hyperlipidemics were found to be 261.9 mg/dl and female hyperlipidemics was 250.2 mg/dl who are in the “At Risk” category.

Out of the 1000 hyperlipidemics, 150 hyperlipidemics were selected for the dietary intervention program. Data on anthropometry, dietary intake and lipid profile were collected before and after the intervention and the findings were summarized as follows:

- With regard to the mean body weight of the subjects in flaxseed, almond and walnut (FAW) supplemented group, a significant reduction of 2.7 and 2.3 kg was observed in male and female hyperlipidemics respectively after the intervention period. The reduction in body weight observed for male and female hyperlipidemics in the almond and walnut (AW) supplemented group was 2.6 and 3.3kg respectively. Similar results were also observed in flaxseed and garlic (FG) group. With regard to the body weight, the findings of the flaxseed (FS) group recorded a reduction of 2.8 kg respectively both in male and female hyperlipidemics after the intervention period of three months. The control group did not show any difference in the body weight after the intervention period.
- Intake of cereals, pulses, roots and tubers, green leafy vegetables, other vegetables, fruits and milk and milk products except for the fats and oils and sugar and jaggery (which are in excess) were deficit when compared to recommended allowances among the male hyperlipidemics of the experimental group before the intervention. After the intervention the intake of all the food groups was deficit and showed same trend as initial when compared to recommended dietary allowances. The control group showed a deficit in the intake of all the food groups except fats and oils and sugar and jaggery which are in excess before and after the intervention period when compared to recommended allowances.

- With regard to the daily nutrient intake by the male hyperlipidemics before the intervention period was deficit in energy, protein, fibre, iron, beta carotene, riboflavin and niacin whereas other nutrients namely fat, calcium, thiamine and ascorbic acid were excess when compared with RDA. Similar trend was observed even after the intervention period except for calcium (deficit) and riboflavin (excess) when compared to RDA.
- In the case of female hyperlipidemics of the experimental group, there was deficit in the food intake of all the food groups except for the fats and oils and sugar and jaggery (which are in excess) before the intervention when compared to RDA. After the intervention period all the foods groups were deficit. The control group showed deficit in all the food groups except for the fats and oils and sugar and jaggery which are in excess before and after the intervention period when compared with RDA.
- The daily intake of the nutrients by the female hyperlipidemics before the intervention period was deficit for energy, protein, fibre, iron, beta carotene, thiamine and niacin and other nutrients like fat, calcium, riboflavin and ascorbic acid were excess when compared to recommended dietary allowances. Except for thiamine and niacin, other nutrients followed the same trend that of their initial values. The control group showed an excess in energy, fat, calcium, riboflavin and ascorbic acid and deficit in the nutrients like protein, fibre, iron, beta carotene, thiamine and niacin before the intervention period. After the intervention period fibre, iron and beta carotene were deficit whereas other nutrients were excess when compared with RDA.
- Supplementation with flaxseed, almond and walnut (FAW) powder brought about significant reduction in total cholesterol, LDL cholesterol, triglycerides, VLDL cholesterol and TC/HDL ratio at ($P < 0.01$) level whereas HDL cholesterol levels had been increased significantly after the intervention period. When compared the initial lipid parameters of the FAW and control group statistical significance was not observed for total cholesterol,

LDL cholesterol and HDL cholesterol levels but significance at ($P<0.01$) level was seen for triglycerides and VLDL cholesterol and TC/HDL ratio shown to be significant at ($P<0.05$). Significant difference at ($P<0.01$) level was recorded between the FAW and control group for the lipid profile values.

- It was evident from the results that AW group comprising thirty hyperlipidemic male and female subjects who were supplemented with almond and walnut showed a marked decrease in the total cholesterol, LDL cholesterol, triglycerides, VLDL cholesterol and TC/HDL ratio after the intervention. The initial and final levels of AW group was statistically analysed and found to be significant at ($P<0.01$) level. The HDL cholesterol level showed a notable increase with a mean difference of 10.13 mg/dl after the intervention and showed a statistical significance at ($P<0.01$) level. When the initial values of the experimental and control group were analysed statistical significance was found in the triglyceride and VLDL cholesterol at ($P<0.01$) level and TC/HDL ratio at ($P<0.05$) level respectively. The difference of the lipid profile between the AW and control group were analysed statistically and found to be significant at ($P<0.01$) level.
- Marked significant decrease was observed in the mean difference of total cholesterol (38.83 mg/dl), LDL cholesterol (47.27 mg/dl), triglycerides (20.27 mg/dl), VLDL cholesterol (4.13 mg/dl) and TC/HDL ratio (2.22) was recorded for the group supplemented with flaxseed and garlic (FG) during the intervention period. Notable increase was observed in the mean difference of HDL cholesterol (12.57 mg/dl). Statistical significance was recorded at ($P<0.01$) level between the difference of FG and control group. The initial levels of the FG and control group showed significance at ($P<0.01$) level except for total cholesterol, LDL cholesterol and TC/HDL ratio.
- When comparison was made between the initial and final levels of the group supplemented with flaxseed of FS group showed a marked significant

difference at ($P < 0.01$) level after the intervention period of three months for total cholesterol (45.03 mg/dl), LDL cholesterol (51.17 mg/dl), triglycerides (22.30 mg/dl), VLDL cholesterol (4.63 mg/dl) and TC/HDL ratio (2.08). Marked significant increase was seen in HDL cholesterol level (10.77 mg/dl). No significant difference was found between the initials of FS and control group except for triglycerides and VLDL cholesterol which are significant at ($P < 0.01$) level. It was statistically proved that significant difference was observed at ($P < 0.01$) level between FS and control group.

- The mean difference and the test of significance values obtained were compared within the intervention groups, the group supplemented with FAW was found to be the best in lowering total cholesterol and triglycerides levels when compared to other groups.
- Statistical correlation was computed between the income and cholesterol levels of the one thousand hyperlipidemic subjects selected, the chi-square analysis revealed that the income level had influence on the cholesterol levels ($\chi^2 = 15.730$, $P < 0.01$). Therefore, the hypothesis concluded that as the income level increases cholesterol level also increases and is associated with one another.
- Correlation was computed using chi-square analysis between the activity and cholesterol levels of the one thousand hyperlipidemics reveals that the activity level effects the cholesterol levels among the individuals ($\chi^2 = 32.919$ $P < 0.01$). Hence it can be concluded that the activity level is a major player towards lowering cholesterol levels.
- The hypothesis set for the correlation is when fat consumption increases total cholesterol levels may increase or decrease depending on the type of fat consumed by the individual. The fat consumption by the individual was calculated and computed for correlation. The 'r' value is 0.097 and compared to be low degree correlation

- The correlation between the cholesterol levels and body weight of the hyperlipidemics subjects was recorded and computed for the experimental groups, the results showed that r value is 0.92 and considered to be high degree correlation.

CONCLUSION

Around the world, health authorities recommend to eat more plant foods for good health. Plant foods including fruits, vegetables, nuts, mushrooms, legumes grains and seeds – protect against many of the common lifestyle-related health issues. Nuts like walnut, almond and flaxseed are major source of omega-3 fatty acids and high in fiber, low in saturated fats, packed with heart-healthy unsaturated fats and very high in antioxidants and important vitamins and minerals – they're nature's own vitamin pill and ready-to-eat snack food. Nuts are high in polyphenol antioxidants, which helps in binding to lipoproteins would inhibit oxidative processes that lead to atherosclerosis *in vivo*. In particular, including nuts in daily diet may improve heart health and cholesterol levels, help to protect against diabetes, as well as assist with weight control. In human supplementation studies nuts have been shown to improve the lipid profile, increase endothelial function and reduce inflammation, all without causing weight gain. These qualities make nuts a nutritious healthy snack and food additive providing both nutrients and bioactive antioxidants which provide significant health benefits to the consumer.

As for young and middle-aged adults, it is the time to start making fiber a big part of daily diet. The present study revealed that starting a high-fiber and omega-3 rich diet may help to improve long-term risk like hyperlipidemia and cardiovascular problems. It's important to ensure that the fiber and omega 3 in daily diet comes mostly from raw vegetables, nuts and seeds (including flaxseeds, almonds and walnuts) with minimal amounts from fruit and whole grains to maximize health protection against hyperlipidemia and its risk factors.

The present study concluded that the intervention of flaxseed, walnut and almond helps to reduce body weight and had hypolipidemic effect, because of the nutrient dense quality. Hence, we can conclude that flaxseed, almond, walnut

combination provides a safe and relatively inexpensive alternative for reducing cholesterol and thereby the risk of cardiovascular disease complications.

RECOMMENDATIONS FOR THE FUTURE RESEARCH

- ❖ Cardio-protection must become an essential component of modern therapy. Further research has to be conducted to find out the interrelationship between phytoestrogen and cardiovascular disease risk among the population.
- ❖ Value added flaxseed products can be developed and evaluated for its acceptability and shelf life.
- ❖ Fatty acid composition of walnuts, almonds and flaxseed is an area of interest. ALA to DHA and EPA conversion ratios in the context of Indian diet should be investigated.
- ❖ Studies are necessary to determine antioxidant potential of nuts.
- ❖ Future research can be carried out to shed important light on the potential health benefits of both flaxseed and flaxseed oil.
- ❖ Long-term studies targeting effects of nut consumption on metabolic syndrome, diabetes, coronary heart disease events and risk for chronic degenerative diseases can be another thrust area.
- ❖ In future benefits of walnuts for bone health to be demonstrated.