SUMMARY AND CONCLUSION

Among women with increase in age, bone mass start decreasing as early as 30 years of age. Bone formation reaches the peak in the mid 20's and continues till the age of 30 years after which the bone resorption gradually becomes faster than the development of new bone. Healthy lifestyle, diet, exercise and other factors can have a major positive impact on the bone metabolism and bone health. Public health measures are recommended for the population at large as they are efficacious, safe and cost effective. Nutritional supplements play a major role and can help to strengthen the cartilage and joints which may decrease due to the onset of the disease.

There is an urgent need for greater public awareness about low bone mass disorder. For middle aged and elderly women early detection and treatment of low bone mass disorder can significantly reduce the risk of fractures and associated morbidity and mortality. Women need to concentrate on lifestyle management, dietary pattern, food supplements and weight bearing exercise to reduce the fracture risk and lead a healthy life. With this background the present study was planned with the following objectives

- To collect information on socio-economic background, lifestyle pattern and dietary details and assess the nutritional and health status of selected women
- To assess the Bone Mineral Density (BMD) and find out the incidence of osteopenia and low bone mass disorder among the selected women
- To develop nutrient rich mixes to overcome bone related problems and study the effect of supplementation on selected osteopenic women
- To plan and conduct nutrition education and evaluate the impact on knowledge of nutrition among selected women.

The area selected for the present study was Coimbatore District which is the third largest district and second most popular city in Tamilnadu, India. In Coimbatore district 8 rural areas like Thudiyalur, Kavundampalayam, Vadavalli, Madukkarai, Thondamuthur, Palladam, Sultanpet, Sulur and 4 urban areas like Selvapuram, Saibaba Colony, Peelamedu and Gandhipuram were selected for the study. Help was obtained from five hospitals and two pharmacies located in Coimbatore city for conduct of Bone Health Awareness camps.

An interview schedule was administered among the selected women to elicit the socio-economic, dietary and other background details. All the 2230 women aged 21- 70 years who attended the health camps were interviewed using the interview schedule in convenient places and times.

For assessing the nutritional status anthropometric measurements such as height, weight, waist circumference and hip circumference were recorded for all the selected women. The Bone Mineral Density test to assess the prevalence of low bone mass disorder and osteopenia was done by ultra sound method for all the 2230 selected women and the data was recorded and analysed as normal, osteopenia and osteoporosis. Clinical examination was carried out for all the selected women with the help of a medical practitioner. Haemoglobin estimation was done for all the selected women. Biochemical tests such as blood glucose, serum calcium, phosphorus and cholesterol were done using standardised procedures for a subsample of women.

The food intake of a subsample of 120 women was assessed through a 24 hour recall method for three days and the quantity of food consumed was found out using standard method. From the mean food intake, nutrient intake was computed and compared with the Recommended Dietary Allowance (RDA) given by ICMR (2010). Based on the food intake data it was found that calcium and phosphorus intake was inadequate among the selected women.

Dietary supplements combined with normal food intake may show improvement in bone health.

In consultation with doctors and nutritionists, nutrient rich nutri mixes were planned for supplementation study for the osteopenic women to meet the daily requirements that helps in improving the calcium nutriture. The ingredients selected for nutri mixes included ragi flour, soya flour, wheat flour, milk powder, flax seeds and oats based on their calcium and protein content and other trace minerals. Various proportions of ingredients were tried out for the preparation of basic mix, nutri mix I and II with sesame seeds and groundnuts and they were evaluated for acceptability by hedonic scoring. The mixes with high scores were finalised for supplementation study.

The nutrients namely energy, carbohydrate, fat, protein, fibre, calcium, iron, phosphorus, moisture, ash, vitamin B group and D were analysed in basic mix, nutri mix I and II by standard procedures.. Shelf life of nutri mixes was evaluated through microbial tests like total bacterial count, yeast and mould count and keeping quality of the nutri mixes was tested for 3 months, but nutri mixes were prepared once in a week and given for supplementation. The cost of the nutri mixes was also computed.

Among the 2230 women taken for general survey 245 women were screened for intervention study and were briefed about the food supplementation and nutrition education and the benefits. Among them 120 osteopenic women in the age group of 30 – 45 yrs with normal BMI, free from menopause, chronic diseases and other health complications were selected after getting their willingness for the supplementation study.

They were divided into three groups with 40 women in each group. The two experimental groups were provided with nutri mix I and II respectively and the group without supplementation acted as control. For experimental groups 50 g of nutri mix I and II each per day was given for 5 months respectively. At the beginning and end of supplementation period, anthropometric measurements, clinical and biochemical tests were performed. Bone Mineral

Density test, blood glucose, cholesterol, serum calcium and haemoglobin were measured at the initial and final phase of supplementation study.

To improve nutrition knowledge through education, nutrition education was conducted for a period of 2 hrs per week for 3 months for 125 osteopenic women highlighting on healthy diet, low cost nutritious foods, role of nutrients and disease management, women's health issues, identification of bone related complications, management and treatment etc.

Based on the nutrition knowledge of the selected women, nutritional counselling was given on various aspects in the management of osteopenia. Various teaching aids such as booklets, pamphlets, charts, powerpoint presentations were used along with lecture method, demonstration, individual contacts etc. A questionnaire was formulated to elicit the information regarding the nutrition knowledge of the selected women at the initial and final stage after the nutrition education. The impact of nutrition education was evaluated by comparing the KAP scores before and after nutrition education. As part of nutrition education, life style management exercises and physiotherapy treatment sessions for 2 hours per week for 3 months was conducted and feedback was collected.

As part of entrepreneurial activity, demonstration and training on the preparation of nutri mixes were imparted to a group of selected women. Various traditional recipe preparations namely ladoos, kollukattai, cookies, adai, idiyappam, plain puttu, sweet puttu, kolaputtu and health drink using the nutri mixes were demonstrated to women in groups during convenient times. With a view of popularization and commercialisation of the nutri mixes, cookies were also prepared using the nutri mix powders. Marketing of the nutri mix powder and cookies was also done with the support of the hospital authorities and pharmacies.

Salient Findings of the study

Phase I Socio-Economic, Food Consumption, Life Style and Other Background Details

- A total of 2230 women were included for the present study and among them a majority of 32 per cent belonged to 31 to 40 years of age and a minority of 9 per cent were between 61 to 70 years of age.
- With regard to educational status 26 per cent being the majority had higher secondary education. It is discouraging to note that 11 per cent did not have any education. Regarding occupation 62 per cent being the majority were employed in business (17%) and a least of 12 per cent were retired from jobs.
- A majority of 89 per cent were married and a minority of 11 per cent unmarried. It is seen that 61 per cent of the selected women belonged to nuclear family type and 39 per cent belonged to joint family system.
- Among the selected families 63 per cent belonged to middle income category with Rs. 7,301 to Rs.14,500 as monthly income, 20 per cent high income and only 17 per cent low income category.
- A majority of 89 per cent of the selected families of women spent 0 - 25 per cent and a minority of 3 per cent spent 51 - 75 per cent of their income towards food. Among the selected women a majority of them spent 0 - 25 per cent of their income on clothing, house rent, education and medicine, other services, savings and recreation.
- A majority of 58 per cent of the selected women were following non vegetarian diet pattern followed by vegetarians 27 per cent and a minority of 15 per cent ova-vegetarians. Vegetarian food supply better amount of vitamins and minerals and help in enhanced bone metabolism.
- Among the selected women a majority of 59 per cent followed three meal pattern and 14 per cent had more than three meals and a minority had irregular meals. A majority of 64 per cent of the selected women followed regular food consumption and a minority (36%) were skipping their meals.

- A majority of 58 per cent of the selected women did not restrict any foods and a minority of 42 per cent of them avoided certain foods in their diet like milk products (26%), nuts and oilseeds (23%), fried items (19%), specific fruits and vegetables (18%), preserved products (17%) and sweets (14%).
- Among the selected women, a majority consumed daily like milk products (14%), non vegetarian foods (6%) and greens (4%) and calcium rich foods consumption on a weekly basis included non vegetarian foods (63%), ladies finger (47%), soya products (26%) and sesame seeds. Vitamin D rich foods like milk products, sea foods, liver and egg were consumed by the selected women either weekly or monthly once and sometimes rarely.
- Among the selected women 60 per cent consumed fast foods occasionally, 25 per cent consumed daily and 15 per cent avoided fast foods consumption. It is observed that 16 per cent of the selected women consumed homemade dietary supplements, 11 per cent consumed commercial food supplements, 7 per cent took multi vitamin supplements and 4 per cent had calcium supplements.
- A maximum of 46 per cent women preferred coffee, 39 per cent tea and 15 per cent had health drinks. It is observed that 45 per cent consumed 2 to 4 cups of the specific beverage every day, 28 per cent had more than 4 cups and 27 per cent consumed 2 cups of beverage per day.
- About 67 per cent of the selected women did not have the habit of chewing betel leaves, pan masala, supari and tobacco.
- Almost 61 per cent of women did not have the habit of doing any exercise, 24 per cent did mild exercise and 15 per cent moderate exercise. Among them 86 per cent did not have the habit of practising yoga or meditation and only 12 per cent performed yoga and meditation.
- About 61 per cent of the selected women had 6 to 8 hours of sleep and minority of 9 per cent had more than 8 hours of sleep.

- ❖ Among the selected women, 37 per cent being the maximum had stress due to their family members, 25 per cent with occupational stress, 21 per cent other reasons for stress and 17 per cent had a relaxed life style.
- ❖ A majority of 63 per cent had the habit of watching television, 12 per cent hearing music, 9 per cent doing outdoor activities and shopping and 8 per cent each reading books and other activities during their leisure time.

Phase II Nutritional, Health Status and Bone Health Profile

- ❖ Among the selected women 37 per cent had the normal height of 161 cm to 170 cm and a minimum of 12 per cent had 171 cm of height. The mean height of women was 159 cm which is 2 cm less than ICMR reference height.
- ❖ A maximum of 34 per cent had less than 50 kg body weight and 15 per cent had body weight above 71 kg. The mean weight of the selected women was 56.91 kg which is slightly higher than ICMR reference value of 56 kg.
- ❖ It is found that about 33 per cent of the selected women had normal BMI as suggested by WHO (2011) and observed that 40 per cent of them had BMI below the normal level of less than 18.5. Among them 15 per cent were in obese category and 12 per cent were in overweight category.
- ❖ A majority of 52 per cent had a normal Waist to Hip Ratio less than 0.8, 27 per cent at moderate risk (0.81 to 0.85) and a least of 21 per cent (above 0.85) at high risk.
- ❖ BMD Test of selected women revealed that a majority of 53 per cent were under normal category of BMD scores. But 29 per cent had osteopenia with T scores -1.0 to 2.5 and 18 per cent had osteoporosis with T scores ≤ - 2.5.
- ❖ A majority of women expressed that they had sleep disturbance (64%), inability to work (63%), mental tension (61%), followed by tiredness

(54%), shoulder pain (53%), hair fall (52%) back pain(51%) and joint pain (44%).

- A maximum of 35 per cent of the selected women had normal blood pressure, 29 per cent came under pre-hypertension stage, 18 per cent had low blood pressure and 18 per cent had high blood pressure.
- Among the selected women 31 per cent had normal haemoglobin levels (>12 g / dl) and 46 per cent had moderate anaemia and about 9 per cent had severe anaemia.
- A majority of 54 per cent of the selected women had low serum calcium levels (8 to 9 mg / dl), 23 per cent had normal serum calcium (9 to 10.6mg/dl) and 14 per cent had elevated serum calcium (>10.6 mg / dl) and 9 per cent had very low serum calcium levels (7 to 8 mg / dl).
- The mean food intake of the subsample compared with the ICMR RDA revealed that cereal consumption was deficit by 11.1 per cent and pulse consumption was excess by 8.3 per cent.
- Consumption of roots and tubers, green leafy vegetables, other vegetables and fruits was found to be inadequate by 62.5, 30, 40 and 35 per cent respectively. Milk and milk product consumption was deficit by 46.7per cent. Fat, sugar and jaggery intake was excess by 50 and 75per cent respectively. Nuts and oilseeds intake was deficit by 40 per cent when compared with the RDA.
- Energy intake of the selected women was deficit by 16.6 per cent and protein intake was excess by 12.7 per cent compared to RDA. Fat consumption was excess by 44 per cent.
- A deficit intake of calcium by 26.7 per cent was observed leading to poor bone health. Iron intake was deficit by 19 per cent compared to RDA being the cause of anaemia incidence among the selected women.

- Beta carotene and vitamin C intake was deficit by 25.6 and 32.5 per cent respectively. B – vitamins like thiamine, riboflavin and niacin intake were also deficit compared to RDA. Fibre intake was deficit by 52.5 per cent pointing the necessity for satisfactory fibre consumption.
- A majority of 63 per cent had their puberty between the age of 13 to 14yrs and 11 per cent attained puberty above 15 yrs of age. A majority of 63 per cent had regular menstrual cycle and a least of 37 per cent had attained menopause.
- A maximum of 49 per cent of the selected women had their periods between 26 to 35 days and 24 per cent by 25 days.
- Among those who attained menopause 49 per cent had their menopause at the age of 46 to 55 yrs and 19 per cent had their menopause after 55 yrs.
- It is seen that 49 per cent of the selected women got married between the age of 26 to 29 yrs, followed by 42 per cent below 25 yrs and a least of 9 per cent got married at 30 yrs and above.
- A majority of 64 per cent of the selected women had their pregnancy before the age of 23 years and a minority of 5 per cent had at the age of 30 years and above. Among the selected women a maximum of 56 per cent had 1 to 2 children and a least of 2 per cent had 4 children and more.
- Health problems during menstrual periods like sleeplessness (62%), tension and stress (59%) and physical discomfort (58%), stomach ache (46%), emotional disturbance (46%) and excessive bleeding (37%) were reported by the selected women.
- Major problems of weight gain (76%), irritability (72%), depression (69%), breast tenderness (65%), frequent urination (64%) and joint pain / muscle pain (62%) were reported by the women during menopause.

Phase III Formulation and Testing of the Supplements

- The overall scores of the developed basic and nutri mix combinations revealed, that a highest score of 38.5 out of 45 by basic nutri mix and nutri mix combination I and II scored 38.5 and 37.7 respectively with sesame seeds combinations. Nutri mix III and IV with ground nuts scored only 36.7 and 36.3 respectively. The two nutri mixes I and II with sesame combinations were selected for supplementation study.
- Basic mix and nutri mixes I and II with sesame seeds with high acceptability scores were analysed for various nutrients.
- In the case of energy, a maximum of 420 kcal per 100 g was found in nutri mix II followed by nutri mix I with 400 kcal and basic nutri mix with 336 kcal per 100 g. The highest carbohydrate of 56 g per 100g was found in nutri mix I, followed by basic nutri mix with 53 g and nutri mix combination II with 51 g per 100 g. A highest protein content was found in nutri mix II with 18.88 g in 100 g. The fat content of the nutri mixes ranged from 5.5 g to 7.68g per 100 g.
- The fibre content of the basic mix, nutri mixes I and II was found to be 2.78 g, 3.07 g and 3.08 g per 100 g respectively. The moisture content of the nutri mixes ranged from 1.63 to 1.8g per 100g suitable for good storage. The ash content of the nutri mixes ranged between 3.70g to 3.96 g per 100 g.
- Nutri mix I, II and basic mix had a calcium content of 455 mg, 445 mg and 307mg per 100 g. Iron content of the nutri mixes ranged between 3.0 to 5.5mg per 100 g respectively. The phosphorus content of the nutri mixes was between 330 to 356 mg per 100 g.
- With regard to the vitamin content of nutri mixes, vitamin A, B12 and D were not at the detectable level. Among the B-complex vitamins B1 (thiamin) content ranged from 0.6 to 0.8 mg per cent. Vitamin B2 (riboflavin) ranged from 0.25 to 0.3 mg per cent and vitamin B3 (niacin) content from 6.6 to 6.8 mg, B5 ranged from 1.0 to 1.2 mg, B6 ranged from

0.2 to 0.3 mg and B9 ranged from 92 to 97 mcg per 100 g.

- The nutri mixes were analysed for Total Bacterial Count, Total yeast and mould count and found to be nil during the study period of 3 months. The nutri mixes were prepared every week freshly and distributed to the women during the supplementation study.
- With regard to the cost, basic nutri mix costed the minimum of Rs.11.50 per 100 g and nutri mix II was maximum by Rs.12.60 per 100 g and nutri mix I was Rs.11.75 per 100 g. The cost of 50 g mix for one serving to the selected women ranged from Rs. 5.87 to Rs.6.30. This was reasonable and inexpensive compared to other health mixes.

Phase IV Impact of the Supplementation Study

- The mean body weight of selected women of nutri mix I and II groups reduced by 2.25 kg and 2.22 kg respectively over a period of 5 months. Control group showed an increase of 0.45 kg body weight. The comparison of the change in body weight between the experimental groups G1 and G2 showed a statistical significance at 5 per cent level and control group shwed no statistical significance.
- The mean BMD score of nutri mix I and II was found to decrease by 0.47 T score each with a statistical significance at one per cent level. The control group without any supplementation showed a slight increase with regard to BMD score. Comparison of the change in Bone Mineral Density between the experimental groups G1, G2 and control groups showed a statistical significance at 5 per cent level.
- An increase of haemoglobin level by 0.48 g/dl and 0.46 g/dl after the supplementation period was observed with nutri mix I and II group and the control group showed a slight reduction by 0.15 g/dl. A comparison of the change in blood haemoglobin between the experimental groups G1 and G2 showed statistical significance at 5 per cent level and the control group showed no statistical significance.
- Among the selected women, both nutri mix I and II groups showed a

mean increase in serum calcium levels by 0.98 mg/dl and 1.12 mg / dl and the control group also showed a slight increase by 0.07mg/dl. A comparison of the change in serum calcium level between the experimental groups G1, G2 and the control group showed no statistical significance.

- Mean serum phosphorus levels of the nutri mix I and II showed an increase by 1.09 mg/dl and 0.71 mg/dl and the control group showed a reduction in phosphorus by 0.26 mg/dl. The comparison of the change in serum phosphorus level between the experimental groups G1, showed a statistical significance at 5 per cent level and experimental groups G2 and control group did not show any statistical significance.
- The mean fasting blood glucose decreased by 12.90mg/dl and 13.90mg/dl among the nutri mix I and II groups and a slight increase in control group was noted. A comparison of the change in fasting blood glucose in experimental groups G1 and G2 was statistically significant at 5 per cent level and control group showed no significance.
- The mean post prandial blood glucose of nutri mix I and II groups reduced by 12.10 mg/dl and 14.53 mg/dl respectively with a statistical significance at one per cent level. The reduction in the mean post prandial blood glucose of control group was not statistically significant. A comparison between nutri mix I and II and nutri mix I with control showed a statistically significant difference at one per cent level. Nutri mix II with control showed a significance at five per cent level.
- Among the nutri mix I and II groups a reduction in the mean total cholesterol levels by 22.13 mg/dl and 19.53 mg/dl was observed. Control group showed a reduction of 2mg/dl in total cholesterol levels was not statistically significant. A comparison of the change in blood cholesterol levels among the experimental groups G1, G2 and control group did not

show any statistical significance.

- With regard to the correlation of serum calcium with other parameters, among nutri mix I group, a positive correlation was found with respect to weight, haemoglobin and cholesterol and a negative correlation was noted between the serum calcium and serum phosphorus. Among nutri mix II group, serum calcium had a positive correlation with parameters such as weight and cholesterol and a negative correlation with haemoglobin and serum phosphorus. Control group without any supplementation showed a positive correlation of serum calcium with weight, haemoglobin and a negative correlation with serum phosphorus and cholesterol.
- With regard to correlation of Bone Mineral Density (BMD) with other parameters among the nutri mix I group, a positive correlation with weight and serum phosphorus and a negative correlation with haemoglobin, and cholesterol was noted. Among the nutri mix II group, BMD had a positive correlation with parameters such as serum phosphorus and cholesterol and a negative correlation with weight and haemoglobin was observed. Control group without any supplementation showed a positive correlation of BMD with serum phosphorus. A negative correlation was observed between the BMD and parameters like weight, haemoglobin, and cholesterol.
- With regard to the impact of nutrition counselling and lifestyle management it is observed that the mean initial nutrition knowledge was found to be 8.12 score out of 25 which improved to 20.40 scores after nutrition education. The impact was found to be statistically significant at one per cent level.
- The feedback from the selected women acknowledged towards lifestyle management programme of exercises showed that the symptoms of pain in the joint and leg were noticeably reduced highlighting the importance of lifestyle management and exercise.

- ❖ With regard to the entrepreneurial activity, most of the selected women initiated the preparation of nutri mixes at home scale level and 60 per cent of them started home scale production and marketing of nutri mixes and cookies.

RECOMMENDATIONS

From the findings of the present study further research can be undertaken in the following areas:

- ➢ Study on the relationship between bone health and nutrients supporting bone mineral density of different age groups.
- ➢ Development of new food products and assess nutrients and their acceptability for regular consumption to overcome osteopenia
- ➢ Supplementation of calcium and other nutrients rich foods and study the effect on bone health.

Following are the recommendations to institutions, government agencies and public

- ➢ Educate the public and create awareness on importance of calcium rich foods in the management of bone diseases.
- ➢ Identify important functional foods related to bone health and popularise them.
- ➢ Conduct bone health awareness camps periodically
- ➢ Organise lifestyle management programme to all age groups to avoid chronic degenerative diseases.