IMPACT OF NUTRITIONAL CALCIUM SUPPLEMENTS ON CALCIUM DEFICIENT WOMEN OF DIFFERENT PHYSIOLOGICAL STATES

A THESIS SUBMITTED TO
DEPARTMENT OF HOME SCIENCE
KURUKSHETRA UNIVERSITY, KURUKSHETRA
FOR THE AWARD OF DEGREE OF
DOCTOR OF PHILOSOPHY
IN
HOME SCIENCE (FOODS AND NUTRITION)

(SUMMARY)

By

SHWETA SAINI
Regn. No. 01-uc-207

Under the Supervision of

Dr. VINTI DAVAR
Associate Professor & Chairperson
DEPARTMENT OF HOME SCIENCE
KURUKSHETRA UNIVERSITY, KURUKSHETRA

DEPARTMENT OF HOME SCIENCE
KURUKSHETRA UNIVERSITY, KURUKSHETRA
2012
SUMMARY

Nutrition plays an important role in the development and maintenance of bone mass as well as pathogenesis, prevention and treatment of many chronic diseases including osteoporosis. Women particularly in pre and post menopause states are very prone to osteoporosis and the reason attributed to low mineral density and fractures is calcium deficiency. Calcium is the main nutrient needed for bones but there is no authentic available data about the calcium intake patterns and effect of nutritional calcium supplementation in calcium deficient women of different physiological states in District Kurukshetra (Haryana). Keeping this into consideration, the present study was undertaken with the main aim to assess the impact of nutritional calcium supplements on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal). Nutritional deficiencies can be prevented or tackled more effectively if along with supplementation nutrition education is also imparted. Keeping this in mind, along with nutritional calcium supplements, the effect of nutrition education on nutrient intake of calcium deficient women of different physiological states (normal, premenopausal and postmenopausal) was also assessed.

The main objectives of the study were: to determine calcium content in commonly edible foods; to evolve calcium rich recipes using indigenous calcium rich food stuffs; to assess the effect of nutritional calcium supplements on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal); to explore the effect of nutrition education on nutrient intake of calcium deficient women of different physiological states (normal, premenopausal and postmenopausal); to examine the combined effect of nutritional calcium supplements and nutritional education on calcium deficient women of different physiological states (normal, premenopausal and postmenopausal).

The overall consumption of calcium through diet is considered very
low in females particularly in dairy products which is one of the best source of calcium. This fact led the researcher to find out other calcium rich sources in local foods and increase the consumption of calcium from all sources.

In Phase I of the study, the calcium content of commonly edible food stuffs of District Kurukshetra was determined by standard method. The mean calcium contents mg/100g were 43.63±1.63, 7.9±1.042, 14.967±1.357, 66.467±1.826 and 222.2±1.668 in wheat flour, rice, rice flakes, green gram and soybean samples respectively. However, mean calcium contents in the samples of masur dal, rajmah, moth, bengal gram and maize were respectively 67±1.613, 242.5±6.16, 193.13±2.448, 182.23±3.77 and 11.467±2.164 mg/100g. Among the studied cereals and pulses the maximum calcium content (mg/100g) was found in rajmah and minimum in rice.

The mean calcium contents mg/100g were 782.66±14.77, 192±4.581, 66±2.776, 40.33±2.100, 354.433±25.239 and 11.767±3.655 in curry leaves, amaranth, spinach, beans, lotus stem and tomato samples respectively. However, mean calcium contents in the samples of onion, potato, carrot, cauliflower and lady finger were respectively 31.533±2.101, 2.933±1.347, 62.733±5.357, 27.767±1.511 and 48.9±4.88 mg/100g. Papaya, guava, banana, apple and raisin had mean calcium values 11.767±1.156, 4.167±1.452, 6.533±0.68, 2.433±0.65 and 70.13±4.584 mg/100g respectively. Among the studied vegetables and fruits the maximum calcium content (mg/100g) was found in curry leaves and minimum in apple.

The mean calcium contents mg/100g were 1317±40.228, 150.47±3.435, 1006.03±47.553, 1167.67±32.245 in ajwain, amchur, cumin seeds and til samples respectively. However, mean calcium contents in the samples of coconut dry, turmeric, coriander and khus-khus were respectively 349.20±20.615, 131.26±3.842, 496.93±25.094 and 1289.13±14.686 mg/100g. Among the studied spices and condiments the maximum calcium content (mg/100g) was found in ajwain and minimum in turmeric.

Among the studied milk and milk products the maximum calcium content (mg/100g) was found in buffalo’s milk (115.16±13.09) and minimum
in curd (40.71±4.37). The mean calcium content (mg/100g) in cow’s milk was 50.91±8.94. In the studied nuts (Table 4.1) the maximum calcium content (mg/100g) was found in almonds (192.28±11.67) and minimum in ground nuts (43.69±3.33). The mean calcium content in cashew nuts was 70.23±7.09 mg/100g. The studied sample of eggs contained 47.91±5.63 mg/100g of calcium content. The idea of this study was to help the clinicians to prescribe the right kind of food to the calcium deficient patients.

Recipes were developed from locally available calcium rich sources and sensory evaluation was done using 9 point Hedonic scale. These recipes were demonstrated and illustrated in nutrition education booklet distributed to each subject undergoing trial. Among all the developed calcium rich preparations from calcium rich foods, the most acceptable food preparation was Dhandai (8.7±0.483) and the least gujia (7.4±0.516). The overall acceptability of khus khus coconut ladoo, coconut burfi and til ladoo were 8.5±0.527, 8.6±0.516 and 7.8±0.632 respectively. However, the respective overall acceptability score of paushtik ladoo, namkeen, rings, idli and chilla were 7.7±0.483, 8.5±0.527, 8.5±0.527, 8.6±0.516 and 8.5±0.527.

The women (360) in different physiological states {normal(npnl), premenopause, postmenopause} who were declared calcium deficient by the Doctor based on Bone Mineral Density test and volunteered to participate in intervention trials were selected for the study. Clinical observations of all the respondents (360) were done by the Doctor.

The selected 360 calcium deficient subjects were screened for their socio-economic status, menstrual history, reproductive history, lactational history, clinical symptoms as well as dietary habits with the help of self structured and pre tested questionnaire. An anthropometric measurement (height and weight) of each subject was recorded before the intervention trials. Bone Mineral Density (BMD) test was done before (0th day), during (45th day) and after (90th day) the intervention trials. Serum calcium and serum alkaline phosphatase was tested before (0th day) and at the end (90th day) of the intervention trials. The data obtained were statistically analyzed.
using SPSS (version-11.5) computer programme for mean, standard deviation, T-test, ANOVA to draw conclusions.

The women enrolled in the study were in the age group of 28 to 59 years. Out of the selected subjects, normal subjects (33.33%) were belonging to the age group of 28-40 years, premenopausal (33.33%) subjects were between 41-47 years whereas the postmenopausal respondents (33.33%) were between 48-59 years of age. Maximum subjects (25.83%) in the present study were graduates and minimum (1.94%) were Ph.D/M.Phil. Those who were middle school pass, matriculate and under graduate were 13.61, 21.67 and 22.22 per cent respectively. Percentage of post graduate respondents was 8.33 per cent. About 6.39 per cent of the total respondents were illiterate who had never attended the school. Most of the subjects (88.6%) were married. The subjects who were single were 5.27 per cent. About 6.11 per cent of the total respondents were widow. Out of three hundred sixty subjects, majority (53.61%) were living in joint families followed by 46.39 per cent who were living in nuclear family system. Data on occupational status of the respondents revealed that 74.44 per cent of the respondents were housewives and the remaining 25.55 per cent were working. Most of the subjects (37.22%) belonged to the families having monthly income of Rs 10,001-15,000 per month. Between Rs 5001-10,000 monthly income was reported by 35.28 per cent of the subjects. Further, about 15.55 and 11.94 per cent of the subjects belonged to <Rs 5000 and >15,000 family income per month respectively.

Menstrual history of the subjects revealed that 42.77 per cent of the total respondents had regular menstrual cycle, while 23.89 per cent reported irregular cycle. About half of the subjects (58.33%) informed normal blood flow during menstruation. However, heavy and scanty blood flow during menstruation was reported by 24.72 and 16.94 per cent of the subjects respectively. A total 44.44 per cent of the subjects were experiencing pain during menstrual cycle while, 46.39 per cent of the subjects felt occasional pain during menstruation. Majority of the subjects (72.22%) suffered from
pain throughout the menstrual cycle. Nearly 21.67 per cent of the subjects were having pre menstrual pain, whereas 6.11 per cent of the respondents reported post menstruation pain. For reducing the pain during menstruation, 5.83 per cent of the subjects were taking medicine regularly and 16.39 per cent occasionally. A majority of the respondents (77.78%) were not in the habit of taking medicine for pain relief.

Most of the respondents (41.66%) in the present study were having 1-2 offsprings. About 55 per cent of the total respondents were having 3-4 children and only 3.33 per cent of the studied respondents had more than 4 children. Among the total subjects, more than half (61.67%) of the respondents were having 3-4 years of gap between each child and a gap of 1-2 years was found in 26.39 per cent of the subjects. There were only 11.94 per cent of the respondents who had more than 4 years of gap between each child.

Reportedly, all the respondents had successfully breast fed their children. The variation was only seen in the duration of feeding. A majority of the subjects (58.33%) had fed their each child for the duration of one year. However, two year and six months of feeding duration was found in 29.17 and 8.06 per cent of the respondents respectively. Only 4.44 per cent of the total respondents had fed their child for more than 2 years. Most of the subjects had exclusively breast fed the child in early months, but they used water along with breast milk as a thirst reliever.

The data regarding symptoms and clinical manifestation of calcium deficiency indicated extensive prevalence of joint pain (56.11%), irregular heart beat (12.78 %), muscle cramps (4.44%), yellowish teeth (5.28 %), poor sleep disorder (15.56%), nerve irritability (2.5%) and brittle bone (5%) among the studied subjects.

The study of physical activity pattern revealed that nearly all of the respondents (90.56%) were leading a sedentary life and paid no attention to exercise. Yoga, walking and jogging was done only by 2.22, 5.83 and 1.39 per cent of the subjects in day to day life respectively.
The analysis of household work pattern showed that more than half of the respondents (53.61%) do their household work themselves. The help of full time and part time servants was taken by only 3.06 and 18.61 per cent of the subjects respectively. A sizable number of the respondents (24.72 %) took the help of their family members in doing household work.

Majority of the subjects (95.28%) were vegetarian. The percentage of non-vegetarian and ovatarian subjects in the study was only 2.22 and 1.39 per cent respectively. Two, three and four or more than four meals were taken by 12.5, 86.67 and 1.39 per cent of the subjects respectively. More than half (56.67%) of the studied subjects were not keeping any fast whereas, about 30.56 per cent kept fast occasionally. Only 12.78 per cent of the subjects were in the habit of keeping fast reportedly for religious purpose.

Skipping of meals was common in 43.33 per cent of the total subjects. The most commonly skipped meal was dinner (63.33%), followed by breakfast (30%) and lunch (6.67%). The data indicated that 80.56 per cent of the subjects were skipping meals usually. There were only 19.44 per cent of the respondents who were in the habit of skipping the meals sometimes. The factors responsible for skipping the meals were dieting (3.89%), to save time (40.55%) and not feeling hungry (55.55%) respectively. The food preference of the subjects indicated that cereal/pulses was the most liked food group (72.22%) followed by vegetable/fruits (16.67%) and milk & milk products (11.11%) respectively. Buffalo milk was preferred by 55 per cent of the subjects, while 20.83 per cent of the subjects consumed cow milk followed by toned milk (24.16%).

Out of 360 studied subjects, majority of the subjects were not knowledgeable about calcium deficiency (86.66%) and osteoporosis (95%) respectively.

In Phase II, the total 360 subjects were broadly classified into two groups of 180 each i.e. osteopenia and osteoporosis. These two groups were further sub divided into three categories on the basis of their
physiological state {normal (npnl), premenopause, postmenopause} of 60 subjects each. The categories of different physiological states (60 each) were again sub divided on the basis of nutrition intervention into four sub groups (15 each) independently as CONTROL (no intervention), nutrition calcium supplement (NCS), nutrition education (NE), nutritional calcium supplement + nutrition education (NCS+ NE). The duration of the intervention trial was 3 months. Calcium supplements were given to the subjects as prescribed by the Doctor for the period of three months. Similarly, Nutritional education was imparted to selected subjects for duration of three months. The impact of these calcium supplements as well as nutrition education on women of different physiological states (normal, premenopause, post menopause) was assessed and compared with the subjects of CONTROL sub group to whom no supplements were given. Dietary intake of interventional trial subjects namely: nutrition education, nutrition calcium supplement and nutritional calcium supplement plus nutrition education was studied at 0th day of intervention.

Phase III was the Post Intervention phase. After 90 days of intervention, data regarding dietary intake was collected from the selected group subjects. Bone mineral density test was again conducted for calculation of the BMD-T scores. Blood samples were again taken by the lab technician to study the serum calcium as well as alkaline phosphatase levels. The prominent findings obtained are being summarized below:

Before commencing the intervention trial, the mean Bone Mineral Density-T scores were -1.79±0.37, -1.82±0.41 and -1.98±0.27 respectively in normal (npnl) osteopenic subjects. After 45 days of intervention trial with nutritional calcium supplement, nutrition education and nutrition calcium supplement + nutrition education, the mean BMD-T scores increased to -1.47±.33, -1.67±.43 and -1.58±.37 respectively in NCS, NE and NCS+NE subgroups of normal (npnl) osteopenic subjects. The respective increase in mean BMD-T score was -1.12±0.48, -1.44±0.59 and -1.12±0.53 in NCS, NE, NCS+NE subgroups of normal (npnl) osteopenic group when the intervention trials were extended to 90 days.
Statistical analysis indicated a non significant variation in all the subgroups including NCS, NE, NCS+NE when they were compared to each other as well as with their respective CONTROL sub group on 45th day. A significant (p≤0.05) difference in the Bone Mineral Density-T score values of each sub group (NCS, NE, NCS+NE) with their respective CONTROL sub group was observed after 90 days. However, a non significant difference in the Bone Mineral Density-T score values was noticed on comparison of different sub groups (NCS, NE, NCS+NE) with each other after 90 days.

Efficacy of the intervention for increasing Bone Mineral Density- T score value was found maximum in NCS +NE subgroup (43.43%) followed by NCS (37.43%) and NE (20.88%) sub group respectively.

The mean values of Bone Mineral Density- T score increased from -1.96±0.29 to -1.26±0.51 in NCS, -1.98±0.29 to -1.51±0.51 in NE and -2.05±0.23 to -1.15±0.47 in NCS+NE sub groups of premenopausal osteopenic subjects after 90 days of intervention trials. After 45 days, the mean Bone Mineral Density-T scores increased to -1.62±.34, -1.71±.31 and -1.60±.32 respectively in NCS, NE and NCS+NE subgroups of premenopausal osteopenic subjects. The intervention with NCS +NE for 45 days resulted in significant (p≤0.005) variation in Bone Mineral Density-T scores of the premenopausal osteopenic subjects in comparison to its CONTROL sub group. After 90 days a significant (p≤0.05) difference in the BMD-T score values of each sub group (NCS, NE, NCS+NE) with their respective CONTROL sub group was noticed. However, a non significant difference in the Bone Mineral Density-T score values was found on comparing different sub groups (NCS, NE, NCS+NE) with each other. Maximum per cent increase in the Bone Mineral Density-T score value was found in the subjects who were on NCS+NE (43.9%) followed by subjects with NCS (35.11%) and NE (23.74%) respectively.

Before beginning intervention trials in subgroups of postmenopausal osteopenic subjects, the mean Bone Mineral Density-T scores were -2.04±.22, -2.01±.22 and -2.13±.21 respectively. After 45 days of
intervention trial, the mean Bone Mineral Density-T scores increased to -1.72±.34, -1.79±.30 and -1.82±.38 respectively in NCS, NE and NCS+NE subgroups of postmenopausal osteopenic subjects. On extending the intervention trials for 90 days, the mean BMD-T scores increased to -1.46±0.52, -1.60±0.44 and -1.48±0.62 in NCS, NE, NCS+NE subgroups of postmenopausal osteopenic group respectively. Interventions for 45 days resulted in non significant variation in Bone Mineral Density-T scores in all the subgroups of postmenopausal osteopenic subjects in comparison to its CONTROL sub group as well as with each other. After 90 days there was a significant (p≤ 0.05) difference in the Bone Mineral Density-T score values of sub group of NCS and NCS+NE with their respective CONTROL sub group. However, a non significant difference in the Bone Mineral Density- T score values was found on comparison of different sub groups (NCS, NE, NCS+NE) with each other. Efficacy of the intervention for increasing Bone Mineral Density-T score value was found maximum 30.52% in NCS +NE subgroup followed by 28.43% in NCS and 2.04% in NE sub group respectively.

Before commencing the intervention trial, mean value of BMD- T score was -2.73±0.17, -2.72±0.18 and -2.88±0.15 in sub groups of normal (npln) osteoporotic subjects respectively. After 45 days of intervention trial the mean Bone Mineral Density-T scores increased to -2.06±.40, -2.27±.38 and 2.04±.40 respectively in NCS, NE and NCS+NE subgroups of normal (npln) osteoporotic subjects. On extending the trials for 90 days in normal (npln) osteoporotic subjects (NCS, NE, NCS+NE) the mean BMD- T score improved to -1.48±0.60, -1.89±0.59 and -1.48±0.71 respectively. A significant (p≤ 0.05) difference in the BMD- T score values of each sub group (NCS, NE, NCS+NE) with their respective CONTROL sub group during (45 days) and after (90 days) different interventions was found. However, a non significant difference in the BMD- T score values of all sub groups (NCS, NE, NCS+NE) was noted on comparison with each other. Efficacy of different interventions for increasing BMD- T score values was found maximum in the
subjects who received intervention of NCS+NE (48.61%) followed by NCS (45.79%) and NE (30.51%) respectively.

After three months of interventions, the mean values of BMD- T score increased from -2.86±0.19 to -1.72±0.67 in NCS, -2.87±0.19 to -2.10±0.55 in NE and -2.92±0.20 to -1.53± 0.69 in NCS+NE sub groups of premenopausal osteoporotic subjects. On 45 days of intervention trial, the mean BMD-T scores increased to -2.18±.42, -2.33±.40 and -2.33±.40 respectively in NCS, NE and NCS+NE subgroups of premenopausal osteoporotic subjects. A significant (p≤ 0.05) difference in the BMD- T score values of each sub group of premenopausal osteoporotic subjects (NCS, NE, NCS+NE) with their respective CONTROL sub group was seen during the intervention trials (45 days). Again, a significant (p≤ 0.05) difference in the BMD-T score values of NCS and NE sub group subjects with their respective CONTROL sub group after the intervention trials (90 days) was noticed. However, a non significant difference in the BMD- T score values of all sub groups (NCS, NE, NCS+NE) was observed on comparison with each other. Efficacy of increasing the BMD-T score was found maximum (47.6%) on giving NCS+NE intervention followed by NCS (39.86%) and NE (26.83%).

An improvement in the mean BMD-T score values of postmenopausal osteoporotic subjects in different subgroups(NCS, NE, NCS+NE) after receiving different interventions was from -3.18±0.22 to -1.99±0.77, -3.22±0.30 to -2.48±0.51 and -3.40±0.31 to -1.96±0.89 respectively. During (45 days) the intervention trial, the mean Bone Mineral Density-T scores increased to -2.44±.59, -2.86±40 and -2.68±.59 respectively in NCS, NE and NCS+NE subgroups of postmenopausal osteoporotic subjects. Interventions for 45 days resulted in significant (p≤ 0.05) variation, in Bone Mineral Density-T scores in NCS and NCS+NE sub groups of postmenopausal osteoporotic subjects in comparison to its CONTROL sub group. Further, a significant (p≤ 0.05) difference in the BMD-T score values of each sub group (NCS, NE, NCS+NE) with their respective CONTROL sub group was noticed after the completion of the intervention trial (90 days). However, a non significant difference in the BMD- T score values was
observed on comparison with different sub groups (NCS, NE, NCS+NE) with each other. Per cent increased in the BMD T score was found maximum on giving NCS+NE (42.35%) followed by NCS (37.42%) and NE (22.98%) in postmenopausal osteoporotic subjects respectively.

Before commencing the intervention trial in three subgroups of normal (npnl) osteopenic subjects: NCS; NE; NCS+NE, the mean serum calcium levels were 8.58±.192, 8.69±.193 and 8.68±.180 mg/dl of blood respectively. The mean serum calcium level in corresponding three subgroups of premenopausal osteopenic subjects were 8.69±.272, 8.71±.179 and 8.72±.149 mg/dl. In postmenopausal osteopenic category, the mean serum calcium levels were 8.63±.252, 8.66±.173 and 8.60±.154 mg/dl in respective sub groups. After 90 days of intervention, serum levels increased to 8.65±.171, 8.72±.155 and 8.75±.158 mg/dl respectively in three subgroups of normal (npnl) osteopenic subjects. In corresponding sub groups of premenopausal subjects 8.70±.151, 8.73±.157 and 8.86±.345 mg/dl increase in serum calcium levels was noticed. Increase in serum calcium levels were 8.71±.145, 8.71±.137 and 8.75±.127 mg/dl in sub groups of postmenopausal subjects. A non significant difference (p≥ 0.05) was observed in serum calcium levels of normal (npnl) and premenopausal osteopenic subjects after intervention trials. Statistically significant (p≤ 0.05) variation in serum calcium levels of each sub group of postmenopausal osteopenic subjects (NCS, NE, NCS+NE) with their respective CONTROL sub group was noted after the trial. However, Post Hoc test indicated a non significant difference in the serum calcium values on comparison with different sub groups (NCS, NE, NCS+NE) with each other at the end of the trial.

The data revealed that intervention trial based on NCS+NE was most effective in increasing serum calcium levels i.e. 0.80, 1.60 and 1.70 per cent in normal (npnl), premenopausal and postmenopausal conditions, respectively. Minimum per cent increase of 0.34, -0.22 and 0.57 respectively in serum calcium level was noticed when interventions was given in each physiological state. Whereas, a moderate increase in serum calcium level i.e. 0.81, 0.11 and 0.92 per cent was seen after the intervention trial with
NCS respectively in normal, premenopausal and postmenopausal conditions.

After the intervention trial in three subgroups of normal (npnl) osteoporotic subjects: NCS; NE; NCS+NE, the mean serum calcium levels increased from 8.44±.29 to 8.44±.287, 8.38±.251 to 8.38±.245 and 8.41±.311 to 8.43±.28mg/dl of blood respectively. The mean serum calcium levels in corresponding subgroups of premenopausal osteoporotic subjects were raised from 8.21±.201 to 8.28±.217, 8.26±.204 to 8.27±.212 and 8.25±.279 to 8.27±.222 mg/dl. In sub groups of postmenopausal osteoporotic category, the mean serum calcium level increased from 8.23±.208 to 8.29±.218, 8.27±.216 to 8.25±.182 and 8.24±.284 to 8.29±.295 mg/dl respectively after intervention.

A non significant difference (p≥0.05) in serum calcium levels of normal (npnl) and premenopausal osteoporotic subjects was noticed after the intervention trials. Statically non significant (p≥0.05) variation in serum calcium levels of each sub group (NCS, NE, NCS+NE) was noticed with their respective CONTROL sub group as well as on comparing different sub groups (NCS, NE, NCS+NE) with each other after the completion of intervention trial in postmenopausal osteoporotic subjects.

The intervention trial based on NCS+ NE was most effective in increasing serum calcium levels in normal (npnl) osteoporotic subjects (1.74%) followed by postmenopausal (0.60%) and premenopausal (0.24%) conditions, respectively. Minimum per cent increase in serum calcium level was observed when intervention with nutrition education was given to normal (0%), premenopausal (0.01%) and postmenopausal (-0.02%) osteoporotic subjects respectively. Whereas, efficiency of nutritional calcium supplement in increasing respective serum calcium level was seen maximum in premenopausal (0.85%) osteoporotic subjects followed by postmenopausal (0.72%) and normal (0%).

After the intervention trial, the decrease in mean serum alkaline phosphatase (U/L) values were from: 87.466±14.47 to 84.400±14.841 in
NCS; 86.8±15.757 to 86.2±14.512 in NE and 92.6±10.03 to 91.4±9.432 in NCS+NE subgroups of normal (npnl) osteopenic subjects. The decreased values of mean serum alkaline phosphatase (U/L) in corresponding intervention trial of premenopausal osteopenic subjects were from: 92.4667±9.56 to 90.8667±11.141 in NCS; 86.46±15.042 to 86±12.386 in NE and 92.53±9.164 to 90.66±8.837 NCS+NE subgroup. Whereas, decrease in mean alkaline phosphatase (U/L) values of 97.6±9.014 to 94.066±12.646 in NCS; 95.2±15.942 to 92.266±11.144 in NE and 98±8.459 to 94.483±10.039 in NCS+NE was found in subgroups of postmenopausal osteopenic subjects. Statistically, a non significant difference (p≥0.05) in serum alkaline phosphatase levels of normal (npnl) premenopausal and postmenopausal osteopenic subjects was noticed after the intervention trials.

Maximum decrease in serum alkaline phosphatase was noticed in nutritional calcium supplements sub group i.e. -4.18, -1.73 and -3.62 per cent respectively in corresponding categories of normal (npnl), pre and post menopausal subjects. Minimum per cent decrease in serum alkaline phosphatase level was observed when intervention with nutrition education was given in all three states i.e. 0.69, -0.53 and -3.08 per cent respectively. However, a moderate decrease in serum alkaline phosphatase level was seen after the intervention trial with NCS+NE i.e. -1.29, -2.02 and -3.59 per cent in corresponding categories of normal (npnl), pre and post menopausal osteopenic subjects.

After intervention trial the decrease in mean alkaline phosphatase (U/L) values were: 104±10.94 to 103.4±10.554 in NCS; 100.33±12.14 to 97.3 ±8.476 in NE and 108.33±14.17 to 104.66±11.197 in NCS+NE subgroups of normal (npnl) osteoporotic subjects were noticed. The decrease in mean alkaline phosphatase (U/L) in corresponding intervention trial sub groups of premenopausal osteoporotic subjects were from: 105.53±10.034 to 103.06±10.826 in NCS; 101.533±11.293 to 98.6±9.545 in NE and 108.66±11.393 to 102.93±10.305 in NCS+NE subgroup. In postmenopausal osteoporotic subjects, respective decrease in mean alkaline phosphatase (U/L) was from: 101.93±6.681 to 100.93±8.353 in NCS;
103.93±10.074 to 100.46±8.846 in NE and 107.933±10.957 to 103.53±8.21 in NCS+NE subgroups.

Statistically, a non significant difference (p≥0.05) in serum alkaline phosphatase levels of normal (npnl) and premenopausal and postmenopausal osteoporotic subjects was found after the completion of intervention trials. Maximum decrease in serum alkaline phosphatase was noticed in nutritional calcium supplements plus nutrition education sub group i.e. -3.44, -5.27 and -4.07 per cent respectively in corresponding categories of normal (npnl), pre and post menopausal subjects. Minimum per cent decrease in serum alkaline phosphatase level was noticed when intervention with nutritional calcium supplements was given in all three physiological states i.e. -0.57, -2.34 and -0.98 per cent respectively. Whereas, a moderate decrease in serum alkaline phosphatase level was seen after the intervention trial with nutrition education i.e. -2.99, -2.88 and -3.33 per cent in corresponding categories of normal (npnl), and pre and post menopausal osteoporotic subjects.

The mean BMD- T score levels in normal (npnl), premenopausal and postmenopausal subjects before giving any intervention were 1.855±0.352, 1.980±0.285 and 2.052±0.235 respectively. However, respective BMD, mean T score of 1.416±0.610, 1.495±0.609 and 1.650±0.571 were found in normal (npnl), premenopausal and postmenopausal subjects after completion of intervention trials. A non significant difference in the BMD- T score values of different physiological states (normal, premenopausal and postmenopausal) was noted on comparison with each other. Per cent increase in the BMD- T score was found maximum in premenopausal (24.49%) followed by normal (23.66%) and postmenopausal (19.55%) osteopenic subjects after the interventions.

The increase in mean BMD-T score levels in normal (npnl), premenopausal and postmenopausal osteoporotic subjects after the intervention trials were -2.758±0.23 to -1.905±0.768, -2.873±0.194 to -2.090±0.806 and -3.245±0.299 to -2.440±0.862 respectively. A non
significant variation in the BMD-T score values among the normal (npnl) and premenopausal as well as pre and post menopausal subjects with each other after the completion of all interventions. However, a significant (p≤0.05) variation was seen in normal (npnl) and postmenopausal subjects on comparison with each other at the end of the intervention trials. Per cent improvement in BMD-T scores levels was seen maximum in normal (30.92%) followed by premenopausal (27.25%) and postmenopausal (24.80%) osteoporotic subjects after the interventions.

The mean serum calcium levels in normal, premenopausal and postmenopausal osteopenic subjects before intervention were 8.69±.279, 8.75±.321 and 8.59±.243 mg/dl respectively. However, respective mean serum calcium of 8.73±.262, 8.77±.303 and 8.72±.183 mg/dl was found in normal (npnl), premenopausal and postmenopausal subjects after the intervention. A non significant variation in the mean serum calcium values among the normal, premenopausal and post menopausal subjects was found after the intervention trial. Efficacy of increasing the mean serum calcium was found maximum in postmenopausal (1.465%) followed by normal (npnl) (0.483%) and premenopausal (0.274%) osteopenic subjects after the interventions.

The mean serum calcium levels in normal (npnl), premenopausal and postmenopausal osteoporotic subjects before intervention trials were 8.36±.272, 8.22±.221 and 8.22±.221 mg/dl respectively. However, respective mean serum calcium of 8.37±.269, 8.24±.222 and 8.23±.229 mg/dl were found in normal (npnl), premenopausal and postmenopausal subjects after giving different interventions. Deviation in the mean serum calcium was found significant (p≤.05) in subjects of different physiological states (normal, premenopausal and postmenopausal) before and after commencing the intervention trial. A significant (p≤0.05) variation in the mean serum calcium values among the pre and post menopausal subjects was noticed when these were compared with normal (npnl) osteoporotic subjects. In contrast, a non significant variation in serum calcium levels of pre and post menopausal
subjects was there while comparing each other. Per cent improvement in mean serum calcium was found maximum in normal (npnl) (0.71%) followed by premenopausal (.225%) and postmenopausal (.036%) osteoporotic subjects after different interventions.

The mean serum alkaline phosphatase levels in normal, premenopausal and postmenopausal subjects before intervention were 88.28±13.6, 90.516±10.662 and 96.6±10.669 U/L respectively. However, respective mean serum alkaline phosphatase of 87.16±13.52, 89.96±10.267 and 95.38±9.86 U/L was found in normal (npnl), premenopausal and postmenopausal subjects after the intervention trials. After the intervention trials a significant (p≤0.05) variation in the mean serum alkaline phosphatase values among the normal (npnl) and postmenopausal as well as pre and post menopausal osteopenic subjects was found. Whereas, a non significant variation existed among normal and premenopausal osteopenic subjects after the completion of intervention trial. Per cent decrease in mean serum alkaline phosphatase levels was seen -1.26, -0.61 and -1.25 respectively in normal, premenopausal and postmenopausal osteopenic subjects after giving different interventions.

The mean serum alkaline phosphatase levels in normal, premenopausal and postmenopausal osteoporotic subjects before intervention trials were 103.58±12.30, 104.75±10.852 and 103.58±9.186 U/L respectively. However, respective mean serum alkaline phosphatase of 101.8±10.656, 102.15±10.484 and 102.01±8.365 U/L was found in normal (npnl), premenopausal and postmenopausal osteoporotic subjects after the intervention trials. The mean serum alkaline phosphatase was found non significant (p≥.05) in subjects of different physiological states (normal, premenopausal and postmenopausal) before and after commencing the intervention trial. Per cent decrease in mean serum alkaline phosphatase levels was seen -1.71, -2.48 and -1.51 respectively in normal (npnl), premenopausal and postmenopausal osteoporotic subjects after giving different interventions.
The mean BMD-T scores of total group of osteopenic subjects (180) before and after different interventions increased from -1.962±0.304 to -1.520±0.602. Whereas, a change of -2.958±0.311 to -2.145±0.838 was found in the total group of osteoporotic subjects (180) before and after the interventions. A statistical significant (p≤ 0.01) variation in the BMD-T scores of both the conditions (osteopenia and osteoporosis) before and after the intervention trials was observed. Efficacy of the intervention for increasing Bone Mineral Density-T score values was found maximum in osteoporotic group of subjects with a per cent change of 27.48. On the other hand per cent change in BMD- T score of osteopenic group of subjects was 22.52.

The mean serum calcium of total group of osteopenic subjects (180) before and after different interventions increased from 8.67±.288 to 8.74±.254mg/dl of blood. Whereas, a change of 8.27±.247 to 8.28±.248mg/dl was found in the total group of osteoporotic subjects (180) before and after the interventions. Statistically significant (p≤0.000) variation in the mean serum calcium levels of both the conditions (osteopenia vs osteoporosis) before and after the intervention trials was observed. Efficacy of the intervention for increasing mean serum calcium was found maximum in osteopenic group of subjects with a change of 0.73per cent. On the other hand per cent change in mean serum calcium of osteoporotic group of subjects was 0.12 % after the intervention trials.

The mean serum alkaline phosphatase of total group of osteopenic subjects (180) before and after different interventions decreased from 91.8±12.22 to 90.83±11.781U/L. Whereas, a change of 103.97±10.80 to 101.98±9.836U/L was found in the total group of osteoporotic subjects (180) before and after the interventions. A significant (p≤ 0.000) variation in the mean serum alkaline phosphatase levels of both the conditions (osteopenia and osteoporosis) before and after the intervention trials was observed. Per cent decrease in mean serum alkaline phosphatase among osteopenic group of subjects was -1.05. On the other hand per cent decrease in mean serum alkaline phosphatase in osteoporotic group of subjects was -1.91 after the intervention trials.
The mean intake of energy by all the normal (npnl) subjects increased from 1251.958±90.54 to 1418.67±95.28 kcals/day after the intervention trials. Respective increase in intake of protein, fat and calcium was from 31.966±4.17 to 37.183±3.47g; 16.81±3.86 to 18.52±1.53g and 353.59±79.75 to 432.53±86.51 mg/day in normal (npnl) subjects after the interventions. The per cent increase in energy, protein, fat and calcium of the normal (npnl) subjects was 74.66, 67.6, 92.6 and 72.08 per cent after the trials which were initially 65.8, 58.10, 84.05 and 58.93 per cent respectively before the intervention trials. Though intake of all the nutrients increased among all the subjects after intervention trials but was still found less than the RDAs. Statistically, a significant ($p\leq 0.05$) variation was found in nutrient intake after the intervention trials in normal (npnl) subjects.

The mean intake of energy by the premenopausal subjects increased from 1235.29±77.10 to 1368.29±90.20 kcals/day after receiving different interventions for ninety days. Consumption of energy by the premenopausal subjects was respectively 65.01 and 72 per cent of RDAs before and after the intervention trials. Respective increase in intake of protein, fat and calcium was from 32.74±6.77 to 38.94±4.97g; 16.28±3.68 to 19.26±2.21g and 342.00±86.33 to 417.40±99.11 mg/day in premenopausal subjects after the interventions. The per cent increase in energy, protein, fat and calcium of the premenopausal subjects was 70.8, 96.3 and 69.5 per cent after the trials which were initially 59.52, 81.4 and 57 per cent respectively before the intervention trials. Though intake of all the nutrients increased in all the subjects after intervention trials but was still found less than the RDAs. Statistically, a significant ($p\leq 0.05$) variation was found in nutrient intake after the intervention trial in premenopausal subjects.

After receiving different intervention packages, the mean intake of energy by the postmenopausal subjects increased from 1210.22±80.50 to 1341.68±76.00 kcals/day. Consumption of energy by the postmenopausal subjects was respectively 63.69 and 70.61 per cent of RDAs before and after the intervention trials. Respective increase in intake of proteins, fat and
calcium was from 30.38±5.32 to 37.33±4.65 g; 13.50±2.22 to 18.61±1.59 g and 319.96±87.77 to 394.82±95.93 mg/day in postmenopausal subjects after receiving different interventions. The per cent increase in energy, protein, fat and calcium of the postmenopausal subjects was 67.8, 93.05 and 49.35 after the trials which were initially 55.23, 67.5 and 39.93 per cent respectively before the intervention trials. Though intake of all the nutrients increased among the subjects after intervention trials but was still found less than the RDAs. Statistically, a significant (p≤ 0.05) variation was found in each nutrient intake after the intervention trial in postmenopausal subjects.

Findings of the present study revealed that interventions with NCS, NE and NCS + NE can manage calcium deficiency, low bone mineral density, osteopenia and osteoporosis to a satisfactory degree. Further, beneficial effects would accrue by combining calcium rich foods with nutritional calcium supplements and nutrition education.