A study is usually undertaken with the context of an existing knowledge base. Literature review is undertaken to familiarize researches with knowledge based on it. This chapter consists of two sections: Related literature of the study and Conceptual framework.

2.1 RELATED LITERATURE OF THE STUDY

The related literature reviewed is presented as follows:

2.1.1. Burden of osteoporosis.
2.1.2. Knowledge on osteoporosis.
2.1.3. Osteoporosis preventive behaviors.
2.1.4. Self-efficacy and osteoporosis prevention.
2.1.5. Osteoporosis Prevention Program.

2.1.1 Burden of osteoporosis

2.1.1.1. Prevalence of osteoporosis and osteopenia

Marwaha, Tandon, Garg, Kanwar, Narang, Sastry, et al. (2011) evaluated 1,600 healthy subjects (792 males & 808 females) aged more than 50 years, residing in Delhi for bone mineral metabolic parameters that included anthropometric, biochemical, hormonal evaluation and BMD measurement. The researchers concluded that 35.1% of the subjects (males – 24.6% & females – 42.5 %) were evaluated to have osteoporosis and
prevalence of osteoporosis increased with age in females, but not in males. BMD at all sites except distal radius was positively correlated with body mass index. Total body BMD was negatively correlated with alkaline phosphates and parathyroid hormone levels respectively. This study clearly indicated the high prevalence of osteoporosis in elderly Indian subjects.

Kadam, Chiplonkar, Kadilkar, Divat & Kadilkar (2010) conducted a study to assess the prevalence and the relative importance of risk factors for low bone mass in Indian pre- and post-menopausal women. Data were collected on anthropology and life style factors in apparently healthy 80 pre- and 92 post- menopausal women of 40 – 75 years. BMD measurement was obtained using Dual Energy X ray Absorptiometry (DEXA). The results depicted that BMD at all three sites was significantly lower in post-menopausal than the pre-menopausal women (p < 0.001). Prevalence of osteoporosis was the highest at the lumbar spine (25.8%) in post-menopausal women, while prevalence of osteopenia was high in pre-menopausal women (44.3%). The major risk factors contributing to bone loss in Indian women above 40 years of age observed were age, weight, height, menopause, low intakes of calcium and low 25(OH) D along with poor sunlight exposure.

Gulati, Kumar, Arora, Aggarwal & Bhargava (2010) assessed the BMD of patients in the age group of 20-40 years with traumatic proximal femoral fractures and compared with age matched controls. Radiographs of the pelvis to determine the Singh index and DEXA scan of the unaffected hip were done to assess BMD of 30 patients with traumatic proximal femoral fractures and 39 healthy volunteers of the study. Based on Singh’s index, 60%
of fracture cases and 20% of controls were osteoporotic. T-score by DEXA revealed that 24 patients with fracture and 22 controls had osteopenia or osteoporosis. There was no significant difference in BMD assessed by DEXA scan. The study pointed out the failure of our population to attain an adequate peak bone mass.

Sundaravalli, Amrita, Prabhu & Saraswati (2010) conducted a study to find out the BMD status through QUS test among 89 women teaching staff above 31 years of age working in university and college at Bangalore. It was found that out of 89 women teaching staff, 43% of them were normal, 50% of them were osteopenic and 7% of them were osteoporotic. The findings of the study also revealed that there was a significant relation between the age, age of onset of menopause, and sitting & standing postures in relation to osteopenia/osteoporosis status. The study results suggested that low BMD is widely prevalent among teaching women and the need to intervene to curtail the menace of osteoporosis.

Multani, Sarathi, Shivane, Bandgar, Menon & Shah (2010) carried out a prospective, cross sectional study in a tertiary health care center to assess the BMD by DEXA method among 214 resident doctors. Osteopenia was noted in 104 (59.7%) females and 27 (67.5%) males. Thirty two (18.39%) females and five (12.5%) males had osteoporosis. BMD had significant positive correlation with weight, height, body mass index, physical activity and dietary calcium phosphorus ratio.

Abraham Samuel Babu, Faizal Ikbal, Manjula Sukumari Noone, Anupama Naomi & Joseph Prasanna Samuel (2009) conducted eight camps in
the rural region of north Kerala between September 2005 and April 2007 to observe the prevalence of osteoporosis and osteopenia. QUS of the distal radius was used in these camps for determining the T-scores. The results showed that out of the 609 persons studied, 538 (88.3%) were women and 71 (11.7%) were men, with the average age of 52 ± 12.8 years. In the population studied, 105/609 (17.2%) had a normal T-score, 247/609 (40.6%) were osteopenic and 257/609 (42.2%) were osteoporotic. Of the 257 persons with osteoporosis, 237 (92.2%) were women and the rest men. Among the 247 with osteopenia, 221 (89.5%) were women. Among the osteopenic women, the maximum number was recorded between the age group of 40-49 years (35.8%) and 50-59 years (29.4%), whereas among the osteoporotic women, maximum numbers were observed in the age groups of 60-69 years (33.8%) and 50-59 years (29.5%). From this study it is evident that osteopenia and osteoporosis strikes much earlier among women in the premenopausal period itself.

Thomas Paul, Nihal Thomas, Mandalam Seshadri, Regi Oommen, Arun Jose & Narayana Mahendri (2008) assessed the prevalence of osteoporosis among ambulatory postmenopausal women in a semi urban region of southern India and studied the dietary calcium intake and vitamin D status and their influence on bone mineral density. This community-based cross-sectional study adopting a randomized cluster sampling technique included a cohort consisted of 150 ambulatory postmenopausal women (≥50 years old). Dual-energy x-ray absorptiometry for BMD was performed at the lumbar spine and femoral neck. Dietary calcium intake and biochemical variables were assessed. The prevalence of osteoporosis was found to be 48%
at the lumbar spine, 16.7% at the femoral neck, and 50% at any site. The mean dietary calcium intake was much lower than the recommended intake for this age-group. There was a significant positive correlation between body mass index and BMD at the lumbar spine and the femoral neck (r = 0.4; p = .0001). BMD at the femoral neck was significantly less (mean, 0.657 versus 0.694 g/cm2) in the vitamin D-insufficient study subjects in comparison with the vitamin D-sufficient women (p = .03). This study emphasizes the need to take measures such as adequate calcium intake and vitamin D supplementation in women of this age-group to prevent osteoporosis and its complications.

Teotia & Teotia (2008) surveyed 337.68 million population residing in 0.39 million villages in 22 states of India during the period 1963 to 2005. Of the 4,11,744 clients identified with the disorders of bone and mineral metabolism, 2,13,760 (52%) clients had nutritional bone disease. They identified dietary calcium deficiency (< 300 mg/day), calcium deficiency induced osteoporosis and calcium and vitamin D deficiency induced osteoporosis in the elderly were the commonest disorders responsible for bone disease and deformities.

Sharma, Tandon, Mahajan, Kour & Kumar (2006) carried out a study to screen the bone status of urban women of 25 years of age and above in a hospital at Jammu. A total of 158 women were screened calculating WHO T-scores utilizing calcaneal QUS as diagnostic tool. The result suggested that a substantial female population had osteopenia and osteoporosis after the age of 45 years. The incidence of osteoporosis was 26.25% and osteopenia (36.79%)
with almost 100% incidence of either osteopenia or osteoporosis after the age of 65 years. The results indicated that the incidence increased with age and in postmenopausal period, thereby suggesting lack of estrogenic activity to be responsible for this increasing trend.

Ashwini Bhalearao Gandhi, & Ashok Kumar Shukla (2005) found out the incidences of osteopenia and osteoporosis and their relation with age, diet and menstruation in women above the age of 40 years. The sample included 200 women attending a well women clinic during January 2002 to December 2003. They all underwent BMD test, mammography, pelvic sonography, X-ray chest, ECG and other basic investigations. The analyzed results revealed that there was an almost 100% incidence of either osteopenia or osteoporosis among women above the age of 60 years whereas, the incidence of osteopenia was 34% and osteoporosis 8% in the age group of 40 and 60 years. The finding related to type of diet depicted that 50% of osteoporotic and 98.82% of osteopenic women had vegetarian diet. The study findings revealed that a substantial female population has osteopenia and osteoporosis after the age of 40 years.

Holi, Radhakrishnan, Swaranamani & Jayavelan (2005) conducted a study to assess osteoporosis and predict the fracture risk using QUS at Institute Hospital, IIT-Madras. The study included 108 premenopausal women between 24 and 50 years of age, 85 postmenopausal women between 45 and 78 years, and 283 men between 30 and 68 years of age. Assessment of osteoporosis based on T-score was carried out and the results showed that the percentage of osteoporosis cases were more in postmenopausal women.
(~ 45%) compared to premenopausal women (~ 4%) and men (~ 9%). Among premenopausal women 39 and four women were found to have osteopenia and osteoporosis respectively. Osteopenia was present among 25 postmenopausal women and osteoporosis among 38. The other significant finding noticed was association between women with higher BMI and body weight with higher stiffness index. The study concluded that QUS can be effectively used to study the bone mineral loss and QUS clearly distinguishes between normal and low BMD subjects and can be a useful index in clinical management of osteoporosis. This study clearly indicated the prevalence of low BMD even among premenopausal women and the need to address this issue to prevent complications.

Pande (2002) analysed the database of BMD in the Indian women and men and said that 29.9% of women and 24.3% of men between the age of 20 & 79 years had low bone mass and about 50% of women and 36% of men over 50 years of age were noted to have low bone mass. The observations of this study suggested the existence of a higher prevalence of low BMD in the Indian population compared to the western population.

Kim, Kim, Choi, Park, Lee, Lee, et al. (2000) performed a study to establish the normative data of QUS for Korean women and to determine the prevalence and risk factors of low QUS values in a Korean elderly population. They studied 238 healthy women aged 20-29 years working at a hospital, and 552 women above 50 years of age living in six villages of Chung-Up district, a rural area of South Korea, using QUS measurement of BMD at the calcaneus. Of the 552 elderly women, 34.2% had T-scores
between -1.0 and -2.5 and 11.8% had T-scores below -2.5. The prevalence of low BMD increased with age, longer duration following menopause, lower body mass index, younger age at menopause and smoking. These results suggested that QUS measurement of the calcaneus could be a useful tool for epidemiological surveys of BMD. Also, utilization of QUS for screening osteoporosis reduced the economic burden associated with other diagnostic methods.

2.1.1.2 Osteoporosis and its sequelae

Brown, Mc Neill, Leung, Radwan & Willingale (2011) estimated the number of osteoporotic fractures and cost of treatment and management of osteoporosis and osteoporotic fractures to the health system in New Zealand. Data related to health services usage and costs were estimated combining the data from New Zealand hospitals; the New Zealand Health survey on the number of people diagnosed with osteoporosis, and the New Zealand Health Information service on pharmaceutical treatments. The impact on morbidity and mortality due to osteoporotic fractures were assessed by losses in quality adjusted life years (QALYS). The result depicted an estimation of 84,354 osteoporotic fractures in New Zealand in 2007, including 3803 hip and 27,994 vertebral fractures and a loss of 11,249 QALYS. The total direct cost of osteoporosis was estimated as 330 million New Zealand dollars ($N), including $N34 million for treatment and management of the estimated 70631 people diagnosed with osteoporosis. The lost QALYS and economic cost associated with osteoporosis were projected to 2013 and 2020 using population projections from the New Zealand census, the data revealed that
the cost of treatment and management of osteoporosis is expected to increase to over $N 391 million in 2013 and $N 458 million in 2020, with the number of QALYS lost increasing to 13,205 in 2013 and 15,176 in 2020. This study highlighted the burden of osteoporosis and the need for essential steps to mitigate the burden.

Guitirrez, Roskell, Castellsague, Beard, Rycroft, Abeysinghe, et al. (2011) carried out a retrospective cohort study among women aged 50 years or older hospitalized for an incident hip fracture. The data were collected from 2,427 women within one week of the fracture date. This group of women’s age and co morbidity was matched to women without fracture who formed another group. The follow up was carried out for one year through the health improvement network database, UK. The results stated that about 18% of women with hip fractures and 4% of women without fractures had at least one emergency admission. Mortality was 18% in the hip fracture cohort and 7% in the non-fracture cohort. The overall one year mean incremental cost of hip fractures was found out to be 104,222, with an increment of 104,095. The findings of this study indicated that the cost and clinical burden associated with hip fractures in UK were considerable.

Choi, Shin, Ha, Jang, Jang, Park, et al. (2011) evaluated the number of osteoporosis patients under treatment and secular trends in 2005-2008 in South Korea. The data were obtained from the Health Insurance Review Agency, which included the nationwide information and from the reimbursement records. Patients aged 30 years old with osteoporosis were identified based on a study-defined algorithm using prescription data and
diagnostic codes. It was observed that during the study period, the number of patients receiving medical treatment related to osteoporosis increased from 1,034,399 to 1,392,189 for women and from 120,496 to 171,902 for men. The calculated proportion of osteoporosis patients under treatment in the general population over 50 years of age was 6.1% for men and 33.3% for women and in the general population over 30 years of age was 2.7% for men and 16.6% for women. Also, more than 40% of patients were treated with medication indicated only for osteoporosis. This study reflected the pronounced burden of osteoporosis among women and the substantial increasing trend in medical claims related to osteoporosis.

Chakrabarthy, Mandal, Manna, Mallik, Ghosh, Chatterjee, et al. (2010) executed a cross sectional, observational community based study in a rural area of West Bengal, India. The data were collected through house to house visits for clinical examination, observation and interview with a predesigned pre-tested proforma. Out of 495 study population, 80(16.16%) were found to be functionally disabled as per Activities of daily living scale and more than half (56.2%) of them had three or more chronic conditions. 92.5% of study population had one or more chronic conditions. Association between different risk factors and disability was found. Age, gender, anaemia, chronic obstructive pulmonary diseases, ischaemic heart disease, osteoporosis and osteoarthritis were the risk factors associated with disability. These data suggested the association of certain chronic conditions with disability. Measures to reduce such chronic conditions would be the useful approach for the prevention of disability.
Leboime, Confavreux, Mehsen, Paccou, David & Roux (2010) reported that osteoporotic fractures were associated with mortality. They stated that hip fractures constitute the most severe complication of osteoporosis as they could induce permanent physical disability, loss of self-sufficiency, institutionalization and an increased risk of death.

Curran, Marvaic, Kiefer, Tochon & Fardellone (2010) summarized the findings of a literature review of French studies published between 1960 and 2009, characterized the epidemiology of osteoporosis and osteoporotic fractures and predicted future trends. They observed that osteoporosis was under diagnosed in many countries and the incidence of fracture increased exponentially with age, alongside a concurrent decrease in BMD, a risk factor for fracture. They also stated that the incidence of fracture was high in osteopenic population with a high risk of fragility fracture which might be underestimated if reports focused only the osteoporotic women.

Burge, Dawson-Hughes, Solomon, Wong, King & Tosteson (2007) predicted the burden of incident osteoporosis-related fractures and costs in the United States, by sex, age group, race/ethnicity, and fracture type, from 2005 to 2025. By 2025, annual fractures and costs are projected to rise by 50%. The growth rate estimated for people aged between 65 to 74 years would be more than 87%. The study concluded with a suggestion that osteoporosis prevention, treatment, and education efforts should address all skeletal sites.

Pasco, Seeman, Henry, Merriman, Nicholson & Kotowicz (2006) determined the proportion of the population burden of fragility fractures arising from women at modest risk for fracture. The baseline BMD was
measured in a population-based random sample of 616 postmenopausal women aged 60-94 years and they were followed for a median of 5.6 years. Based on WHO criteria, 37.6% of the women had normal total hip BMD, 48% had osteopenia and 14.5% had osteoporosis. The incidence of fracture during follow-up was as follows: 26.9% in women with osteoporosis; 56.5% in women with osteopenia and 16.6% in women with normal BMD. These findings indicated that reducing the population burden of fractures required attention to women with osteopenia, as well as osteoporosis, as women with osteopenia have the same risk as women with osteoporosis.

Orsini, Rousculp, Long & Wang (2005) studied the annual health care utilization and associated expenditures of osteoporotic patients who sustain a new fragility fracture and of those without a fracture. The study sample included patients from commercial claims databases enrolled in US plans between January 1, 1997, and December 31, 2001. Patients with both an osteoporosis diagnosis and a related fracture were classified as ‘osteoporosis with concurrent fracture’; all other osteoporosis patients were classified as ‘osteoporosis without concurrent fracture’. Annual utilization and expenditures for the concurrent-fracture cohort were compared with those without concurrent fracture, as well as with a group of patients without osteoporosis (controls) that was matched to the concurrent fracture cohort based on age, gender, US region, health plan type and length of enrollment. During the study period, the osteoporosis patients with concurrent fracture incurred more than twice the overall health care expenditures, compared with those without fracture (US $15,942 vs. $6,476), and nearly three times those of the control group (US $15,942 vs. $4,658). Approximately 25% of the
overall health care expenditures (US $4,014 of $15,942) for the concurrent-fracture group were osteoporosis-related expenditures, leading to the conclusion that comorbid conditions in osteoporosis patients with concurrent fracture contributed significantly to overall health care costs. The study stressed the need for osteoporosis prevention, early identification and management to reduce the economic burden associated with this disease.

2.1.2. Knowledge on Osteoporosis

Doheny, Sedlak, Estok & Zeller (2007) performed a secondary analysis that used healthy community based women (218) and men (226) of age 50 to 65 years. Data collection period was 18 months during 2001-2003 for women and during 2004-2006 for men. The variables assessed were DXA T-scores, knowledge of osteoporosis, susceptibility, seriousness, benefits and barriers of calcium intake and exercise. They concluded that abnormal bone density scans were found among half of the sample and knowledge of osteoporosis was low for women and even lower for men.

Von Hurst & Wham (2007) investigated the knowledge and health beliefs regarding osteoporosis risk factors of New Zealand women aged 20-49 years. A descriptive web-based survey was adopted to recruit 622 women into the study. There was only a moderate level of knowledge about osteoporosis risk factors among the women surveyed with a mean total score for all subjects of 16.4 out of a possible 26 correct responses. Overall, about a third of the women perceived that they were likely to develop osteoporosis.
Spencer (2007) assessed the level and source of osteoporosis knowledge in a group of patients attending for DEXA scanning. The study was conducted with a sample size of 176 in two centers; Glasgow Royal Infirmary, UK (120 patients) and Christchurch public hospital, New Zealand (56 patients). The overall knowledge of osteoporosis was found to be poor. In terms of risk factors 31.8% knew no risk factors at all, 19.3% knew no risk reducing measures and 39.2% knew no signs or symptoms of osteoporosis. This study pointed out a dire need for the public to be made aware of osteoporosis, thereby enabling them to be more actively involved in preventive measures.

Gerend, Erchull, Aiken & Maner (2006) carried out a study to assess the perceptions of risk for osteoporosis and to identify the factors that shape those perceptions among 358 women aged 40-86 residing in a community. The findings of the study were derived from the analysis of the content of open-ended responses. The study participants believed that they were less likely to develop osteoporosis. In all, 63% of them perceived their risk as lower than other women of their age and only 16% as higher. Only one-third of all women, mentioned calcium consumption and exercise as protective factors employed to reduce osteoporosis risk. Women also had misconceptions about osteoporosis risk and protective factors. The study results created a need to increase the knowledge on osteoporosis of women to promote specific behavioural strategies for osteoporosis prevention.

Mattews, Laya & Dewitt (2006) explored the rural women’s knowledge about osteoporosis through a survey of 437 women in rural
Washington and Oregon. The response rate was 93% (N=406). The mean age of the respondents were 63 years and 74% (n=301) of women were postmenopausal. 27% of women above 40 years (n=111) reported to have fracture as an adult, less than half of this group (42%, n=47) considered themselves at risk for osteoporosis. Of the 42% (n=171), only 18% (n=30) answered calcium and vitamin D questions correctly. Over half of the women in this group wanted more information about osteoporosis, most wanted it before 50 years, and health care providers were a preferred source.

Burgener, Arnold, Katz, Polinski, Cabral, Avron, et al. (2005) investigated older adults’ knowledge and beliefs regarding osteoporosis and its health education messages and materials. A semi structured one-to-one interview was conducted. A standard interview guide was used for all interviews which were audio taped and transcribed. The results showed that many participants had only a fragmented understanding and they were confused about the difference between osteoporosis and osteoarthritis.

Pande, Pande, Tripathi, Kanoi, Thakur & Patle (2005) executed a study to assess the knowledge about osteoporosis among learned Indian women. The sample included a total of 75 female staff members (average age 44.7 years) of a teaching institute. An Osteoporosis Questionnaire was administered. The mean +/- SD of total score for the sample was 4.1 +/- 4.1 (range – 8 to 15: maximum possible score 20). The study concluded with the findings that there was a general lack of awareness in all the areas assessed and there was a statistically significant difference in the total score depending
on the faculty of education, with staff members from the science faculty having the maximum mean score (p < 0.05).

Werner (2005) reviewed and analysed the literature related to assessment of knowledge about osteoporosis, factors associated with knowledge, and relationship between knowledge about osteoporosis and participation in health related behaviours. The investigator reported that serious deficits in knowledge were noted among healthy and diagnosed women and men, as well as among health professionals. These findings stressed the need to address the low level of knowledge on osteoporosis by providing information through appropriate teaching measures.

William, Cullen & Barlow (2002) examined the knowledge of osteoporosis, health behaviors, and health beliefs among a sample of women in west Midlands of the United Kingdom. This cross sectional study had a sample size of 163 with a mean age of 40 years. Data were collected through self-administered questionnaires. The findings of the study showed that increased age was associated with increased perception of risk (p < 0.01). Women were fairly knowledgeable about some aspects of osteoporosis; gaps in knowledge were identified in relation to hereditary links, bone density scans and preventive measures. There existed a statistically significant association between receipts of osteoporosis information and predictive knowledge at p < 0.05 but, the majority (65%) appeared to be largely unaware of the potential threat.

Ungan & Thmer (2001) conducted a study to determine Turkish women’s knowledge and attitudes to osteoporosis and its prevention. Data
were collected using a questionnaire about osteoporosis from 270 women at Family medicine department of the Middle East Technical University Medical centre. The results showed that 90% of the women were somewhat familiar with osteoporosis whereas more than 65% were unaware of the disease being directly responsible for disabling hip fractures, and more than 40% were unable to identify significant risk factors. With relation to knowledge on calcium, only 36% of them were able to identify the correct source of calcium rich foods.

Riberio, Blakeley & Laryea (2000) designed a descriptive/exploratory study and assessed the women’s knowledge and practices regarding the prevention and treatment of osteoporosis. The data were obtained from a convenience sample of 185 women through hand-delivered questionnaire. The results suggested that women received inadequate information about osteoporosis, possessed limited knowledge about the disease, and adequate measures were not taken to prevent or treat osteoporosis.

2.1.3. Osteoporosis Preventive Behaviors

Narasinga Rao (2010) reported that calcium is an essential mineral for bone formation, the deficiency of which leads to reduced bone formation, osteoporosis and proneness to bone fracture. The calcium intake of people in developed countries was high (~1g/day). Also, the high intake of animal protein and sodium increased calcium loss in urine and raised the calcium requirement among people in developed countries. Calcium intake in developing countries ranged between 300-600 mg/day and is derived mainly from cereals and vegetables. The article also featured the daily calcium intake
for an adult Indian woman as 600 mg/day as recommended by the ICMR expert group, 2009.

Martyn-St James & Carroll (2009) assessed controlled trials to evaluate the effects of impact exercise on lumbar spine, femoral neck and total hip bone mineral density in post-menopausal women. The results revealed a statistically significant association between exercise and BMD. The impact protocols included jogging/ walking, stair climbing and resistance exercises which were effective at lumbar spine with the p values as 0.02 and 0.005 respectively. Effects on femoral neck BMD following these types of protocols were also significant at p < 0.001 and 0.05 respectively.

Malhotra & Mithal (2008) estimated that 25 million Indians were affected with osteoporosis based on the available data and clinical experience. They stated that a healthy lifestyle that include diet, exercise and exposure to sunlight could have a major impact on the bone health of Indians and recommended these measures to the population at large as they were efficacious, safe and cost-effective.

Bhatia (2008) reported the necessity for a reappraisal of dietary calcium recommendations for Indians as the calcium intake by Indians, both in reality and the recommendations were far lower than the western data.

Chang (2006) executed a cross sectional survey of calcium intake in relation to knowledge of osteoporosis and beliefs in young adult women (N=265). The investigator found out that the women had a very low intake of calcium (454 mg/ day).The factors that most strongly affected the intake of
calcium by women that accounted for 31.8% of the variation in calcium intake were, in order, knowledge, number of children, self-rated health score, body mass index, graduation from high school, experience of bone density examination and family history.

Shatrugna, Kulkarni, Kumar, Rani & Balakrishna (2005) carried out a study among 289 women of 30 – 60 years of age to estimate the BMD and its relationship to the nutritional status. The analyzed data yielded the results as follows. The mean (+/- SD) age was 41.0 +/- 8.60 years. Their mean (+/- SD) height, weight and body mass index were 149.1 +/- 5.49 cm, 49.2 +/- 9.85 kg and 22.1 +/- 3.99 kg/m² respectively. The estimated dietary calcium intake was 270 +/- 57 mg/day. The prevalence of osteoporosis at the femoral neck was around 29%. BMD T scores at all the skeletal sites were found to be low and were indicative of a high prevalence of osteopenia and osteoporosis. The multiple regression analysis revealed calcium intake as an important determinant of BMD (p < 0.05) apart from body weight, age and menopause.

Sedlak, Doheny, Estok & Zeller (2005) determined the effectiveness of tailored nursing interventions based on personal knowledge of BMD from a DEXA cause increases in knowledge of osteoporosis, health beliefs and osteoporosis- prevention behaviours in postmenopausal women of 50-65 years. The design for this pilot study was a two group quasi- experimental design with 124 as sample size. The posttest was conducted after six months following the intervention. The results depicted that there were significantly more perceived barriers to exercise in the tailored group (mean= 14.39) than in the nontailored group (mean = 12.21) at p<0.05. Daily calcium intake
increased in both the tailored and the nontailored groups. The tailored intervention increased women’s daily calcium intake from 614.28 to 1039.10 mg and in the nontailored group from 587.91 to 916.30mg.

Wallace (2002) examined the personal characteristics and expanded health belief model (EHBM) constructs associated with the practice of osteoporosis-protective behaviours among a random sample of 273 nontraditional college women. The knowledge on osteoporosis, EHBM constructs, weight-bearing exercise and dietary calcium intake were assessed. The findings of the study showed 50.7% of women did not meet the then guidelines for exercises and 67.8% of them did not consume the recommended intake of dietary calcium.

Kasper, Peterson & Allegrante (2001) surveyed 321 women of mean age 21.6 years who were enrolled in an undergraduate health course at a Southeastern state university to assess osteoporosis knowledge, beliefs and preventive behaviors. The results obtained indicated that 86% of the 321 participants had heard about osteoporosis, but only 3.8% of them reported to have received both adequate exercise and the recommended 1,200 mg of calcium per day. The study concluded by saying that the majority of young women studied were at risk for developing premature osteoporosis.

Hsieh, Novielli, Diamond & Cheruva (2001) conducted a pilot study to determine the health belief factors associated with osteoporosis prevention behaviours in per- and postmenopausal women. The survey was conducted to a convenience sample of 60 women aged 40-95 years old in an urban family practice center and an associated retirement community. The results were:
only 29% perceived a personal susceptibility; women were less concerned about osteoporosis when compared to cancer, cardiovascular disease and neurologic disorders and only 40% of women were taking active measures to prevent osteoporosis.

New (1999) reported that calcium is important not only to peak bone mass development but also in reducing bone loss in women. The role of calcium and vitamin D in fracture prevention among elderly was also stressed.

Anderson & Metz (1993) stated the then reports that investigated developmental changes in skeletal mass of adolescent girls and young women under different experimental or ecological conditions supported the contention that modification of environmental factors, especially dietary calcium and physical activity, could favourably modulate bone mass and bone density compared to controls. The investigators also discussed the need for a national policy to prevent osteoporosis through primary prevention strategies focused at young girls to achieve peak bone mass and at premenopausal women to gain 3-5% additional bone mass.

2.1.4. Self-efficacy and Osteoporosis Prevention

Swaim, Barner & Brown (2008) aimed to find out the associations between postmenopausal women’s osteoporosis health beliefs and osteoporosis preventative behaviours. A self-administered survey was used to obtain data from a convenience sample of 187 postmenopausal women, with no history of osteoporosis at a community pharmacy and senior nutrition sites
in Central Texas. Multiple regression was used to assess the relationship between health beliefs and modifying factors with calcium intake and exercise. The data analysis revealed that the calcium intake (mean+/-SD) was 1604.7/-907mg/day and the women engaged in five hours [(mean+/-SD): 5.1+/-5.3] of weight bearing exercise per week. Self-efficacy of calcium and self-efficacy of exercise had significant (p<0.05) positive relationship with calcium intake behaviour. Also, self-efficacy of exercise was significantly (p<0.05) and positively related to exercise behavior. This study tells the role of increased self-confidence in engaging in appropriate calcium intake and exercise, preventive behaviours of osteoporosis.

Schmiege, Aiken, Sander & Gerend (2007) determined the two osteoporosis – preventive behaviours, calcium consumption and weight-bearing exercises, in two samples of young women (Sample 1, n=202; Sample 2, n= 209). A prospective two panel design was used. Baseline data were obtained and after six months the behavioral follow-up data were obtained. Comparison of the proximal and distal outcomes of behavior yielded results as follows: Perceived barriers and self-efficacy directly predicted intentions to consume calcium and to exercises. With initial behaviour controlled, intentions to consume calcium and to exercise predicted the corresponding behaviours that were measured six months later.

Shin, Hur, Pender, Jang & Kim (2006) conducted a study to compare the perceived exercise self-efficacy, exercise benefits, exercise barriers and commitment to a plan for exercise between Korean women with a diagnosis of either osteoporosis or osteoarthritis. The influence of exercise, self-
efficacy, exercise benefits and barriers on commitment to a plan for exercise were also assessed in each group. The samples in the study were 154 Korean women above 40 years of age who were recruited from Hospital health centers or a nursing home. The results revealed that exercise self-efficacy was the most influential variable on commitment to a plan for exercise accounting for 57% of variance in commitment among osteoporosis patients and 53% among osteoarthritis patients. This study generated information on the need for assessment of self-efficacy prior to initiation of any behavioral change program.

Shin, Shin, Yi & Ju (2005) examined the relationship of knowledge, health beliefs and self-efficacy on osteoporosis through a research study adopting a correlative design. The participants were 1,615 Korean adults above the age of 20, registered in a new town. The osteoporosis knowledge test, osteoporosis health belief scale and osteoporosis self-efficacy scale were administered to obtain data related to the study variables. They identified the average score of osteoporosis self-efficacy as 40.40 against the maximum score 100; and a statistically significant positive correlation between osteoporosis knowledge and self-efficacy.

Li & Chen (2005) surveyed 290 middle-aged and elderly community dwellers to understand the self-efficacy and health behaviors with respect to osteoporosis. The results depicted that the mean score of the self-efficacy was 64.75 + / - 21.93 without any statistically significant difference in terms of gender and with a significant difference in terms of age, educational background and calcium intake (p < 0.01) and the older group had lower
scores than the younger one. The survey also revealed that the preventive behaviors of osteoporosis was insufficient and expressed a dire need for osteoporosis self-efficacy enhancement programs.

Winzenberg, Riley, Frendin, Oldenburg & Jones (2005) described the associations between the socio demographic factors, calcium specific self-efficacy and calcium intake in premenopausal women. This cross sectional study included a total of 467 randomly selected; predominantly Caucasian Tasmanian women aged between 25 and 44 years. The results showed that educational level, calcium-specific osteoporosis knowledge and self-efficacy were all independently associated with calcium intake (p<0.05). The study concluded that those women with low levels of calcium – specific self-efficacy and knowledge were at risk of not achieving adequate calcium intake. This information would assist in targeting of public health strategies at improving the calcium intake of premenopausal women.

Tussing & Chapman-Novakofski (2005) carried out a project with a convenience sample of 42 women to determine the impact of educational, theory-based osteoporosis prevention program on calcium intake. This eight week educational intervention included hands-on activities to increase self-efficacy. Post intervention showed an increased perceived susceptibility to osteoporosis (p<0.001), perceived benefits to increasing calcium intake (p<0.001), and increased self-efficacy related to calcium intake (p<0.001). Post intervention calcium intake was significantly increased to 821+/−372mg/day (p<0.001). Results of this project explained the role of self-efficacy in behaviour modification (calcium intake).
Bandura (1977) stated that ‘knowledge of health risks and benefits creates the precondition for change. Lack of knowledge among people about how their lifestyle habits affect their health limit them to change their lifestyle. Belief of personal efficacy is the foundation of human motivation and action. Self-efficacy is the most important prerequisite for behavior change because it affects how much effort is invested in a given task and what level of performance is attained’.

2.1.5. Osteoporosis Prevention Program

Magee, Stuberg & Schmutte (2008) determined the effectiveness of Osteoporosis Education Program on knowledge, confidence about osteoporosis prevention, self-efficacy and self-reported bone health life style behaviors in adolescent girls. Tests of knowledge, self-efficacy, calcium intake and physical activity were compared before and after the osteoporosis education program in intervention group and without intervention program in control group. The differential effects of intervention, an osteoporosis education program versus no intervention were determined using 2x2 analyses of variance. The results showed a significant increase in knowledge (p < 0.01), self-efficacy (p < 0.01) among the intervention group. Results for calcium intake and exercise were also found to be statistically significant.

Moon Fai Chan, Wing Suet Kwong, Yu-li Zang & Po Yuk Wan (2007) explored the effectiveness of an osteoporosis prevention education program on osteoporosis knowledge, self-efficacy and health belief among young adults in the age group of 18 to 30 years. A quasi-experimental design was adopted with two groups, intervention (n=22) and control (n=23). Using pre-,
post-and follow-up measures the data were collected in one integrated services centre during the period July 2005 to Nov. 2005. The results showed statistically significant increase in the scores of knowledge on osteoporosis risk factors (mean=10.3), knowledge on exercise (mean=7.0), knowledge on calcium (mean=7.7), osteoporosis exercise self efficacy scores (mean=46.5) and calcium self-efficacy (mean=50.0) among the intervention group than the control group as the mean scores were 4.6, 3.3, 3.0, 30.7 and 31.1 respectively.

Winzenberg, Oldenburg, Frendin, De Wit & Jones (2005) carried out a randomized controlled trial to examine the effects of bone density feedback and two different educational programs (an osteoporosis information leaflet and group-based behavioural education) on osteoporosis knowledge and osteoporosis self-efficacy among 470 premenopausal women aged 25-44 years. The division of the subjects by T-scores and randomization to educational intervention resulted in four intervention groups. The results revealed that the osteoporosis knowledge increased across all intervention groups. The average baseline knowledge scores obtained was 8.8/20. All intervention groups showed a statistically significant increase in knowledge score at p<0.001. This two year follow-up study demonstrated that osteoporosis knowledge could be increased by bone density feedback education intervention.

de Carvalko, Fonseca & Pedrosa (2004) analyzed knowledge and changes in eating habits in relation to osteoporosis among 95 elderly university students aged 60 to 80 years, with or without osteoporosis. Data
related to the study variables were collected before and after an educational intervention. The educational intervention was carried out for four months. Pretest data revealed an obvious lack of knowledge concerning important information about progressive loss of bone mass. The posttest results conducted after four months reported that more than half of the group had started implementing dietary changes to prevent osteoporosis. These study findings signified the role of education program in dietary modification that focused on osteoporosis prevention.

Laslett, McNeil & Lynch (2004) emphasized that the Osteoporosis education initiatives such as the Osteoporosis Prevention and Self Management Course could increase knowledge, self-efficacy and health related behaviours such as calcium intake and exercise.

Piaseu, Belza & Mitchell (2001) tested the effectiveness of an osteoporosis educational program among 100 young women who were undergraduate students, enrolled in the first year of a nursing program in Thailand. The participants were randomly assigned to control and experimental group. Osteoporosis Education Program was instituted to the experimental group. The program included instructional materials and a slide presentation titled ‘Osteoporosis throughout the life span’. The content included were identification of osteoporosis risk factors, identification of potential sequences of osteoporosis and strategies to prevent osteoporosis including effective exercises and maintenance of the daily calcium requirement. The data were obtained through the administration of osteoporosis knowledge test, the osteoporosis health belief scale and the
osteoporosis self-efficacy scale from all the participants. A higher mean score among the experimental group than control group for knowledge on risk factor (8.3, 5.0), knowledge on exercise (14.6, 9.1), knowledge on calcium (15.5, 8.9), exercise self-efficacy (78.3, 57.4) and calcium intake self-efficacy (94.0, 65.5) was observed. These findings indicated the effectiveness of Osteoporosis Education Program and the need for such programs in the prevention of osteoporosis and its complications.

Gupta (1996) emphasized the need for a multidisciplinary approach to identify the etiology of osteoporosis and to devise strategies for mass prevention of calcium and vitamin D deficiency, possibly by fortification of food with those nutrients and coupled with health education of the masses in order to promote bone health and control osteoporosis in India.

2.2 CONCEPTUAL FRAMEWORK

Nola J. Pender developed the Health Promotion Model is proposed as a holistic predictive model of health-promoting behaviour for use in research and practice. Health promotion seeks to increase a client’s level of well-being. The model focuses on the client’s individual characteristics, cognitive – perceptual factors, modifying factors and participation in health- promoting behaviours. It identifies factors that enhance or decrease health promotion activities. It also organizes cues into a pattern to explain the likelihood of a client’s developing health promotion behaviours. In the year 1996, the model was revised by Pender. From the revised model the concept of commitment to plan of action is included in the present study. It is conceptualized that commitment to a plan of action results in health promoting behavior.
Health promotion is defined as a behavior motivated by the desire to increase well-being and actualize human health potential. It is an approach to wellness. On the other hand, health protection or illness prevention is described as behavior motivated desire to actively avoid illness, detect it early or maintain functioning within the constraints of illness (Kozier, 2004).

The premise of the model is that cognition, action and environment influence health-promoting behaviours. The concepts of this model were modified and utilized for the current study. The underlying assumptions of this study were integrated into the application of this model. The components of the model in the present study are discussed below.

a. Individual factors

These are personal characteristics of the study participants which included the background variables that comprises of demographic and personal variables. The demographic variables are age, education, marital status, type of family, type of residence and yearly family income. The personal variables are dietary pattern, no. of children, family history of osteoporosis, household activity, practice of exercise and body mass index.

b. Cognitive-perceptual factors

Knowledge about osteoporosis illness and the individual’s perception of self capabilities affect health practices. It is conceptualized that knowledge improves individual’s perception on self-capabilities and promotes participation in health promoting behaviors. These are discussed
under the labels perceived health status, perceived self-efficacy and perceived barriers.

(i) **Perceived health status**

The awareness of the bone mineral density and the risk factors of osteoporosis are believed to influence the perception of the female school teachers on their health status.

(ii) **Perceived self-efficacy**

The individual’s perception of self capabilities to implement the osteoporotic preventive measures that include exercises and intake of dietary calcium are included. Assessment of these variables yields necessary data related to this.

(iii) **Perceived barriers**

The barriers included are activity status, knowledge on osteoporosis and confidence in carrying out the osteoporosis preventive behaviours. The other barriers which include lack of time, energy, social support and the cost of exercise and dietary modification were not assessed by the investigator.

**c. Modifying factors**

It is expected that certain factors could influence the behaviour of the study participants. Such factors that are related to the current study are grouped under three labels.
(i) **Interpersonal influences**

The teaching process that includes lecture cum discussion on Osteoporosis & its preventive measures as part of OPP and interaction between the investigator and the study participants are considered.

(ii) **Situational factors**

Participation in the study, issuing of booklets and reinforcements are thought to be influential in the female school teacher’s behavior.

(iii) **Behavioural factors**

These factors include demonstration & return demonstration of exercises, practice of exercises and practice of intake of dietary calcium.

All the above discussed factors are planned to assess as a baseline measurement during pretest which includes measurement of BMD, assessment of knowledge, perception and practice of exercises & intake of dietary calcium. Following the implementation of OPP to the study group the posttests are planned at the end of 1\textsuperscript{st} month, 6\textsuperscript{th} month and 12\textsuperscript{th} month.

d. **Cues to action**

The factors that could lead to desirable behavior in the study participants are included here. Reinforcements in person by the investigator can serve as a cue to action. Apart from that, the other factors that may or may not be present include mass media, news paper, magazines, peer
influences and medical consultation. These cues may promote commitment to implement osteoporosis preventive behaviours.

e. **Commitment to a plan of action**

   In the present study this refers to the study participant’s level of adherence to the osteoporosis preventive measures as per OPP.

f. **Expected outcome**

   Outcome is expected following an intervention. Here it refers to the validation of the health-promoting behavior in terms of improvement or no improvement in knowledge on osteoporosis risk factors, exercises & calcium intake, self-efficacy that includes perception on exercises, perception on intake of dietary calcium, practice of exercises & practice of intake of dietary calcium and bone mineral density.
Figure 1. Conceptual Framework based on Nola J. Pender's Health Promotion Model.