Selected factors related to calcium intake and change in calcium intake resulting from a Health Belief Model and health locus of control-based intervention among 45-54 year old women

by

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DEDICATION

Dedicate to my late sister Hannah Wambui who did not live to go through menopause, and her four children Kabura, Maina, Mukami and Runanu. I miss you alot.

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ABSTRACT

The objective of this study was to investigate selected factors related to calcium intake and change in calcium intake after an intervention among a sample of 45-54 year old women. The theoretical bases for the research were the Health Belief Model and the health locus of control.

A total of 167 women met the criteria and participated in the pre-intervention study. Prior to the intervention, participants completed a five-part questionnaire that provided information on estimates of dietary and supplemental calcium intakes, demographic and lifestyle characteristics, health locus of control, and health beliefs. Immediately following the initial data collection, two-hour informational meetings were held in seven locations in Iowa during Fall, 1995. Approximately six weeks after the intervention, a four-part post-test questionnaire was mailed to the participants. A total of 152 (91% return rate) completed and returned usable questionnaires.

All but three participants were white, and all were well educated. According to the multidimensional health locus of control results, this group of participants had relatively high scores for internal locus of control compared to external or chance locus of control. Similarly, the participants' attitudes related to the Health Belief Model were highly positive. Prior to the intervention participants had a mean total calcium intake of 1,423 mg/day that increased to 1,614 mg/day after the intervention. The health belief attitudes significantly predicted supplemental calcium intake both pre- and post-intervention. Chance locus of control was a significant predictor of dietary calcium intake post-intervention. College

graduate education level in comparison to the high school graduate level, external locus of control, chance locus of control, and age interacted with peri-menopausal status significantly predicted change in calcium intake pre- to post-intervention. Based on these findings, it is reasonable to conclude that in this study the educational intervention may have been responsible for changing some of the participants' dietary and lifestyle behaviors.

CHAPTER 1

INTRODUCTION

Menopause is an inevitable and unavoidable event in the lives of virtually all women, healthy or otherwise, who live into their 50's. Thus, all women in industrialized societies who live to an average life expectancy will spend a significant proportion of their lifetimes in the post-reproductive state. The number of women in the United States aged 45 to 54, the key menopausal group, is expected to grow by 73% between 1990 and 2010, according to Census Bureau projections (Braus, 1993).

Technically, menopause refers to the permanent cessation of menstruation and menstrual cycles. Using a more general definition, menopause refers to an entire stage of menstrual irregularity and fertility decline, leading eventually to the complete cessation of reproductive capacity. As ovulation ceases, a host of other symptoms and effects are brought about by the accompanying reduction in estrogen levels. One of these effects is an increased prevalence of osteoporosis.

Osteoporosis is characterized by bone loss, causing bone fragility and often resulting in fractures. This disease is a major cause of morbidity and mortality in post-menopausal white women. Population based data from the United States indicate that the lifetime risks of hip and vertebral fractures in 50 year old post-menopausal white women are 16% and 32%, respectively (Cummings et al., 1989).

In order to reduce the risk of osteoporosis, researchers have examined factors that may increase the risk for the disease. Risk factors can be divided into three categories--

physiological or descriptive factors, behavioral factors of pre-menopausal women, and behavioral factors of post-menopausal women.

Widely recognized physiological or descriptive factors related to menopause include race, phenotype, and family history. For reasons that are not completely defined, black women rarely develop osteoporosis. Women who are blond with fair complexions, especially those of Northwest European ethnic background, and Oriental women are at high risk. In addition, women who are short and petite and who have a light skeleton are at high risk (Lane and Vigorita, 1983). It is not clear whether risk related to a family history of osteoporosis has a genetic basis or is secondary to the environment and lifestyle of families subject to this condition (Moller et al., 1978).

Pre-menopausal women have been studied because reducing the risk of osteoporosis depends largely upon the accrual of as much bone as possible before menopause. The behaviors of pre-menopausal women that can increase the risk of osteoporosis are primarily cigarette smoking, lack of exercise, and low calcium intake. Assessing the above factors on the development of low bone mass is of great importance since they are open to intervention. Women who smoke tend to have diminished bone mass by the time they enter menopause. In pre-menopausal women, smoking enhances the conversion of estrogen to metabolically inactive forms and results in lower endogenous estrogen levels in the blood. Because of this relative estrogen insufficiency in younger years, peak bone mass in smokers may not reach its full potential (Michinovicz et al., 1986). Mechanical force plays an important role in bone formation and function. Bone mass accrual occurs more readily in 'growing' than in 'mature' bone (Carter, 1984). This fact emphasizes the importance of exercise for young women in preparation for the predictable post-menopausal bone loss. This exercise should be coupled with an adequate calcium intake. Based on the present recommendations the pre-menopausal requirements for this essential mineral are higher than the National Institute s of Health (Optimal Calcium Intake, NIH Consensus Statement, 1994). To be in balance, pre-menopausal women need 1,000 mg of elemental calcium per day (Notelovitz, 1986). According to the most recent U.S. government estimates, average calcium intake among 40 to 49 year old women is 717 mg per day, and among 50 to 59 year olds, 660 mg per day, while intakes for 60 to 69 year old women averages 711 mg per day, far short of the 1,000 to 1,400 mg thought to be needed (Interagency Board for Nutrition Monitoring and Related Research, 1995).

Among post-menopausal women, the behavioral risk factor that has received the most attention is the use of hormone replacement therapy. Estrogen replacement therapy can slow osteoporosis, but it will not reestablish the bone that has been lost. However, the use of estrogen alone after menopause may increase the risk of endometrial cancer (Whitehead et al., 1979). Recent studies have also focused on whether post-menopausal calcium intake and exercise affect bone loss among these women. For example, results of a study by Nelson and co-workers (1991) suggest that exercise coupled with high dietary calcium may decrease bone loss at various skeletal sites.

Recent evidence also suggests that maintaining a high calcium intake will slow bone loss among post-menopausal women, regardless of whether or not they are taking hormone replacement therapy. For example, Heaney and associates (1977) found a linear relationship between dietary calcium intake and balance among post-menopausal women. More importantly, the slope of the line was similar for estrogen deprived and estrogen repleted women. This study showed that increasing dietary calcium to about 1.4 g/day had an effect similar to estrogen in raising calcium balance.

There is a speculation that mild to moderate vitamin D deficiency leading to osteomalacia may contribute significantly to the excess bone loss and fracture rates observed in Causacian women (Parfitt et al., 1982). This speculation is supported, in part, by the observation that vitamin D intake was lower in patients with femoral neck fracture than in control subjects (Baker et al., 1979). These data suggest that the effects of vitamin D deficiency resulting in osteomalacia may be observed in populations identified as having low bone mass and a high rate of fractures.

A variety of other risk factors for osteoporosis about which limited data are available have been reported. For example, caffeine intake has often been cited as a possible risk factor because it mildly decreases calcium balance by increasing urinary calcium excretion (Harris and Dawson-Hughes, 1994). Some experts have suggested that long-term high intake of dietary fiber increases the risk for osteoporosis. Although dietary fiber binds calcium and prevents its absorption, the evidence of its effect on calcium balance is inconclusive (Southgate, 1987). Alcoholism also has been associated with osteoporosis in some individuals, but the degree to which a moderate ethanol intake affects bone maintenance has not been established (Lalar and Counihan, 1982). Another possible risk factor, excessive aluminum intake, has been associated with osteopenia (Spencer and Kramer, 1985). Bone avidly takes up and retains aluminium, reducing bone formation and mineralization. Additionally, unrecognized lactase deficiency may be more common in osteoporotic than in normal persons, and may contribute to a lifetime of low dairy product intake (Notelovitz, 1986). Finally, ingestion of high-protein diets increases fecal loss of calcium (Heaney et al., 1982). Therefore, long-term consumption of protein-rich diets may increase the risk for osteoporosis.

Overall, it appears that the dietary factor that has the most potential for reducing the risk of osteoporosis in post-menopausal women, regardless of their ingestion of estrogen, is calcium intake. However, no research is available suggesting factors related to calcium intake among 45-54 year old women, or factors related to increasing the intake of calcium among these women. Therefore, the objective of this study is to investigate selected factors related to calcium intake and change in calcium intake among a sample of 45-54 year old women. The research model is shown in Figure 1.

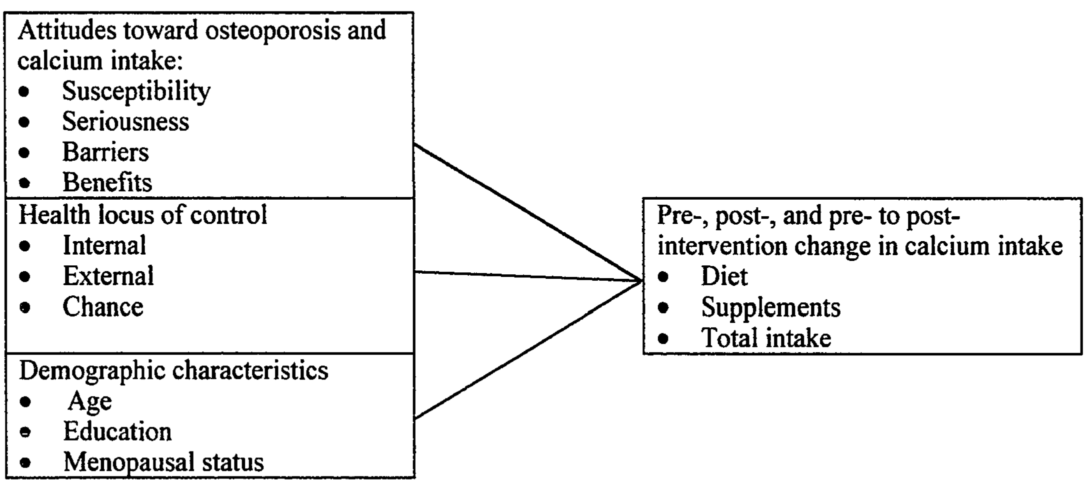

Figure 1. Model to predict calcium intake

Theoretical Base

This research will be guided by two theories widely used to study preventive health behaviors -- the Health Belief Model and the health locus of control theory. The Health Belief Model (McCrae et al., 1984) states that an individual is most likely to engage in a behavior to reduce the risk for a disease if:

- The individual feels that he/she is personally susceptible to the disease.
- The individual perceives that the consequences of the disease are at least moderately severe.
- The recommended behavior change has benefits, particularly in reducing the susceptibility to or severity of the disease.
- The perceived barriers to performing the new behavior are not too great.
- The individual is generally motivated to maintain good health.
- The individual is exposed to appropriate cues to action.

The Health Belief Model has been successful in predicting health behavior change in a wide variety of studies. However, some researchers have pointed out that its predictive value can be improved by adding an additional factor found in many studies to influence health behavior -- health locus of control. This theory differentiates between internal and external locus of control as determinants of adoption of a new health (Rotter, 1954, 1966). When an individual's behavior leads to an anticipated outcome, it reinforces that person's belief that rewards are contingent on personal actions (internal locus of control). Conversely, continual outcomes unrelated to personal behavior increases an expectancy that rewards are contingent on forces outside of the individual, such as luck, chance, fate, or powerful others (external locus of control). The locus of control theory proposes that those with a strong sense of internal locus of control are more likely than those with external locus of control to engage in actions that prevent adverse outcomes.

CHAPTER 2

REVIEW OF LITERATURE

Menopause

Menopause is clinically defined as amenorrhea for more than one year after age 40 and a highly elevated plasma follicle stimulating hormone (FSH) level (>40 IU/L). Approximately 50% of the female population become menopausal by the age of 50 (Rafoff, 1980). Since the female life expectancy in the United States is 78, an average U.S. woman will spend one-third of her life as a post-menopausal individual. Pre-menopausal women are generally in their mid- to late 40s. Peri-menopause refers to the period of transition, during which the menses will cease. This transitional period between the potential child-bearing phase and the post-reproductive phase is also called the climacteric. Post-menopause is the time following the climacteric when reproductive function has ceased, and the hormonal instability of peri-menopause is replaced by the relative stability of the post-reproductive life stage (Pavelka and Fedigan, 1991).

The landmark of the menopausal transition is the appearance of irregular menses. Hormonal changes that signal decreased ovarian function begin to occur in the decade prior to the development of irregular cycles (Sherman and Korenman, 1975). Cycle length shortens due to a shorter follicular phase, and throughout the shorter cycles serum FSH levels are increased (Sherman et al., 1976). Transitional cycles may be ovulatory, as evidenced by a midcycle estrogen surge and subsequent luteal phase progesterone secretion, or anovulatory with a rise and fall in estrogen levels in the absence of progesterone secretion (Sherman and Korenman, 1975).

Following peri-menopause, menstrual cycles cease and the secretion of steroid hormones and gonadotropins changes. Primary among these hormonal changes is a reduction in estrogen levels. Estrogens are secreted primarily by ovaries, although extra-ovarian sources, such as the adrenal glands and peripheral conversion of androgens to estrogens, are also available. Following the menopause, the ovaries no longer function as the primary site of estrogen secretion, and estrogen levels fall significantly. Nevertheless, androgens are converted to estrogens in fat cells, and it has been shown that the ability to convert androgens to estrogens is greater in post-menopausal women than in pre-menopausal women (MacDonald et al., 1978). The possible negative effects of declining estrogen levels include the vasomotor symptom complex including hot flashes, lower urinary tract atrophy, atrophy of the reproductive organs and tissues, and increased risk of osteoporosis (Harmon and Talbert, 1985). Each of these possible negative effects is briefly described below.

Effects of declining estrogen levels

Vasomotor symptom complex The most widely appreciated symptom of the climacteric is the hot flash, the episodic occurrence of sudden skin flashing and perspiration. In cross sectional surveys, about 70% of the women report experiencing hot flashes (McKinley and Jeffereys, 1974).

Lower urinary tract atrophy In association with the lowered estrogen levels seen after the menopause, atrophic changes occur in the urethra and periurethral tissues. The urethra becomes thinner, due to the regression of its squamous epithelial layer. Loss of pelvic tone also contributes to diminished functional integrity of the lower urinary tract. As a result of decreased pelvic support, prolapse of the urethro-vesicular junction occurs; this change is detrimental to continence because the normal intra-abdominal location of the urethro-vesicular junction is one of the mechanisms of bladder control (Bergman and Brenner, 1987).

Genital changes Hypoestrogenemia is associated with changes in both the subepithelial and epithelial tissues of the lower genital tract. There is a loss of vaginal elasticity and increased subepithelial connective tissue, associated with shortening of the vaginal canal. The vaginal epithelium is an estrogen-sensitive tissue, and loss of estrogen is associated with a pale-appearing, thinned, fragile, and sometimes even ulcerated epithelial surface (Notelovitz, 1978).

Bone loss The different gender ratio of hip and wrist fractures has implicated estrogen deficiency as an etiology of osteoporosis unique to post-menopausal women. This condition is further discussed in the section below.

Osteoporosis

Osteoporosis is a condition characterized by a reduced amount of bone, which leads to diminished physical strength of the skeleton and an increased susceptibility to fractures. The typical osteoporotic fractures are those of the distal forearm (wrist or colles fracture), thoracic and lumbar vertebrae, and femoral neck. Other less common sites include the humerus, ribs, and pelvis. There are several causes of osteoporosis, but the most important for women is post-menopausal hormone changes. This disease is a major cause of morbidity and mortality in post-menopausal white women. Population based data from the United States indicate that the lifetime risks of hip and vertebral fractures in 50 year old post-menopausal white women are 16% and 32%, respectively (Cummings et al., 1989). Investigators have suggested that there may be two types of osteoporosis (Riggs and Melton, 1986). Type one or post-menopausal osteoporosis is suggested as occurring around the menopause and is clinically observed as vertebral crush fracture or wrist fracture. Type two or senile osteoporosis reflects changes in bone status with aging. Clinically, this latter type is associated with an increased hip fracture rate after age 70. There are two main factors that determine whether or not a woman will develop osteoporosis: (1) the peak pre-menopausal adult bone mass, and (2) the rate of bone loss following the menopause.

Peak bone mass is to a large extent genetically determined; for example, smaller women have smaller bones than larger women. It is also racially determined. Black women are largely immune to osteoporosis because of their greater bone density and slower rate of post-menopausal bone loss compared to white women (Stevenson, 1991). Indian women suffer from the disease, but it is far more common in Japanese and white Caucasian women. As Mehta (1993) puts it, a typical profile of a woman prone to osteoporosis is a white Caucasian woman in her late forties or fifties, with a family history of osteoporotic fractures, who has had an early menopause, is physically inactive, smokes, likes salty foods rich in protein but poor in calcium, and drinks coffee.

Bone formation is dependent upon a five-stage cycle that results in 'old' bone being removed and replaced with 'new' bone. Normally, this process is coupled; the amount of old bone removed is replaced with an equal amount of freshly formed bone. Bone loss occurs either because the osteoclasts (bone destroying cells) erode cavities that are too deep or the osteoblasts (bone forming cells) lay down insufficient bone. The latter process is thought to account for the slow loss of bone associated with aging, and the former with a rapid bone loss that can actually result in focal perforation of the trabecular plates, with a resultant loss in mechanical support. The two mechanisms also may function in concert, a condition thought to account for the abrupt increase in vertebral fracture rate that sometimes follows estrogen withdrawal (Notelovitz, 1986). Estrogen deficiency brought about by the menopause is thought to cause an increase in osteoclast activity, which combines with the normal age-related decrease in osteoblast activity (Gangar, 1994).

In women, bone loss before the menopause is small and probably parallels that of men. Around the menopause, bone loss accelerates, averaging 2% per year over the next 5-10 years. The accelerated post-menopausal bone loss and the relatively lower peak bone mass of women compared to men explain why osteoporosis is much more common in women than in men. The rate of bone loss in the first 10 post-menopausal years varies widely from one woman to another, ranging from less than 1% to more than 5% per year, or even more if measured in pure cancellous or spongy tissue of bone. On this basis, post-menopausal women can be stratified into two populations, with about 25-30% belonging to a group of especially fast bone loser who may be particularly vulnerable to osteoporotic fractures later in life and the other 70-75% to a group who lose bone more slowly (Christiansen, 1993).

Generally accepted risk factors for osteoporotic fractures in women are age, race, low body weight, and early menopause (Kelsey, 1987). Studies also suggest that a positive family history of osteoporosis and behavioral factors like dietary calcium intake, a low level of physical activity, cigarette smoking, and high alcohol intake increase risk (Stevenson et al., 1989). These risk factors are described below.

Risk factors for osteoporosis

Age-related bone loss Age is by far the most important determinant of bone mass (Riggs et al., 1981). Even after closure of the endochondral growth plate, bone mass increases by radial growth until about the age of 30. After a transient period of stability, age-related bone loss begins. During the last decades of life, women lose about 35% of their cortical bone and 50% of their trabecular bone, whereas men lose about two-thirds of these amounts (Mazess, 1982). Cortical bone predominates in the shafts of the long bones; trabecular bone is concentrated in the vertebrae, the pelvis and other flat bones, and the ends of long bones. Trabecular bone is metabolically much more active than cortical bone, and thus more responsive to changes in mineral homeostasis.

For cortical bone, a slow bone loss begins at about age 40 in both sexes at an initial rate of about 0.3-0.5% per year, and increases with aging until it slows or ceases late in life (Smith et al., 1975). In both sexes, the onset of trabecular bone loss occurs at least a decade earlier than the onset of cortical bone loss. In women, the extent of pre-menopausal trabecular bone loss is much greater than the extent of cortical bone loss. After menopause the loss of trabecular bone initially accelerates and then ceases after about five to six years. In contrast, cortical bone loss continues for a relatively longer period of time (Riggs and Melton, 1986).

Race Black women apparently are protected from osteoporosis relative to women of other races, perhaps because of their greater bone mass at maturity. Women who are blond with fair complexions, especially of Northwest European ethnic background, and Oriental women are at high risk (Lane and Vigorita, 1983).

Low body weight Small, lightweight women are more susceptible to osteoporotic fractures than taller, heavier women. The higher fat mass in heavier women may result in a lower rate of bone loss in both pre- and post-menopausal women because of higher conversion of adrenal androstenedione to estrone in fat tissue (Saville and Nilsson, 1966; Frumar et al., 1980). The beneficial effects of increased body weight may be fully achieved at body weights as low as 110% of ideal body weight (Harris et al., 1992). In addition, body weight, regardless of body composition, may effect rates of change in bone mass density by placing mechanical stress on the entire skeleton.

Early menopause Women who have undergone oophorectomy (removal of the ovaries) in young adulthood have lower bone densities in late life than their peers. Surgical menopause accelerates bone loss and estrogen replacement prevents or slows it (Genant et al., 1982). Early development of osteoporosis in women with gonadal dysgenesis and premature ovarian failure has also been observed (Richelson et al., 1984; Aitken et al., 1973).

Family history of osteoporosis Bone mass is related to family history. Lindsay and Dempster (1985) state that 75% of their osteoporosis cases have a family history component. However, the degree to which this is due to genetics or to environment is not clear. Lutz (1986) found a moderate correlation ($r = .50$) for bone density between mothers and daughters.

Behavioral factors Clinicians in the field of osteoporosis agree that the most effective way to deal with osteoporosis is to prevent it (Lindsay, 1993). Assessing behavioral factors that may increase the risk of low bone mass is of great importance since they are open to intervention. While it may be impossible to eradicate osteoporosis completely, the potential impact of prevention is substantial. Behavioral factors can be divided into two categories--behavioral factors of pre-menopausal women and behavioral factors of post-menopausal women.

Pre-menopausal women have been studied because reducing the risk of osteoporosis depends largely upon the accrual of as much bone as possible before menopause. The behaviors of pre-menopausal women that can increase the risk of osteoporosis are primarily cigarette smoking, lack of exercise, and low calcium intake.

Smoking and exercise In pre-menopausal women, smoking enhances the conversion of estrogen to metabolically inactive forms and results in lower endogenous estrogen levels in the blood. Because of this relative estrogen insufficiency in younger years, peak bone mass in smokers may not reach its full potential (Michinovicz et al., 1986).

It is well established that skeletal stresses from bearing weight and muscle contraction stimulate osteoblast function. Muscle mass and bone mass are directly related (Cohn et al., 1977). Since bone mass accrual occurs more readily in growing than in mature bone, it is important for young women to exercise regularly in preparation for the predictable post-menopausal bone loss. This exercise should be coupled with an adequate calcium intake, as discussed in greater detail in the next section.

Like for pre-menopausal women, among post-menopausal women the primary predisposing behavioral risk factors for osteoporosis include cigarette smoking, limited physical exercise, and low calcium intake. An additional behavioral risk factor after menopause is whether or not a woman takes estrogen replacement hormones. Smoking, exercise, and estrogen replacement are discussed below, and calcium is reviewed in the next section.

Tobacco use appears to cause reduced bone mass and increased rates of bone loss in post-menopausal women for four reasons (Krall and Dawson-Hughes, 1991). First, smoking has been associated with early menopause, and second, smokers tend to have lower body weights than nonsmokers (Jensen, 1986). Both early menopause and low body weight are independent risk factors for osteoporosis. Third, post-menopausal smokers appear to absorb calcium from the gut less efficiently than nonsmokers (Krall and Dawson-Hughes, 1991; Aloia et al., 1983). Finally, smoking is thought to exert an effect on bone by influencing the 2-hydroxylation pathway of estradiol metabolism, which is devoid of peripheral estrogenic activity. This explains the anti-estrogenic effects of smoking (Michinovicz et al., 1986).

Therefore, post-menopausal women who smoke are at higher risk for osteoporosis than non-smokers because they enter menopause with reduced bone mass and lose bone mass more rapidly after menopause.

Positive effects of physical activity on bone density have been demonstrated in studies of post-menopausal women. It has generally been presumed that for exercise to be effective in preventing bone loss with aging, it must be weight bearing in nature to generate enough mechanical strain. In fact, several weight-bearing exercise intervention studies have documented increases in spinal density in response to weight-bearing exercise (Krolner et al., 1983; Chow et al., 1987; Dalsky et al., 1988). Likewise, several prospective studies have documented positive effects on both bone mineral density and total body calcium with a variety of weight-bearing exercise regimen (Aloia et al., 1978; Krolner et al., 1983; Smith et al., 1989).

While weight bearing exercises have been given a lot of emphasis, a few recent studies have demonstrated a significant increase in bone mineral density of the lumbar spine in response to exercise regimens traditionally considered non-weight bearing in nature (Bloomfield et al., 1993). For example, the results of Tsukahara et al. (1994) indicate that continuous water exercise has a suppressive effect on bone loss.

Estrogen replacement therapy Estrogen replacement therapy (ERT) has been shown to reduce bone loss and fractures due to osteoporosis. In fact, ERT initiated at the onset of menopause can decrease the incidence of osteoporosis-related fractures by approximately 50%. The major effect of estrogen is suppression of bone resorption by circulating parathyroid hormone. Estrogen also increases calcium absorption through the gastrointestinal tract by enhancing the conversion of 25-hydroxy vitamin D to 1,25-dihydroxy vitamin D_3, which in turn stimulates the active transport of calcium from the gastrointestinal tract. Estrogen replacement therapy is considered the most effective treatment for preventing bone loss in early menopause. Unfortunately, ERT is not without drawbacks. For example, accelerated bone loss is known to occur when estrogen therapy is discontinued (Riggs and Melton, 1992). ERT is also known to increase the risk of endometrial cancer by about 0.1% per year, and an association with breast cancer has recently been shown (Toniolo et al., 1995) The inconvenience of periodic vaginal bleeding is another negative factor with ERT which limits its acceptance by women. Furthermore, there is no convincing evidence that estrogen benefits women over the age of 75 years (Riggs and Melton, 1992). A comparative study of exercise, calcium supplementation, and hormone replacement therapy in post-menopausal women with low bone density found that bone loss can be slowed by exercise plus either calcium supplementation or estrogen-progestrone therapy. Although the exercise and estrogen-progesterone regimen was more effective than exercise and calcium supplementation in increasing bone mass, it also caused more side effects (Prince et al., 1991).

Impact of Dietary Factors on Osteoporosis

A number of dietary factors potentially affect osteoporosis. Below these factors are discussed in three sections-- calcium, vitamin D, and other dietary factors.

Calcium intake

Calcium is a major component of mineralized tissues and is required for normal growth and development of the skeleton and teeth. Optimal calcium intake refers to the level of consumption necessary for an individual to (1) maximize peak adult bone mass, (2) maintain adult bone mass, and (3) minimize bone loss in the later years. Though mineralized bone contains other compounds like sodium, magnesium, carbonate, and citrate ions, calcium and phosphorous are the principal constituents. Since 99% of the calcium in the body is stored in the skeleton, factors that regulate its supply, absorption, deposition, and withdrawal from bone determine bone health (Notelovitz, 1993). However, for several years there has been considerable controversy over both the amount of calcium intake needed for the maintenance of skeletal mass, and also the need for calcium supplementation in the prevention and treatment of osteoporosis (Kanis and Passmore, 1989; Nordin and Heaney, 1990). Recent studies support the view that dietary calcium may modify both peak bone mass and the subsequent rate of bone loss (Cummings, 1990; Pollitzer and Anderson, 1989).

Bone mass is believed to accrue in young adult women as a result of increased bone formation relative to bone resorption. It has been suggested that promoting greater bone mass in young adult women may be the most effective method of sustaining sufficient bone mass during aging (Newton-John and Morgan, 1968). There is some evidence from cross-sectional studies that increasing dietary calcium may be influential in promoting a high peak bone mass. For example, Sowers et al. (1985a) found that greater calcium intake was associated with greater bone mass, measured by single photon densitometry, in a geographically defined population of women aged 20-35 years after considering the effects of age, body size, lifestyle habits, and reproductive events. Similarly, a Yugoslavian study (Matkovic et al., 1979) found differences in bone mass between persons from high calcium intake and low calcium intake regions. The rural populations of these two districts were of the same ethnic origin, lived in similar conditions, and got comparable physical exercise. Less metacarpal bone mass and a higher proximal femur fracture rate were found in the low calcium district, suggesting the importance of dietary factors in determining cortical bone mass.

Davis et al. (1989) investigated the influence of nutrition and lifestyle factors on the magnitude of bone consolidation in young women between the ages of 18 and 26. One hundred eighty four women were followed for four years. Measurements were made of bone mass, nutrient intake, and physical activity levels. There was no attempt to alter lifestyle, and no intervention was performed. Gain in skeletal mass occurred in these women until age 30. The gain was about 13% for total body bone mass. Variation in self-selected intakes of calcium influenced the gain in skeletal mass. At intakes of or below 200 mg/day there was little or no gain, while at intakes of about 1500 mg/day one individual's bone mass increased by as much as 15%. This finding confirms the results of a study by Recker et al. (1992) which also examined bone gain in young adults. The study examined 156 women of college age in whom no conscious intervention in lifestyle was undertaken. It was found that gain in bone mass occurred over the entire skeleton, was complete by about the age of 30 years, and was enhanced by both increased self-selected calcium intake and increased self-selected physical activity.

In contrast to the relative clarity of the influence of calcium intake on the bone mass of young women, data on the efficacy of calcium intake in the prevention and treatment of osteoporosis in older women are conflicting. Reid et al. (1993) found that a calcium supplement of 1000 mg per day had a beneficial effect on bone loss in normal post-menopausal women. The effect was consistent throughout the skeleton. They examined 122 normal women at least three years after they had reached menopause. Mean dietary calcium intake was 750 mg per day. The women were randomly assigned to treatment with either calcium (1000 mg per day) or a placebo for two years. The bone mineral density of the total body, lumbar spine, and proximal femur was measured every six months by dual-energy x-ray absorptiometry (DEXA). Serum and urine indexes of calcium metabolism were measured at baseline and after 3, 12, and 24 months. The results of this study indicate that in the calcium treatment group the mean rate of loss of total body bone mineral density was reduced by 35% in the legs, and loss was eliminated in the trunk. Calcium supplementation significantly slowed axial and appendicular bone loss in normal post-menopausal women.

Lifelong calcium intake may also be of some importance in the protection against osteoporotic fractures, affording a reduction of up to 60% in hip fractures according to an epidemiological study (Holbrook et al., 1988). In a 14 year prospective study, the effect of dietary calcium intake on risk of hip fractures was assessed. Between 1973 and 1975, a baseline quantified 24-hour diet recall was obtained from 957 men and women aged 50 to 79 years. Follow-up in 1987 with mortality records and interviews showed 15 men and 18 women had had hip fractures. The age-adjusted risk of hip fracture was inversely associated with dietary calcium whether considered as mg per day or as nutrient density (mg per 1000 kcal). No other nutrient studied was consistently associated with hip fracture. The association between calcium and fracture persisted after adjustment for cigarette smoking, alcohol intake, exercise, and obesity. The significant independent inverse association of dietary calcium with subsequent risk of hip fracture strongly supports the hypothesis that high dietary calcium intake protects against hip fracture.

Similarly, Aloia et al. (1994) reported that calcium augmentation of the diet after menopause retarded bone loss from the entire skeleton. One hundred eighteen healthy white Caucasian women three to six years after spontaneous menopause were randomly allocated to daily intake of 1700 mg of calcium, placebo, or conjugated equine estrogens (0.625 mg, days 1 to 25) and 1700 mg of elemental calcium daily for 2.9 ± 1.1 years. Each participant also received 400 IU of vitamin D daily. Total body calcium was measured by delayed gamma neutron activation analysis and whole-body counting; bone mineral density of the spine, femur, and radius was measured by photon absorptiometry. Results showed that bone mineral density declined in the placebo group for the lumbar spine, the femoral neck, the trochanter, ward triangle, and total body calcium. Rates of change were intermediate for calcium augmentation compared with placebo and estrogen-progestrogen combined with calcium, but significantly less compared with placebo for total body calcium and the femoral neck. Calcium augmentation alone significantly retarded bone loss from the femoral neck and improved calcium balance. Recently, meta-analysis of studies in the published literature through 1994 of the effect of calcium intake on bone mass in young and middle-aged females and males found a small, but significantly positive, relation between calcium intake and bone mass in females (Welten et al., 1995).

In addition to calcium intake, Tranquilli et al. (1994) found phosphorous and magnesium intake relevant to bone health in post-menopausal women. In assessing the influence of dietary habits on both healthy women and osteoporotics, a total of 194 women who had been menopausal for five to seven years and had never been treated with hormone or drug therapy were examined with forearm DEXA densitometry. Seventy of the women were osteoporotic and 124 served as controls. A three day dietary recall was completed. The results showed that dietary intake of calcium, phosphorus, and magnesium were significantly lower in osteoporotic women compared to controls and correlated with bone mineral content. Similarly, Strause et al. (1994) found that older post-menopausal women ages 59-73 years supplemented with 1,000 mg of calcium, 15 mg of zinc, 5 mg of manganese, and 2.5 mg of copper maintained spinal bone density and differed significantly from a placebo group that lost bone density during a two year treatment period.

A study of 3,270 healthy ambulatory elderly women 78-90 years by Chapuy et al. (1992) indicated that a combination of vitamin D_3 and calcium supplements reduced the risk of hip fracture and other non-vertebral fractures, decreased parathyroid hormone secretion, and increased the mineral density of the proximal femur. Each day for 18 months, 1,634 women received tricalcium phosphate (containing 1.2 g of elemental calcium) and 20 μg

(800 IU) of vitamin D_3, and 1,643 women received a double placebo. Serum parathyroid hormone and 25(OH)vitamin D concentration were measured in 142 women, and femoral bone mineral density at baseline and after 18 months was determined in 56 women. Results showed that the number of hip fractures was 43% lower and the total number of non-vertebral fractures 32% lower among the women treated with vitamin D_3 and calcium than among those who received the placebo. The bone density of the proximal femur increased 2.7% in the vitamin D_3-calcium group and decreased 4.6% in the placebo group.

Unlike the above studies, a recent report from a large prospective cohort study by Cummings et al. (1995) did not find a relationship between calcium intake and protection from hip fracture. The researchers assessed risk factors for hip fractures in 9,516 white women 65 years of age or older who had no previous hip fractures and followed them at four months intervals for an average of 4.1 years to determine the frequency of hip fractures. However, the authors of this study acknowledge that calcium intake was assessed only once with a short questionnaire that relied on the women's own reports.

Vitamin D intake

Since calcium absorption varies inversely with calcium intake (Heaney et al., 1990), the capacity of an individual to adapt to different calcium intakes rests largely in the gastrointestinal tract. In calcium balance studies, absorbed calcium accounts for more of the variance in calcium balance than calcium intake and excretion together. Since vitamin D is the main regulator of calcium absorption, it is a very important determinant of calcium balance. The best known action of vitamin D is to promote the absorption of calcium from the lumen of the gastrointestinal tract. Absorption occurs by active transport and by diffusion (Bronner, 1988). It is probably the former that is controlled by vitamin D. The hormone $1,25(OH)_2D_3$ stimulates the active transport of calcium and phosphorus in the duodenum and, to a lesser extent, in the ileum. Active transport is very important when dietary calcium intake is low. There is evidence from experimental animals that a reduced calcium intake leads to increased efficiency of calcium absorption due to increased active transport mediated by an increase in $1,25(OH)_2D_3$ concentration (Norman, 1983).

As women become increasingly sensitized to reducing their consumption of foods high in cholesterol, including liver, eggs, and fish oils, dietary intake of vitamin D may decline. This decline, accompanied by diminished sunlight exposure with aging, may perpetuate marginal vitamin D status. Parfitt et al. (1982) have shown that marginal vitamin D status increases parathyroid stimulated bone remodeling and leads to osteoporosis rather than osteomalacia, seen with more severe degrees of vitamin D deficiency. This speculation is supported, in part, by observations that dietary vitamin D intake was lower in patients with femoral neck fracture than in controls (Baker et al., 1979). Villareal et al. (1991) reported low vertebral bone mass in women with subclinical vitamin D deficiency. Likewise, in a recent study, Dawson-Hughes et al. (1995) found that increasing vitamin D intake above the recommended dietary allowance of 200 IU to 700 IU per day reduced bone loss in healthy post-menopausal women residing at latitudes 42^0N. A population-based study indicated that 2% of post-menopausal women had serum vitamin D and alkaline phosphate levels indicative of osteomalacia (Sowers and Wallace, 1986).

Malabsorption of calcium with aging could be due to the fall of serum 25(OH)D, impaired conversion of 25(OH)D to $1,25(OH)_2D$, intestinal resistance to $1,25(OH)_2D$, or a combination of these factors (Baker et al., 1980; Slovak et al., 1981; Eastell et al., 1991). Lukert et al. (1992) studied the pattern of bone loss and the effect of nutrition on calcium regulating hormones and bone loss over a five year period in 22 peri-menopausal Caucasian women 38-45 years old. The most consistent finding was a relationship between vitamin D intake and bone loss in the distal radius. Other results from this study suggest that adequate vitamin D intake protects against bone loss by lowering parathyroid hormone levels, presumably by improving calcium absorption.

Other dietary factors

The bioavailability of calcium may be influenced by a number of other nutrients and food components. For example, dietary fiber may bind calcium and reduce its absorption. It is probably the uronic acid residues in hemicelluose that account for the complexing of calcium by dietary fiber. Phytic acid, found in bran and the seed coat of beans and grains, can also reduce calcium absorption; the same is true for oxalic acid found in vegetables such as spinach (Notelovitz, 1986).

There is a significant inverse relationship between protein intake and calcium balance. Studies have shown that an increase in protein is associated with urinary calcium loss and may result in negative calcium balance (Heaney and Recker, 1982). The mechanism for this calcium loss has been attributed to the sulfur-containing amino acids causing a decrease in renal tubular reabsorption of calcium (Hegsted and Lindswiler, 1981). In this context, it is pertinent to note that Lacto-ovo-vegetarians have a slow cortical bone loss, while omnivores such as Eskimos are rapid cortical bone losers (Marsh et al., 1983).

Phosphorous and aluminum in the diet may also affect calcium balance. Although the effect of inorganic phosphorus on calcium absorption is unclear, excess consumption of phosphorus-containing foods may contribute to an age-related increase in parathyroid hormone and hence increased bone resorption (Avioli, 1984). For example, if soft drinks are substituted for milk, the overall increase in bone resorption may be significant (Massey and Strang, 1982). Excessive aluminum intake also has been associated with bone loss (Spencer and Kramer, 1985). Bone avidly takes up and retains aluminum, reducing bone formation and mineralization. Aluminum-containing antacids enhance urinary calcium and fecal calcium excretion. This loss is brought about by phosphorus depletion and secondary calcium loss. The phosphorus deficiency is caused by the formation of complexes between the aluminum and dietary phosphorous in the intestines, reducing phosphorus absorption (Spencer and Kramer, 1985).

Lactase deficiency may lead to calcium deprivation because of the long-term avoidance of dairy products such as milk. Lactase-deficient individuals not only have a relatively low calcium intake, but also the associated low lactase levels, per se, inhibit calcium absorption (Notelovitz, 1988).

Finally, beverages containing caffeine or alcohol may impact calcium balance. A high caffeine intake in excess of five cups of regular brewed coffee per day increases urinary calcium by an unidentified mechanism (Heaney and Recker, 1982). Bone loss due to excess alcohol may be due to a combination of factors--poor nutrition, including an inadequate intake of calcium and vitamin D; gastro-intestinal and pancreatic malfunction; a deficiency of activated vitamin D due to liver impairment; and a defect in the hydroxylation of the pro-vitamin to its partially activated form have all been implicated. Alcohol also inhibits the absorption of calcium from the gut (Lalar and Counihan, 1982).

Theoretical Models for Health Behavior Changes

Leaders in nutrition education have listed failure to base research on theoretical models as a major shortcoming to research in nutrition education (Sims, 1981; Achterberg et al., 1985). Without a clear theoretical base, Johnson (1985) states, it is difficult to determine the variables that explain how nutrition education programs positively affect nutrition knowledge, attitudes, and behavior, which makes it even harder to study possible mediating variables. Similarly, Terry (1993) states that successful community nutrition interventions are not just randomly planned, but rather are based on a sound theoretical foundation of knowledge about what is needed to produce change in a group's nutrition behavior. The Health Belief Model (HBM) is probably the theory most widely used to study changes in health behavior. This model has proved to be a good predictor for a variety of health and sickness behaviors and is useful for the planning and evaluation of health education programs. Its greatest significance, however, lies in the fact that it attempts to answer the question of why people act the way they do in health matters, not just who acts how (Hockbaum, 1981).

The addition of locus of control to the original HBM for designing research on health behaviors has been suggested (Becker, 1979) in an attempt to make research results more collectivist and less individualistic. Locus of control is believed to be an important factor in explaining health behavior in that the more a person feels powerless to control his/her life, the less likely he or she is to comply with officially recommended health actions (Wallston and Wallston, 1978).

The Health Belief Model

The basic components of the HBM are derived from a well-established body of psychological and behavioral theory (Maiman and Becker, 1974), particularly the work generated from Kurt Lewin's field theory (Lewin, 1936). According to Lewin's field theory, regions within the lifespace consist of both negative and positive regions. In applying Lewin's work to health behavior, Rosenstock (1974) identified ill health as a negative region and preventive health as a positive region. Individuals are thought to move away from ill health or high susceptibility and desire to attain positive states of health (Maiman and Becker, 1974). Using Lewin's concepts of movement and tension within cognitive fields, Rosenstock (1974) identified three components necessary to induce individuals to move to regions of preventive health actions: (1) belief that one is personally susceptible to an illness or disease, (2) belief that contracting the illness or disease will have at least moderately severe consequences on his or her life, and (3) belief that engaging in a preventive health action will be beneficial in reducing the susceptibility of contracting the illness or in reducing the severity if illness occurs, provided the preventive action would not entail overcoming important psychological barriers. Psychological conflict may occur when individuals believe a given action will be effective, but they are deterred from engaging in that action due to barriers caused by fear, inconvenience, or expense (Rosenstock, 1974). According to Rosenstock (1974), three resolutions to this tension can occur. First, if readiness to act is high and barriers are weak, behavior is likely to occur. Second, if readiness to act is low and negative barriers are high, behavior is not likely to occur. Tension is more difficult to resolve in the third possible senario, when readiness to act is high and the barriers are high as well.

Rosenstock (1974) believed that factors acting as "cues" are necessary to move the individual from a 'readiness to act state' into actual behavior, and cues were consequently included in the model as a fourth component necessary to induce individuals to regions of preventive health actions. Cues could be either internal (bodily states) or external (health promotion). It is believed that the intensity of the cues sufficient enough to trigger behavior varies with the degree of susceptibility and seriousness. For example, if perceived susceptibility or seriousness is low, the intensity of cues would have to be high.

Finally, demographic and structural variables, such as social class and reference group, were included in the model. These variables serve to condition individual perceptions and perceived benefits of engaging in preventive health behaviors (Rosenstock, 1974). The five components of the resulting Health Belief Model are (1) the individual's perceived susceptibility or vulnerability to a particular illness, (2) the individual's perception of the severity or consequences of contracting the illness, (3) the individual's perception of the potential benefits of reducing actual or perceived susceptibility weighed against barriers or costs of the proposed action, (4) internal and external cues that trigger appropriate preventive health action, and (5) modifying demographic, social, psychological, and structural variables.

Since its introduction in 1950, the Health Belief Model has been used in a variety of studies of health behavior, including disease detection and prevention (Janz and Becker, 1984). The beliefs measured by this model have been relatively easily modifiable (Rosenstock, 1966). Thus, if psychometrically valid measures of the model's variables are predictive of behavior, educational interventions can be designed in this research which will address women's barriers to and clarify the benefits of increased calcium intake, and will perhaps address the feelings of susceptibility, thus encouraging and prompting women to engage in behaviors that will delay or prevent the onset of osteoporosis or reduce its seriousness.

The impact of the variables in the HBM on participation in disease detection and prevention has been studied by a variety of investigators (Becker et al., 1975; Champion, 1984). Although the results are varied, they suggested that certain HBM variables are useful in predicting specific behaviors. For example, a study by Champion (1987) specifically to investigate the HBM variables as they relate to breast self-examination showed that, along with knowledge, perceived barriers and susceptibility were correlated with frequency of breast self-examination. In a nutrition-related study of the HBM, Kim et al. (1991) evaluated an osteoporosis HBM scale on a sample of 150 men and women ages 60-93 years old. The researchers found perceived barriers and health motivation important constructs in explaining both calcium intake and exercise behaviors. Such information is useful to clinicians. For example, rather than focusing mainly on behaviors, assessment of perceived barriers could suggest an intervention designed to decrease specific deterrents.

Recently Dittus et al. (1995) used HBM variables to examine attitudes toward nutrition and self-reported fruit and vegetables intake among 1,069 randomly sampled Washington state residents. The results of this study showed that barriers to fruit and vegetable intake were the largest component of variability in actual fruit and vegetable consumption.

Beck (1981) suggests that perceived benefits of action in the HBM can be viewed as a measure of outcome expectancies. Similarly, Contento and Murphy (1990) found perceived benefits variables very important in distinguishing between individuals who make dietary changes from those who do not make changes. One hundred seventeen adult supermarket shoppers were systematically surveyed and placed in either a 'self-change' or 'non-change' group depending on whether or not they reported decreasing their intake of red meat and/or butter and making one other change suggested by the Dietary Guidelines. Those who made dietary changes were those who not only felt threatened by diet-related disease, but who also believed that given dietary behaviors would help reduce the threat of diet-related diseases and bring about the health outcome they desired. They reported a negative correlation between barriers and overall health concern, suggesting a conflict between a perception of barriers and carrying out a healthful behavior.

Locus of control

One of the most intuitively appealing potential determinants of health behavior is health locus of control, a construct which has its roots in social learning theory (Rotter, 1954, 1966). The theory asserts that individuals learn to perceive the attainment of a particular goal, reward, or behavior-outcome situation as being either predominantly within their control or outside of their control. A goal or outcome may be, for instance, good health, weight control, or sufficient and delicious food. Three locus of control orientations have been identified. First, internal locus of control is the conviction that attainment of a goal, reward, or outcome is within one's own control, a result of one's own actions and behavior. Second, external locus of control by powerful others is the belief that attainment of a goal, reward, or outcome is in the control of other persons or things more powerful or significant than one's self. One's self is perceived as powerless or helpless in bringing about a given goal. A powerful other may be an authority such as a doctor, money, time, or perceived inability. Last, external locus of control by chance is the belief that attainment of a goal, reward, or outcome is outside of one's own control and is a result of chance, fate, or luck. Although research that has been conducted to test the relationship between locus of control and health behavior offers inconsistent findings, several studies have found that internally controlled individuals who place a high value on health are more likely than others to engage in health-promoting behavior (Seeman and Seeman, 1983; Abella and Heslin, 1984).

The locus of control theory has been shown useful in predicting and understanding nutrition behavior. It appears that nutrition treatments may be differentially effective for internally and externally oriented subjects (Paine, 1980). One use of locus of control theory in nutrition studies has been to study the relationship between locus of control and body weight. These studies have found that overweight subjects are more likely than thinner subjects to be externally oriented (Rosenstock, 1966; Wallston and Wallston, 1978). Further, internally oriented subjects lost more weight in an obesity treatment program (Chavez and Michaels, 1980) and demonstrated greater efforts to initiate treatment and complete a program (Paine, 1980; Wallston and Wallston, 1978). Results suggest that internally oriented subjects may do best in self-controlled, independent, and self-regulated weight reduction programs. Externally oriented subjects may prefer, and have greater success in, programs using social pressure, prestige appeal, and social support or approval (Paine, 1980; Wallston and Wallston, 1978). A few studies on locus of control in diabetic patients (Blackburn, 1977; Lewis et al., 1978; Paine, 1980) have reported significant, although occasionally contradictory, relationships between internal orientations and knowledge of diet or disease and/or compliance with diet.

A study by Eden et al. (1984) was conducted to gain insight into individuals' perceptions of their nutrition behavior. A total of 127 healthy Jewish men and women between ages 18-48 years living in Israel were randomly selected from three different locations in Israel. Two major findings were obtained. First, the locus of control theory was useful, but was too narrow a construct to entirely explain the subjects' responses and beliefs. Subjects with greater willingness and perceived ability to change their nutrition behavior appeared to take responsibility for choosing what is 'right' or 'better' and had firmly established personal guidelines for what is not acceptable. Second, there were significant differences in responses to locus of control statements on the basis of certain demographic variables, especially religious affiliation.

More recently, Falconer et al. (1993) investigated the relationships between nutrient densities and relevant personality variables. They used a random postal survey of 109 adults ages 18-70 years old in Perth, Western Australia. The questionnaire included three dimensions from the Eysenck Personality Questionnaire (EPQ) and two measures of locus of control. The results showed that the locus of control measures were significantly related to several nutrient density variables for both men and women. For example, those with an external locus of control who believe that their lives were largely influenced by people and forces beyond their control, such as 'luck,' reported less healthful diets compared with those who had internal locus of control. They also found that for males, an external locus of control correlated positively with cholesterol density; for females, an external locus of control correlated positively with refined sugar density and negatively with complex carbohydrate and fiber densities. These researchers suggested that locus of control seems to be a strong predictor of various dietary behaviors, and the inclusion of interventions to encourage the adoption of a stronger internal locus of control among participants in education programs might facilitate the translation of knowledge into action.

The Effect of Short-term Education on Changes in Dietary Behavior

Nutrition education is viewed as a form of planned change that involves a deliberate effort to improve nutritional well-being by providing information or other types of education. Since nutrition education puts emphasis on dietary behavior change as a result of the education intervention, behavioral change is the ultimate criterion for the effectiveness of nutrition education, as noted by Sims (1987). According to a recent monograph reviewing results from 217 nutrition education intervention studies (Contento et al., 1995), nutrition education efforts have been effective in achieving various objectives, such as increases in knowledge and awareness, behavioral change, or improvements in physiologic parameters. These gains, however, have often not been maintained beyond the duration of the intervention, except for a few that involved highly motivated participants or left changed, self-sustaining community institutions

Nutrition education can play an impotant role in the prevention of osteoporosis. Prevention is the most cost-effective approach for dealing with this major public health problem. Since osteoporosis is irreversible once established, the most propitious strategy for decreasing the prevalence of osteoporosis might be to prevent or delay the onset and/or reduce the rate of bone loss. One measure to help accomplish this is to maintain a high calcium intake. Two studies suggest that nutrition education may be effective for encouraging individuals to increase calcium intake. For example, a study by Constans et al. (1994) that evaluated the effects of nutrition education on calcium intake in the elderly showed that a brief nutrition education intervention given to subjects between 62-78 years old resulted in a significant increase in dietary calcium intake after a two year follow-up. A total of 54 subjects (24 men and 30 women) volunteered for the study. Each participant recorded food intake during a seven day consecutive period. After the first recording the participants were separated into two groups; the intervention group consisted of subjects with dietary calcium intakes below 800 mg/day, and the non-intervention group were subjects with calcium intake of 800 mg/day or more. The intervention group was provided with information on how to increase their calcium intake, and the nature and frequency of osteoporosis-related risks. A second recording of food intake was completed by both groups after two years. In the second recording the mean calcium intake in the intervention group was higher than 75% of the Recommended Dietary Allowance, while the mean calcium intake in the non-intervention group did not change significantly.

Similarly, Walker and Ball (1993) assessed the effect on actual calcium intake of giving standardized information on the importance of calcium intake and on ways to increase this. The mean calcium intake of 50 women between 40-65 years old was initially 696 mg per day. Three months after the subjects had been given specific advice on calcium, the mean calcium intake was significantly higher at 938 mg per day, with 88% having increased their calcium intake without increasing their fat and saturated fat intakes.

The effects of short term educational programs also have been found successful in changing other dietary habits. For example, the results of a study by Neumark-Sztainer et al. (1995) evaluating a school-based primary prevention program on eating disturbances among adolescent girls indicated that the program was effective in preventing the onset of unhealthy dieting and binge-eating. Likewise, Martin et al. (1994) conducted a community-based cholesterol project as part of an intervention strategy. Results of this study suggest that individuals having borderline-high or high levels of blood cholesterol, when given short-term education, can lower their cholesterol levels through dietary changes.

In general, the more effective programs are those that are theory based, use a combination of theories, such as the Health Belief Model and theory of reasoned action, and use persuasive communication strategies for enhancing awareness and motivation (Becker, 1974; Ajzen and Fishbein, 1980).

CHAPTER 3

METHODS

This chapter describes the study design and the methods utilized in its conduct. The procedures discussed include instrument development, expert review and pilot testing, participant recruitment, and data collection, reduction, and analysis.

Study Design

This research is a study of selected factors related to calcium intake among a sample of 45-54 year old women and changes in calcium intake after an intervention. Two-hour informational meetings were held in seven locations in Iowa during Fall, 1995. At the beginning of the meeting, each participant was asked to fill out a pre-test questionnaire. This exercise was followed by a 2 hour presentation on nutritional health during and after menopause presented by the same speaker at each location, with special emphasis on attaining and/or maintaining a high calcium intake to reduce the risk of bone loss. The following topics were covered: 1) The stages of menopause, 2) How the menstrual cycle works, 3) What happens hormonally during peri-menopause and post-menopause, 4) Menopause and heart disease, 5) Menopause and cancer, 6) Menopause and osteoporosis, and 7) Conclusion. The first three topics took approximately 30 minutes, menopause and heart disease took 20 minutes, menopause and cancer took 15 minutes, while osteoporosis took 45 minutes and the conclusions took the remaining 5 minutes. Approximately six weeks after the workshop, each individual was sent a post-test questionnaire by mail. Participants who had not returned the post-test within two weeks were sent a postcard reminder.

Instrument Development

Pre-test questionnaire

A five-part pre-test questionnaire was developed to solicit information from participants (Appendix A). The first part was a 23 item food frequency instrument developed, validated, and tested for reliability by Musgrave et al. (1989). The food frequency instrument had portion sizes described for each of the 23 calcium-containing foods, with spaces for the participant to record the number of servings she usually ate per day or per week. The responses to the food frequency instrument were tabulated to yield an estimate of dietary calcium intake in milligrams for each participant.

The second part consisted of 18 attitudinal items designed to measure health locus of control. The multi-dimensional Health Locus of Control scale (MHLC) was developed and tested for validity and reliability by Wallston et al. (1978). All items utilized a six-point, Likert-type format response scale ranging from "strongly disagree" to "strongly agree". The instrument includes six items chosen for each of three scales reflecting three types of control, namely internal, powerful others, and chance. The internal scale (IHLC) assesses the degree to which an individual believes that his/her own behavior is responsible for health or illness; the chance scale (CHLC) assesses beliefs that an individual's level of health or illness is a function of luck, chance, fate, or uncontrollable factors; and the powerful others scale

(PHLC) assesses an individual's beliefs that the degree of health or illness is determined by important figures such as physicians, other health professional, parents, or friends. The developers of the MHLC scale constructed two equivalent sets of 18 items for measuring health locus of control, called Form A and Form B (Wallston et al., 1978). In this study, Form A was used for the pre-test questionnaire and Form B for the post-test questionnaire. The reliability estimate (alpha) reported by Wallston et al. (1978) for form A and B ranged from .673 to .767 and .710 to .753, respectively.

The third part of the questionnaire consisted of eight attitudinal items concerning health beliefs related to osteoporosis and calcium intake. The eight items were reflective of each of the five theoretical dimensions of the Health Belief Model (HBM), namely susceptibility to osteoporosis, seriousness of osteoporosis, benefits of reducing the risk of osteoporosis by calcium intake, benefits of taking calcium supplements, and barriers to reducing the risk of osteoporosis by calcium intake. Like the MHLC scale, the HBM scale had a six-point, Likert-type response scale ranging from "strongly disagree" to "strongly agree" with an alpha reliability of .663.

The fourth part of the questionnaire assessed demographic characteristics of the participants in the study. This part solicited information on age, racial group, highest level of education completed, marital status, number of children each woman had given birth to, menopausal status, and bone fractures within the last five years.

The fifth part assessed lifestyle and behavior characteristics such as smoking, frequency of exercising, and intake of caffinated beverages and alcoholic beverages. For the beverages, possible responses were: several times each day, once each day, several times each week, and seldom or never. For those who used calcium supplements, they were asked the brand name of the supplement, the number of supplements taken in one day or in one week, and the amount of calcium in each supplement in milligrams.

Post-test questionnaire

The post-test questionnaire had four parts (Appendix B). The questions regarding demographic characteristics of the participants from the pre-test questionnaire were eliminated. The food frequency instrument, the attitudinal statements related to the Health Belief Model, and the information about supplements taken remained the same as in the pre-test questionnaire. The MHLC scale, Form B, was included in the post-test. The fourth part of the questionnaire assessed changes in lifestyle and behavior that might have occurred after the informational meeting. For example, changes in hormone replacement therapy (HRT) were assessed by requesting the participants to check one statement which would best describe any changes they had made in hormone replacement therapy since the meeting. Possible responses were: 1) Did not use HRT then or now, 2) No change in the type or amount of HRT, 3) Started taking HRT, 4) Stopped taking HRT, and 5) Changed the type or the amount of HRT. Other behavior changes assessed were smoking, frequency of exercise, and intake of caffinated beverages and alcoholic beverages. Possible responses were: 1) No changes since the meeting, 2) More since the meeting, and 3) Less since the meeting.

Expert Review and Pilot Testing

The questionnaires were reviewed by seven nutrition, research, and education specialists. To establish content validity, these professionals reviewed the eight Health Belief Model attitudinal statements organized within the table of specifications to evaluate correspondence between each item and the attitude it was intended to measure (Appendix C). In addition, the experts reviewed all parts of the questionnaire for clarity and relevance to the study. Minor revisions were made in the questionnaire based on the expert panel recommendations. Both the pre- and post-test questionnaires were pilot tested with 10 women who met the study admission criteria but were not residing in the study area. The questionnaires were assessed for clarity of items and instructions, readability of items, and time required to complete the instrument. Minor changes were made based on the pilot study results. Prior to data collection, the research instruments and the research protocol were approved by the Iowa State University Committee on the Use of Human Subjects in Research.

Participant Recruitment

Participants were recruited from seven locations in Iowa through the Iowa State University Cooperative Extension Service. The seven locations were selected on a first come basis after an invitation for participation in the study was announced to the 13 Nutrition and Health Specialists in Iowa through electronic mail. The seven participating specialists recruited participants, organized each meeting locally, and established the meeting locations

(Marengo, Ottumwa, Spencer, Dennison, Red Oak, Creston, and Washington). Each of the seven specialists received a package from the researcher outlining the research project. Recruitment materials sent included recruitment pamphlets describing the study and requirements for participation, a recruitment poster, a news release for the local newspaper, and a radio announcement. Participation at each site was limited to 35 individuals. In order to participate, an individual had to be a woman aged 45 through 54 years old.

Data Collection

The pre-test questionnaire was administered to a total of 170 women in seven different locations of Iowa. Three participants were not in the study age range, and were dropped from the sample. A summary of the participants who were included in the sample completing the pre-test and post-test from each site is shown in Table 1. The sample participants at each site ranged from a minimum of 15 women to a maximum of 33. The participants were briefed on how to fill out the pre-test questionnaire and, to assist in recall and increase accuracy, for the food frequency instrument they were provided with examples of typical serving sizes. In addition, participants had been requested to bring to the meeting their supplements and hormone replacement therapy to assist in filling out certain items. About 15-20 minutes were required to fill out the questionnaire. While the first part of the program was presented, the investigator went through the questionnaires and checked for missing data. If a participant had missing information, the investigator contacted her at the break to get the information.

Table 1. Number of subjects per site who completed pre- and post-tests

Location	Pre-test	Usable pre-test	Post-test	Non-responders
Marengo	15	14	14	0
Ottumwa	25	25	21	4
Spencer	30	29	28	1
Denison	33	33	30	3
Red Oak	15	15	13	2
Creston	33	32	27	5
Washington	19	19	19	0
Total	170	167	152	15

Approximately six weeks after the meeting, the post-test questionnaire was mailed to each woman along with a stamped, addressed envelope and a handout to help in estimating portion sizes. The instruments were numbered so pre/post responses from individuals could be paired. A personal thank you note was attached to the post-test questionnaire. A follow-up postcard was sent to the individuals who had not responded by the end of two weeks after the post-test questionnaire was mailed.

Data Reduction and Analysis

Data were coded and key-punched into the main frame computer at Iowa State University. Analysis was done using the Statistical Package for Social Sciences, release 4.0 (SPSS, Inc., 1990). Frequency distributions were performed cumulatively and categorically to find coding mistakes as well as to examine the general trends in the data. Inconsistencies were resolved by referring to the original questionnaire for correction. Data analysis consisted of seven major procedures: Data reduction and recoding, descriptive statistics, correlational analysis, one-way analysis of variance, chi square, t-tests, and regression analysis.

An estimate of daily dietary calcium intake in milligrams for each participant from the responses to the 23-item food frequency questionnaire was tabulated as follows:

1. For items eaten daily: Multiply number of servings x seven x score. (The 'score' represents the milligrams of calcium in one serving of each item or group of foods.)
2. For items eaten weekly: Multiply number of servings x score.
3. Total all items and divide by seven.
4. Add 100. This factor was added to the daily calcium intake estimation to compensate for two components: the contribution of foods low in calcium but frequently consumed, and the contribution of foods high in calcium but infrequently consumed. Averages of food values in the two categories yield a factor of 100 mg calcium according to Musgrave et al. (1989).
5. Total = milligrams calcium per day.

A percentage of the recommended optimal calcium intake for each participant was calculated (Optimal Calcium Intake, NIH Consensus Statement, 1994). These percentages were collapsed into five the categories as follows: (1=0-25%, 2=26-50%, 3=51-75%, 4=76-100%, and 5=>100%).

A beverage intake score reflecting the overall mean intake of tea, coffee, caffinated soft drinks, and alcohol was computed by transforming these variables into a single score named beverage, with a scale ranging from a score of one for seldom or never to four for several times during the day. Higher mean scores indicated more frequent intakes of these beverages.

The 18 attitudinal locus of control statements were coded so that a high score indicated that one possessed high internal, external, or chance locus of control. Four of the eight Health Belief Model attitudinal statements originally coded negatively were recoded so that a higher score represented a more positive attitude, with a score of one indicating a very negative attitude and a score of six indicating a very positive attitude. Reliability of the health belief model scale was tested using Cronbach's alpha. A coefficient alpha of 0.66 was obtained. Although a coefficient reliability of at least 0.70 is preferred for research purposes (Fraenkel and Wallen, 1993), the coefficient reliability is a function of the number of items in the scale. Because the scale consisted of only eight items, an alpha coefficient of 0.66 was judged acceptable for this research.

Descriptive statistics, including means, percentages, ranges, and standard deviations, were computed for all items. Cases with missing data were omitted from the analysis.

Pearson product-moment correlation coefficients were computed to determine significant correlations between interval variables. Chi-square tests were used to determine relationships between categorical variables. T-tests and analysis of variance were run to determine the differences between means. The MacNemar test of significant change was run to determine significant change in percentage of participants who did not consume food items at least on a weekly basis pre- and post-intervention. For all these tests, a probability level of $p < .05$ was chosen to indicate significance.

Finally, regression models were developed to identify the 'best' predictor for calcium intake and changes in calcium intake among 45-54 year old women. The predictor variables were demographic characteristics, health locus of control, and health belief attitudes. Since the treatment of regression analysis is limited to situations in which the independent variables or predictors are continuous, education, which was an ordinal variable, was coded into four dummy variables, while menopausal status was coded into two dummy variables (with values of zero or one). In coding dummy variables, one group is held as control for comparing the other groups in each variable. In this study high school level of education was the control for the education variable, while pre-menopausal status was the control for the menopausal status variable. This computation makes it possible to use categorical variables in regression analysis, and the results obtained are identical to results obtained from application of analysis of variance which compares more than two groups of variables at the same time (Pedhazur, 1982).

The stepwise selection method was employed. In stepwise selection, tests are performed at each step to determine the contribution of each variable, adjusting for the contribution of the variables currently in the model. Predictors are removed if they lose their usefulness, or if the variable does not contain information that is not provided by the variable in the current model (Pedhazur, 1982). A variable was considered to be a statistically significant predictor if the alpha level was $p \leq .05$ for a two-sided test.

CHAPTER 4

RESULTS AND DISCUSSION

Descriptive Characteristics of Participants

A total of 170 women were recruited and completed the pre-test questionnaire. Three of the participants were not included in the analysis because they did not meet the age criteria. One was too young (36 years old), while the other two were too old (63 and 81 years old). Therefore, a total of 167 women between the ages of 45 and 54 years old met the criteria and participated in the pre-test. Of the 167 participants, 152 completed and returned usable post-test questionnaires (91% return rate). Significant differences were not found in either the age or the education level between those who returned the post-test and those who did not. Demographic characteristics of the participants completing the pre-test are outlined in Table 2.

For those completing the pre-test, the women were well distributed within the 45-54 year age range. All but three participants were white (98.2%). Overall, participants were well educated. All indicated that they had at least graduated from high school. Twenty one percent had completed study beyond college. A majority of the participants were married (86.2%), and nearly 60% had given birth to children. Most of the participants who had children had three to four.

Although a majority of the women were peri-menopausal (55.7%), the sample had women from all four menopausal categories. The surgical post-menopausal group had the

Table 2. Demographic characteristics of participants (n=167)

Characteristic	Frequency	Percentage
Age (in years)		
44-46	39	23.4
47-48	36	21.6
49-50	37	22.2
51-52	23	13.8
53-54	32	19.2
Race		
White	164	98.2
Black	2	1.2
American Indian	1	0.6
Education		
High school graduate	38	22.8
Technical school	17	10.2
Some college	41	24.6
College graduate	36	21.6
Post-graduate	35	21.0
Marital status		
Single, separated, or widowed	23	13.8
Married	144	86.2
Number of children born		
0	68	40.7
1-2	12	7.2
3-4	81	48.5
≥5	6	3.6
Reported menopausal status		
Pre-menopausal	32	19.2
Peri-menopausal	93	55.7
Natural post-menopausal	30	18.0
Surgical post-menopausal	12	7.2
Bone fracture in the last five years		
Yes	8	4.8
No	159	95.2
Use of hormone replacement therapy		
Yes	33	19.8
No	134	80.2
Smoke cigarettes		
Yes	8	4.8
No	159	95.2
Exercise at least once a week		
Yes	128	76.6
No	38	22.8

fewest number (7.2%), while the natural post-menopause group had 18.0% and the pre-menopause group had 19.2%. Very few participants had had a bone fracture in the last five years. A majority of the participants who indicated being post-menopausal were on hormone replacement therapy (HRT) (19.8%). A combination of estrogen and progestin was the hormone replacement therapy most popular with this group, with 25 out of the 33 participants using HRT using it, while only eight women used estrogen alone. Seven of the eight women on estrogen alone had had their uterus removed. Fortunately, this practice is in accordance with the recommendations made by the Writing Group for the Post-menopausal Estrogen/Estrogen Intervention (PEPI) Trial (1996) after they studied the effects of hormone replacement therapy on endometrial histology in post-menopausal women who had not had their uterus removed. In that study a total of 596 post-menopausal women aged 45 though 64 years were randomized to receive placebo, estrogen only, or one of three estrogen plus progestin regimens. The results of this study showed that the subjects that were on estrogen alone were more likely to develop atypical hyperplasia than those who were on either placebo or an estrogen-progestin regimen. They, therefore, recommended the addition of progestin for patients who are on estrogen alone.

While very few participants smoked, the numbers of cigarettes smoked per day ranged from six to 40. This group of participants seemed to be very active, with 76.6% indicating that they exercised at least once a week, and more than half (52.0%) more than twice a week.

The self-reported intake of alcohol and caffeine-containing beverages is reported in Table 3. Among selected caffeine-containing beverages, coffee was the most popular beverage, with 30.5% of the participants indicating that they drank coffee several times each day. Alcohol was the least popular beverage, with 89.8% indicating that they drank alcohol seldom or never. Only one participant indicated drinking alcohol daily.

Tests of significance and correlations were run to determine any relationships between the demographic variables. Few statistically significant relationships were found between descriptive characteristics. As anticipated, significant correlations were found both between age and menopausal status and age and use of hormone replacement therapy (r=.329, p=.000 and r=-.236, p=.002, respectively). This findings suggests that the older participants

Table 3. Percentage of participants consuming caffinated drinks and alcohol (n=167)

	Percent			
Beverage	Several times each day	About once each day	Several times each week	Seldom or never
Brewed or instant coffee containing caffeine	30.5	15.0	10.8	43.7
Alcoholic beverages	0.0	0.6	9.6	89.8
Soft drinks containing caffeine	9.0	25.7	26.9	38.3
Regular tea	10.8	9.0	19.2	61.1

were more likely than the younger ones to be post-menopausal. However, the younger participants were more likely than the older ones to use hormone replacement therapy. A negative correlation between the number of children born and the level of education was found ($r=-.187$, $p=.016$), suggesting that the participants with a higher level of education had fewer children. Similarly, a negative correlation was found between age and education ($r=-.153$, $p=.048$), suggesting that the older participants tended to have had a lower level of education than the younger ones. A correlation was found between age and the intake of caffinated soft drinks ($r=.-181$, $p=.019$), suggesting that older participants had less intake of caffinated soft drinks.

A beverage intake score reflecting the overall mean intake of tea, coffee, caffinated soft drinks, and alcohol was computed by transforming the above variables into a single score named beverage, with a higher mean score indicating more frequent intake of these beverages. A value of one was given to the lowest of the four frequencies for each (seldom or never) and a four to the highest (several times each day), and a mean computed. The potential score ranged from 1.00 to 4.00. The observed scores ranged from 1.00 through 2.75, with a mean of 1.80. This suggests that this group were not heavy consumers of caffinated beverages and alcohol. This score was not significantly related to any demographic variables.

Post-test responses show some behavioral changes during the approximately six weeks between pre- and post-intervention, as described below. Minor changes were made by participants in regards to hormone replacement therapy. While six women started taking

HRT after the intervention, five stopped taking it and another 15 changed the type. Table 4 shows other behavior changes that were made after the intervention. Of the eight participants who smoked, two reported smoking less. A total of 59 participants indicated increasing the number of days they exercised in a week. While a majority of the participants did not make any changes in the frequency of beverage consumption, a significant group indicated that they reduced the amount of beverages consumed. Overall, the change was in the right direction, as most participants who changed their behavior indicated increasing their frequency of exercise and reducing the amount of alcohol and caffeine-containing beverages consumed.

Crosstabulation statistical analysis showed that those participants who were already exercising at pre-test time were the ones most likely to report an increase in exercise on the post-test (χ^2=4.51, df= 1, p=.034). Similarly, those who were not exercising to start with were not likely to report an increase in exercise. For beverage consumption, those who reported frequently consuming coffee or soft drinks on the pre-test were those most likely to report consuming less of these beverages on the post-test (χ^2=17.05, df=3, p=.001 and χ^2=23.5, df=3, p=.000, respectively).

Participants' Locus of Control Scores

The 18-item multidimensional health locus of control (MHLC) scales developed by Wallston et al. (1978) were used to assess the participants' locus of control. Three scales (six-items each) used Likert-type scales requiring the participants to express their opinions on a scale ranging from "strongly disagree" to "strongly agree".

Table 4. Behavior changes reported six weeks after the intervention (n=152)

Behavior change	No change	More	Less
Number of cigarette smoked	150	0	2
Number of days exercised per week	91	59	2
Coffee intake	111	2	39
Alcohol intake	140	1	11
Intake of soft drinks containing caffeine	103	1	48
Tea intake	136	3	13

Scores for the three types of locus of control for both pre- and post-test are reported in Table 5. Potential scores ranged from 1.00 to 6.00. The scale is keyed such that the higher the score the more internal, external, or chance locus of control the individual possesses. According to these scores, this group of participants had relatively high scores for internal locus of control compared to external or chance locus of control, and higher than the mean score of 332, 45 to 60 year old supplement users studied by Williams et al. (1993), whose mean score for internal locus of control was 3.44. Individuals whose locus of control relates to internal factors tend to respond well to measures which they can carry out on their own. They are more likely to believe that health is the result of their own behavior. On the other hand, those with high scores for chance seem less likely to associate preventive measures with reducing the risks for diseases. Those with high scores for external tend to depend on health professionals or family members for advice which influences their behavior and they also do well in support groups.

Table 5. Locus of control scores

Locus of control	Mean ± SD	Range
Pre-test internal	4.57±.72	2.33-6.00
Post-test internal	4.62±.70	2.83-6.00
Pre-test external	2.37±.84	1.00-5.00
Post-test external	2.90±.81[α]	1.00-5.17
Pre-test chance	2.37±.85	1.00-4.50
Post-test chance	2.45±.81	1.00-4.50

[α] Pre- and post-test scores significantly different, p=0.000.

A t-test did not show any significant difference between the pre-and post-test scores for either internal or chance locus of control, but a significant difference between pre- and post-test external locus of control was found (p=.000). Since people that possess high external locus of control tend to depend on their families and health professionals, this finding might imply that the participants felt the need to consult with physicians or dietitians after the intervention.

Intercorrelations for the three MHLC scores showed that pre-test chance was negatively correlated with pre-test internal (r=-.229, p=.003), but positively correlated with pre-test external (r=.281, p=.000). On the other hand, pre-test internal and pre-test external were independent. Theoretically this outcome is expected, because individuals that posess a strong internal locus of control and feel a high degree of personal control over health should have low feelings that external factors or other individuals strongly influence their health.

Correlations of the MHLC scores with descriptive characteristics showed no significant correlation between locus of control and either use of hormone replacement therapy or menopausal status. However, internal locus of control inversely correlated with age ($r=-.208$, $p=.007$), suggesting that younger participants were more likely than older ones to possess internal locus of control. Although Gekoski and Knox (1990) concluded that age alone is not a critical factor in determining individuals' locus of control, Williams et al. (1993) found that middle-aged and older adults have different perceptions on the amount of control they have over their own health. One way analysis of variance revealed a significant relationship between internal locus of control and education ($F=2.268$, $df=4$, $p=.034$). While there was no significant difference between the other levels of education, the participants that had post-graduate level of education had a significantly higher internal locus of control compared with the other education groups. Locus of control scores were not significantly related to the behavioral changes reported after the intervention.

Participants' Attitudes Related to the Health Belief Model

Participants' beliefs about their susceptibility to and the seriousness of osteoporosis, and their perceptions regarding the benefits of or barriers to calcium intake in prevention of osteoporosis were assessed using an eight-item scale constructed for this study, based on the Health Belief Model. The eight attitudinal items concerning health beliefs relating to osteoporosis and calcium intake were reflective of each of the four dimensions of the HBM,.

Table 6. Percentage of subjects responding to pre- and post-test attitudinal items related to the Health Belief Model (n=167 and n=152, respectively)

Statement	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Pre-test susceptibility						
I am worried about getting osteoporosis.	15.0	8.4	8.4	35.3	22.8	10.2
I think it is very likely that I will get osteoporosis.	28.1	25.7	16.8	16.8	10.8	1.8
Post-test susceptibility						
I am worried about getting osteoporosis.	10.5	11.8	9.2	36.8	18.4	13.2
I think it is very likely that I will get osteoporosis.	23.0	27.0	17.8	21.1	7.9	3.3
Pre-test seriousness						
Since there are so many health problems that I could have, it is silly for me to worry about osteoporosis.	34.7	31.7	13.8	8.4	9.0	1.8
I do not think that osteoporosis is a very serious disease.	67.1	20.4	5.4	1.8	3.0	2.4
Post-test seriousness						
Since there are so many health problems that I could have, it is silly for me to worry about osteoporosis.	32.2	31.6	12.5	13.2	7.2	3.3
I do not think that osteoporosis is a very serious disease.	67.8	19.1	4.6	3.9	2.6	2.0

Table 6. Continued

Statement	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Pre-test benefit						
I think I will be less likely to have osteoporosis if I take calcium supplements.	3.0	6.6	7.8	22.8	38.3	21.6
I think I will be less likely to have osteoporosis if I have a lot of calcium in my diet.	0.0	4.2	5.4	16.2	34.1	40.1
Post-test benefit						
I think I will be less likely to have osteoporosis if I take calcium supplements.	2.0	2.0	7.9	27.6	35.5	25.0
I think I will be less likely to have osteoporosis if I have a lot of calcium in my diet.	2.6	2.0	1.3	14.5	38.2	41.4
Pre-test barrier						
It is not realistic for me to eat a diet high in calcium.	44.9	24.0	18.6	9.0	1.8	1.8
It is not realistic for me to take calcium supplements.	50.3	24.0	16.8	4.8	2.4	1.8
Post-test barrier						
It is not realistic for me to eat a diet high in calcium.	44.7	28.3	9.9	11.2	4.6	1.3
It is not realistic for me to take calcium supplements.	50.7	20.4	18.4	7.2	0.7	2.6

namely susceptibility to osteoporosis, seriousness of osteoporosis, and benefits of and barriers to reducing the risk of osteoporosis by calcium intake. The HBM scale had a six-point, Likert-type response scale ranging from "strongly disagree" to "strongly agree". Table 6 outlines the participants' pre- and post-test responses for each item by percentages

Two questions measured the participants' perceptions of being susceptible to osteoporosis. Although about 68% reported worrying about getting osteoporosis both before and after the intervention, only 29.4% and 32.3% felt that they were likely to get osteoporosis before and after the intervention, respectively. These results show that only about one-third of this group of participants felt susceptible to osteoporosis.

Similarly, there were two statements that measured the participants' perceptions of the seriousness of osteoporosis. On the pre-test a majority of the participants (80.2%) disagreed that it is silly for them to worry about osteoporosis since they have many other problems to worry about, compared to 76.3% after the intervention. Prior to the intervention most (92.4%) of the participants disagreed with the statement that osteoporosis is not a very serious disease, compared to 91.5% after the intervention. Even though there is a slight decrease in this percentage between the pre- and post-test, a majority of the participants perceived osteoporosis as a serious disease on both tests.

Two other questions measured the participants' perceptions of the benefits of calcium intake. Prior to the intervention, most of the participants (87.7%) agreed that they would be less likely to get osteoporosis if they took calcium supplements. This percentage increased slightly to 88.1% after the intervention. An even higher percentage (90.4%) agreed on the pre-test that they would be less likely to have osteoporosis if they increased calcium in their diets, with a slight increase to 94.1% after the intervention. The high scores show that both before and after the intervention a majority of the participants perceived taking calcium either in the diet or as a supplement as beneficial in reducing the risk of osteoporosis.

Participants' perceptions of barriers to calcium intake were also measured by two statements. Prior to the intervention, a majority (87.5%) disagreed that a diet high in calcium was not realistic for them, compared to a slightly lower percentage (82.9%) after the intervention. Similarly, most participants did not perceive taking calcium supplement as a barrier either before or after intervention (91.0% and 89.5%, respectively). According to the Health Belief Theory, responses to these statements on benefits and barriers should predict the participants' willingness to either have a high calcium diet (pre-test) or, for those with low calcium intakes, increase their calcium intake (post-test). These participants apparently perceived few barriers and significant benefits to consuming calcium either in the diet or as a supplement.

The response scale for the HBM statements was recoded such that the higher the score the more an individual perceived herself as susceptible to osteoporosis, perceived osteoporosis as a serious disease, and considered more benefits and few barriers to increasing calcium intake. The potential score ranged from 1.00 to 6.00. Therefore, higher scale scores indicated attitudes which, according to the Health Belief Model, favored high calcium consumption. Overall, the participants' health beliefs measured by these items were favorable, with a mean score of 4.50±.69 and a range of 2.50 to 5.88 on the pre-test, which slightly improved to a mean score of 4.53±.60 and a range of 3.00 to 5.88 after the intervention. However, a t-test showed no significant difference between the pre- and post-test HBM scores. Tests of correlation between pre- and post-test HBM attitudinal scores and demographic characteristics did not show any significant correlation with either age, education level, or menopausal status. Neither were significant correlations found between HBM attitudinal scores and behavioral characteristics like the frequency of consumption of caffeine-containing beverages and alcohol.

Intercorrelations between the HBM attitudinal scores and the locus of control scores show that scores for internal locus of control and HBM attitudinal scores were positively correlated ($r=.201$, $p=.009$), while HBM attitudinal scores were inversely correlated with chance locus of control ($r=-.166$, $p=.032$). These results suggest that the participants who possessed high internal locus of control also tended to score high on the HBM attitudinal statements, and both variables were inversely correlated to chance locus of control. These results are in accordance with the locus of control theory, which indicates that individuals with internal locus of control feel in control of their health while those with chance do not feel in control of their health situation. This relationship implies that one cannot possess both high internal and high chance locus of control, but that those with internal locus of control also have positive health belief attitudes based on the HBM. This relationship is expected because, according to the Health Belief Model, when individuals perceive a disease as serious, and they perceive themselves susceptible and perceive more benefits and fewer barriers in behavior change they are more likely to change their behavior.

Calcium Intake Estimates From Food and Supplements

Estimates of dietary calcium intake were obtained from the 167 and 152 participants, pre- and post-intervention, respectively, using a 23-item food frequency questionnaire (Musgrave et al., 1989). Table 7 outlines the percentages of the participants consuming each food on a daily or weekly basis, and mean serving amounts for both daily and weekly intakes. Milk was the most popular dairy item, with over half of the participants (58.7%) reporting daily intake and a mean serving size of 2.03 cups daily before the intervention. This percentage increased to 69.1% after the intervention, with a slight increase in the mean serving amount to 2.11 cups daily. Only 7.2% reported consuming milk less than weekly after the intervention, compared to 13.8% before the intervention. A majority of the participants reported consuming cheese items (natural and American cheese, cheese dishes, and cottage cheese) on a weekly rather than daily basis. Although the percentage of participants using natural cheese weekly decreased slightly from 68.3% before the intervention to 65.1% after the intervention, those reporting using it on daily basis increased from 4.8% to 5.9%. Approximately 60% to 70% consumed American cheese slices and cheese dishes weekly both pre- and post-intervention, while just over one-half reported consuming cottage cheese during both periods. Ice cream was consumed weekly by just over half of the participants both pre- and post-intervention. On the other hand, the following items were not frequently consumed by the participants either on a daily or weekly basis: Yogurt, frozen yogurt, pudding made with milk, cream soup, and Egg McMuffin. The three

Table 7. Pre- and post-test percentages of subjects consuming calcium-rich foods and mean amounts consumed (n=167 and n=152, respectively)

	Daily		Weekly		<Weekly or non-user
Food (serving size)	% Subjects	Mean amt.	% Subjects	Mean amt.	% Subjects
Milk (1 cup)*					
Pre-test	58.7	2.03	27.5	3.55	13.8
Post-test	69.1	2.11	23.7	3.00	7.2
Natural cheese (1 oz.)					
Pre-test	4.8	1.25	68.3	2.08	26.9
Post-test	5.9	1.44	65.1	2.25	29.0
American cheese (1 oz.)					
Pre-test	7.2	1.66	59.9	0.71	32.9
Post-test	8.6	1.46	58.6	2.17	32.8
Cheese dishes (1 serving)					
Pre-test	1.2	1.00	68.9	1.87	29.9
Post-test	0.7	1.00	72.4	1.88	26.9
Cottage cheese (0.5 cup)					
Pre-test	2.4	1.75	41.9	2.12	55.7
Post-test	2.6	1.00	43.4	1.86	54.0
Ice cream (1 cup)					
Pre-test	3.0	1.00	53.3	2.03	43.7
Post-test	0.7	0.05	52.6	1.86	46.7
Yogurt (1 cup)					
Pre-test	8.4	1.10	37.1	2.00	54.5
Post-test	9.2	0.92	34.9	2.08	55.9
Frozen yogurt (1 cup)					
Pre-test	1.8	1.00	19.2	1.54	79.0
Post-test	0.0	-	20.4	2.00	79.6
Pudding, milk (0.5 cup)					
Pre-test	0.0	-	25.1	1.38	74.9
Post-test	0.0	-	27.0	1.39	73.0
Cream soup (1 cup)					
Pre-test	0.0	-	37.1	1.53	62.9
Post-test	0.0	-	42.1	1.39	57.9
Egg McMuffin (1)					
Pre-test	0.6	1.00	24.0	1.27	75.4
Post-test	0.0	-	15.8	1.08	84.2
Canned salmon (0.5 cup)					
Pre-test	0.0	-	15.0	1.10	85.0
Post-test	0.0	-	17.1	1.01	82.9
Sardines (0.5 cup)					
Pre-test	0.0	-	3.0	0.30	97.0
Post-test	0.0	-	2.0	0.76	98.0

Table 7. Continued

Food (serving size)	Daily % Subjects	Daily Mean amt.	Weekly % Subjects	Weekly Mean amt.	<Weekly or non-user % Subjects
Haddock or cod (3 oz.)					
Pre-test	0.6	2.00	22.2	1.21	77.2
Post-test	0.0	-	23.0	1.24	77.0
Broccoli (1 cup)					
Pre-test	4.8	1.50	61.1	1.60	34.1
Post-test	1.3	3.25	69.1	1.66	29.6
Spinach (0.5 cup)					
Pre-test	0.6	3.00	21.6	1.80	77.8
Post-test	1.3	1.00	21.7	1.51	77.0
Baked beans (1 cup)					
Pre-test	0.0	-	35.9	1.44	64.1
Post-test	0.7	1.00	36.2	1.30	63.1
Bread (1 slice)					
Pre-test	68.9	2.11	28.1	4.75	3.0
Post-test	76.3	2.24	19.7	4.70	4.0
Waffles or pancakes** (1 large)					
Pre-test	0.0	-	28.7	1.70	71.3
Post-test	2.6	1.50	38.8	1.47	58.6
Muffins or biscuits (1 med.)					
Pre-test	5.4	1.33	41.9	1.90	52.7
Post-test	4.6	1.28	46.7	1.77	48.7
Calcium-fortified cereal (0.75 cup)					
Pre-test	12.0	1.00	25.1	2.83	62.9
Post-test	15.8	1.10	23.7	2.99	60.5
Calcium-fortified juice* (0.5 cup)					
Pre-test	15.0	1.28	26.3	2.93	58.7
Post-test	26.3	1.25	25.0	2.97	48.7
Chocolate candy (1 oz.)					
Pre-test	6.0	1.60	52.7	2.28	41.3
Post-test	7.2	1.54	55.3	2.06	44.7

*Significant change in proportion of <weekly/non-users between pre- and post-intervention, $p<.05$.

** Significant change in proportion of <weekly/non-users between pre- and post-intervention, $p\leq.001$.

categories of fish listed were not eaten often by this group of participants. Over 75% reported less than weekly intake of canned salmon, sardines, and haddock or cod both pre- and post-intervention.

Broccoli was a popular vegetable, with 65.9% reporting daily or weekly consumption prior to the intervention, which increased to 70.4% after the intervention. On the other hand, spinach and baked beans were less frequently consumed, with over half of the participants reporting intakes of less than weekly. Wheat or white bread was frequently eaten, with 68.9% and 76.3% pre- and post-intervention, respectively, reporting consuming it on a daily basis. Waffles, pancakes, muffins, and biscuits were less popular, with about 50% or more reporting consuming those items less than weekly. Few participants reported consuming calcium-fortified cereal and juice daily pre-intervention (12.0% and 15.0%, respectively). These percentages increased to 15.8%, and 26.3%, respectively, after the intervention. Just over half of the participants reported consuming chocolate candy weekly both before and after the intervention.

Overall, the food frequency questionnaire revealed that milk and bread were the most popular items consumed by one-half or more of the participants on a daily basis. Cheese, cheese dishes, broccoli, ice cream, and chocolate candy were popular items consumed by one-half or more on a weekly basis. Although yogurt, fortified juice, and fortified cereal are good sources of calcium and are readily available, very few participants reported consuming them on either a daily or weekly basis.

The McNemar test for significant change in proportions revealed that there was a significant decrease in the proportion of the participants who drank milk less than weekly between the pre- and post-intervention ($p=.038$). Similarly, there was a significant decrease in the proportion of participants who consumed waffles or pancakes less than weekly between pre- and post-intervention ($p=.000$). Likewise, there was a significant decrease in the proportion of participants who infrequently consumed calcium-fortified juice before and after intervention ($p=.038$). These significant changes suggest that the intervention was a possible cause of the change.

The estimation of dietary calcium intake from food prior to the intervention for the 167 participants ranged from 170 mg/day to 2,479 mg/day, with a mean and standard deviation of 992±500 mg/day. These results compare favourably with the results of Musgrave et al. (1989), who reported a mean calcium intake of 928 mg/day for 26 peri-menopausal women. Approximately six weeks after the intervention, 152 of the participants reported a mean intake of 1,085 mg/day, with a range of 269 to 2,802 mg/day. This was a mean increase of 93 mg/day pre- to post intervention. A summary of the mean and range for both study periods is found in Table 8. A t-test shows a significant difference between the mean dietary calcium intakes before and after the intervention ($p=.003$).

Although the preferred approach to attain optimal calcium intake is through dietary sources, in the prevention and treatment of osteoporosis physicians and dietitians are advised to recommend calcium supplementation for peri- and post-menopausal women when the

Table 8. Means and ranges of participants' calcium intakes pre- and post-intervention from both food and supplements in mg/day

Source	% Subjects	Mean±SD (mg/day)	Range (mg/day)
Food*			
Pre-test (n=167)	100.0	992±500	170-2,479
Post-test (n=152)	100.0	1,085±471	269-2,802
Supplement			
Pre-test (n=167)	55.7	812±689	11-3,250
Post-test (n=152)	65.8	784±656	69-4,650
Total**			
Pre-test (n=167)	100.0	1,423±785	179-4,163
Post-test (n=152)	100.0	1,582±810	301-6,086

*Significant difference in pre- and post-intervention mean intakes, $p \leq .01$.
** Significant difference in pre- and post-intervention mean intakes, $p \leq .001$.

some individuals, such as those who suffer from lactose intolerance or have a concern for daily diet does not include 1,000 to 1,500 mg calcium daily (Wardlaw, 1988). Moreover, for weight gain or have a general dislike for dairy products which are the primary source of dietary calcium, calcium supplements may be the preferred way to attain optimal calcium intake.

In this study, 55.7% and 65.8% of the participants reported using calcium supplements before and after the intervention, respectively. McNemar test for significant change in proportions revealed that there was a significant increase in the proportion of the participants who consumed calcium supplement between pre- and post-intervention ($p \leq .003$). Table 8 summarizes the percentages of the participants taking supplements, and the mean and range amounts in mg/day. Prior to the intervention, over half of the participants reported taking supplements, with a mean intake of 812 mg/day and a range of 11 to 3,250 mg/day, which decreased to a mean intake of 784 mg/day post-intervention. This was a total decrease of 28 mg/day pre- to post-intervention. Although the mean dietary calcium intake among the group that did not use supplements was notably higher than among the supplement users (1,043 mg/day vs. 851 mg/day, respectively), the difference was not significant. Although, the participants as a group reported decreased consumption of calcium from supplements and increased consumption of dietary calcium after the intervention, there was an increase in the number of participants who consumed calcium from supplements after the intervention. See Figure 2.

Based on the results of the food frequency questionnaire and supplement intake information, pre-intervention the mean total calcium intake for the 167 participants was 1,423±785 mg/day with a range of 179 to 4,163 mg/day. These intakes increased to 1,582±810 mg/day after the intervention, a mean increase of 159 mg/day, with a range of 301 to 6,086 mg/day, based on the 152 participants who responded to the post-test questionnaire.

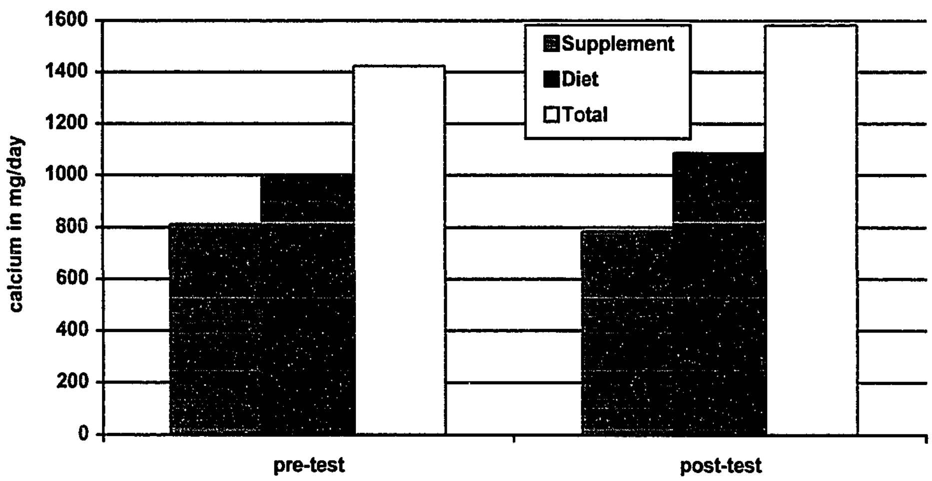

Figure 2. Supplemental, dietary, and total mean calcium intakes pre- and post-intervention

The pre- to post-intervention change was significant at p=.000.

Compared to the mean intake of 717 and 660 mg/day by females of ages 40-49 and 50-59, respectively, reported in the *Third Report on Nutrition Monitoring in the United States* (Interagency Board for Nutrition Monitoring and Related Research, 1995), the participants in this study reported a higher consumption of total calcium intake by over 50% in both age groups (1,420 and 1,427, respectively). However, the methods of dietary assessment were different, being a combination of a 24 hour recall and a 2-day food record for the NHANES, and a food frequency questionnaire in this study. The 23-item questionnaire used in this study is a revision of a 53-item questionnaire validated by Musgrave et al. (1989). The calcium levels estimated from the 53-item questionnaire correlated with the estimated amount from 4-day food records ($r=.73$; $r^2=.53$ in winter and $r=.84$; $r^2=.71$ in summer). However, the variance explained by the questionnaire was somewhat low, especially for the winter months. This implies that there was an explained variance of 47%, and 29% in winter and summer months, respectively. Therefore, for the sample in this study, the calcium estimate should be regarded as an approximation rather than a specific measure of their calcium intake. The minimum intake increased from 179 mg/day pre-intervention to 301 mg/day post-intervention. While the minimum intakes for both periods are undesirably low, the maximum intakes were well above the recommended intakes (4,163 and 6,086 mg/day pre- and post-intervention, respectively). The National Institutes of Health (Optimal Calcium Intake, NIH Consensus Statement, 1994) notes that calcium intoxication is a risk at consistent calcium intakes of 4,000 mg/day or higher.

Table 9 shows the percentage of participants and their calcium intakes relative to the National Institutes of Health (Optimal Calcium Intake, NIH Consensus Statement, 1994) recommendations for their age and menopausal status. The recommendations are as follows: 1) For women 25-50 years, and post-menopausal women on estrogen, a daily intake of 1,000 mg, and 2) For post-menopausal women not on estrogen, a daily intake of 1,500 mg. Prior to the intervention, 56.3% of the participants reported consuming 76% or more of the recommended optimal calcium intake from dietary sources. This percentage increased to 65.8% after the intervention. Only 4.2% reported consuming 25% or less of the recommended intake before the intervention, compared to less than 1.0% after the intervention.

On the other hand, for those who obtained a proportion of their calcium from supplements, 56.9% and 46.7% pre- and post-intervention, respectively, reported consuming 25% or less of their requirement from supplements, while approximately 13% in both periods consumed more than the recommended intake of calcium from supplements.

When total calcium intake was considered, very few (1.8% and 1.3% pre- and post-intervention, respectively) of the participants consumed 25% or less of the recommended intake, while most of the participants (76.7% and 84.9% pre- and post-intervention, respectively) consumed over 75% of the recommended calcium intake.

Tests of correlation between dietary calcium, calcium from supplements, and total calcium intake; internal, external, and chance locus of control; health belief attitudes;

Table 9. Participants' pre- and post-intervention calcium intakes (n=167 and n=152, respectively) compared to the NIH recommended calcium intake (Optimal Calcium Intake, NIH Consensus Statement, 1994)

	Percentage of recommended calcium intake				
Source	0-25%	26-50%	51-75%	76-100%	>100%
			Percent of participants		
Food					
Pre-test	4.2	16.2	23.4	19.8	36.5
Post-test	0.7	11.8	21.7	23.0	42.8
Supplement					
Pre-test	56.9	12.6	10.8	6.6	13.2
Post-test	46.7	21.7	7.9	9.9	13.8
Total					
Pre-test	1.8	6.0	15.6	18.6	58.1
Post-test	1.3	4.6	9.2	12.5	72.4

demographic characteristics; and beverage intake found the following significant Prior to the intervention, dietary calcium intake was not significantly correlated with any other variable, but was negatively correlated to chance locus of control after intervention (r=-.202, p=.012). This result suggests that the higher the participants scored on chance locus of control, the less calcium they consumed from food after the intervention. On the other hand, both prior to and after the intervention calcium supplement intake was positively correlated with health belief scores (r=.194, p=.012 and r=.221, p=.006, respectively).

This correlation is expected since individuals with positive health belief attitudes are likely to change behavior towards a more healthful lifestyle. The total calcium intake was positively correlated to the health belief attitudes both pre- and post-intervention (r=.154, p=.046 and r=.242, p=.000, respectively), but negatively correlated to chance locus of control post-intervention (r=-.215, p=.008).

These results suggest that participants who possessed high internal locus of control and had positive health belief attitudes also had a high intake of calcium from supplements, whereas those who possessed high chance locus of control tended to consume less calcium from the diet. On the other hand, frequent caffeine and alcohol intake was inversely correlated with pre-intervention dietary and total calcium intakes, but positively correlated with chance locus of control (r=-.143 p=.039; r=-.228, p=.005; and r=.221, p=.006, respectively). A possible explanation of these results is that individuals who possessed high chance locus of control may have replaced beverages that are good sources of calcium like milk with either caffeine-containing beverages or alcohol, or both.

Regression Analysis

One of the major applications in statistics is the prediction of one or more characteristics of individuals on the basis of knowledge about related characteristics. Multiple regression analysis is a method for examining the relationship between a dependent variable and one or more independent predictor variables. The multiple regression coefficient is an index of the degree to which the dependent and weighted composite of the independent variables correlate. The square of the coefficient (R^2) indicates the proportion of the variance in the dependent variable which is predicted by the independent variables (Pedhazur, 1982). The total sum of squares of the dependent variable may be explained by two sources of variability: 1) Due to the regression with the independent variables, and 2) due to error or unexplained variance. However, if the independent variable does not contribute significantly to the variability of the dependent variable, the F statistic will not be significant at the selected alpha level (Pedhazur, 1982).

In this analysis the stepwise multiple regression procedure was employed, where one independent variable at a time is added to the regression model. The independent variables are added in decreasing order of contribution to the variance in the dependent variable. Typically, this procedure first selects the independent variable which has the highest simple correlation with the dependent variable. Next, each of the remaining variables in descending order of correlation are tested to see which significantly contribute the most to an increase in the R^2. This process is repeated until either all the independent variables are entered in the regression equation or no remaining variable provides a significant increase in R^2. Sometimes, a variable that has been previously entered may no longer contribute significantly after other variables are entered due to the multicollinearity among the independent variables. If this occurs, the stepwise procedure will remove an independent variable from the model. However, in the analyses reported in this section, none of the correlations between pairs of independent variables was greater than 0.35, and multicollinearity was not found to be a problem.

To establish the contribution of certain demographic characteristics, attitudes related to locus of control, and attitudes related to the Health Belief Model to variation in calcium intake and change in calcium intake among the participants, a series of multiple regression models were tested using the SPSS program (SPSS, Inc., 1990). First, three models were tested to establish the effect of the independent variables on dietary calcium, calcium from supplements, and total calcium intake before the intervention. Secondly, using data collected after the intervention, three regression models were tested to establish the variables that predict post-intervention dietary calcium intake, supplemental calcium, and total calcium intake. Lastly, three other regression models were tested to predict the pre- to post-intervention change in dietary calcium, supplemental calcium, and total calcium intakes.

Pre-intervention regression models

Regression models based on pre-intervention data and their associated R^2, beta coefficients, and F values are shown in Table 10. In the first model, dietary calcium intake was regressed on age, menopausal status, level of education, pre-intervention internal, external, and chance locus of control, and the pre-intervention health belief attitudes. In this analysis, none of the independent variables significantly explained the variability in dietary calcium intake. This outcome is consistent with the result of the simple correlations which did not show any significant correlation between dietary calcium and the independent variables. This result implies that other variables not included in this study influenced the pre-intervention dietary calcium intake

In the second model, calcium intake from supplements was regressed on the same independent variables. The health belief attitudes were a significant predictor, accounting for approximately 3.7% of the variation (beta=.194, t=2.54, p =.011). A significant regression equation was found (F=6.46, df=1, p=.011). This result suggests that a higher

Table 10. Pre-intervention regression models

	Dependent variables								
	Dietary calcium			Supplemental calcium			Total calcium		
Independent variables	beta	R^2	F	beta	R^2	F	beta	R^2	F
Health belief attitudes	-.083		1.20	.194*	.037	6.46*	.154*	.023	4.03*
Education									
Post-graduate level	-.004			-.103			-.080		
Graduate level	.063			-.077			-.040		
College graduate level	.059			.137			.107		
Technical school level	.085			-.011			.026		
Peri-menopausal	-5.028			.055			.085		
Post-menopausal	-5.417			.026			-.004		
Internal locus of control	-.104			.095			.017		
Chance locus of control	-.118			.025			-.047		
External locus of control	.046			-.058			-.053		
Age	-.611			.090			.051		
Age x peri-menopausal	5.371			.054			.086		
Age x post-menopausal	5.569			.031			.002		

*Significant at $p \leq .05$.

score on the health belief attitudes predicted a higher intake of calcium from supplements.

The third analysis regressed total calcium intake on the independent variables. Once again, health belief attitudes significantly predicted total calcium intake (beta=.154, t=2.01, p=.046), with a significant equation (F=4.03, df=1, p=.046). Although the health beliefattitudes explained only a small amount of variance (2.3%) in calcium intake, it was the only significant predictor for both supplemental calcium and total calcium intake prior to the intervention.

Results from these three models suggest that participants who felt susceptible to osteoporosis, perceived osteoporosis as a serious disease, and perceived more benefits and fewer barriers to consuming calcium were more likely than those who had lower health belief attitudinal scores to have higher calcium supplement intakes and higher total calcium intakes. The small amount of variation is an indication that other variables not included in these models influenced the participants' calcium intake as well.

Post-intervention regression models

Table 11 shows the post-intervention regression analyses. In the post-intervention regression analyses one post-intervention variable, external locus of control, was included along with the list of independent variables used in the pre-intervention analyses. This variable was added because a t-test showed a significant difference between pre- and post-test external locus of control scores. The first model regressed post-intervention dietary calcium intake on the independent variables.

Table 11. Post-intervention regression models

	Dependent variables								
	Dietary calcium			Supplemental calcium			Total calcium		
Independent variables	beta	R^2	F	beta	R^2	F	beta	R^2	F
Chance locus of control	-.257***	.065	10.58***	-.043	.048	7.72**	-.183*	.128	7.24***
Health belief attitudes	.104			.221**			.242**		
Post-test external locus of control	.057			-.151			-.085		
Education									
Post-graduate level	-.085			-.059			-.052		
Graduate level	-.039			-.095			-.041		
College graduate level	.111			.139			.185*		
Technical school level	.091			-.139			-.035		
Peri-menopausal	.041			.020			.058		
Post-menopausal	-.026			-.065			-.089		
External locus of control	.075			-.128			-.047		
Internal locus of control	-.047			.105			.015		
Age	.018			.003			.012		
Age x peri-menopausal	.041			.019			.055		
Age x post-menopausal	-.023			-.066			-.089		

*Significant at $p \leq .05$.
**Significant at $p \leq .01$.
***Significant at $p \leq .001$.

Chance locus of control was the only significant predictor of calcium intake from food, explaining 6.5% of variation (beta=-.257, t=-3.25, p = .001), with a significant regression equation (F=10.58, df=1, p=.001). Once again, this is consistent with the simple correlation between chance locus of control and post-intervention dietary calcium intake that was inversely related (r=-.202, p=.012). A lower chance locus of control was associated with a higher post-intervention dietary calcium intake.

When calcium supplement intake was regressed on the same independent variables, health belief attitudes was the only significant predictor of calcium supplement intake (explaining about 5% variation, beta=.221, t=2.78, p=.006), with a significant regression equation (F=7.72, df=1, p=.006).

In the third post-intervention analysis, three variables were significant in predicting total calcium intake. First, health belief attitudes explained about 6% variance in total calcium intake (beta=.242, t=3.05, p=.003). Secondly, college level of education in relationship to high school level was a significant predictor (beta=.185, t=2.45, p=.016), and together they explained 9.4% variance. Thirdly, chance locus of control was inversely significant (beta=-.183, t=-2.38, p=.019). Together these three variables explained about 13% of variance in total calcium intake. Similarly, a significant regression equation was found (F=7.24, df=3, p=.000).

To investigate change in calcium intake from pre-test to post-test, three variables were computed as follows: 1) Change in dietary calcium intake = post-test dietary calcium minus pre-test dietary calcium; 2) Change in supplemental calcium intake = post-test supplement intake minus pre-test supplement intake; and 3) Change in total calcium intake = post-test total calcium minus pre-test total calcium intake. Table 12 shows the regression results.

The independent variables age and menopausal status were interacted (age x menopausal status). The interaction procedure was done because age and menopausal status are correlated and, as Pedhazur (1982) explains, it is possible to have joint effects. That is, a given combination of variables may be particularly effective because they enhance the effects of each other in prediction. Chance locus of control inversely predicted change in dietary calcium (beta=-.278, t=-2.75, p=.007). This result is in accordance with the earlier prediction of post-intervention dietary calcium intake, implying that individuals most likely to increase their dietary calcium intake after the intervention were those with lower scores for chance locus of control. In addition, post-test external locus of control was a significant predictor of change in dietary calcium (beta=.192, t=2.33, p=.021). This result is not surprising after the intervention as individuals who possess a high external locus of control feel that other people like doctors or dietitians have control of their health, and tend to comply with instructions or prescriptions. Both variables explained 8.1% of the variance of change in dietary calcium, with a significant regression equation, (F=6.58, df=2, p=.001).

An interaction of age and peri-menopausal status was the only predictor of change in supplemental calcium intake (beta=-.161, t=-2.01, p=.047), explaining a small but significant amount of the variation (2.6%), with a significant regression equation (F=4.02, df=1, p=.046).

Table 12. Pre- to post-intervention change in calcium intake regression models

	Dependent variables								
	Dietary calcium			Supplemental calcium			Total calcium		
Independent variables	beta	R^2	F	Beta	R^2	F	beta	R^2	F
Post-test external locus of control	.192*	.081	6.58***	.041	.026	4.02*	.175		1.61
Age x peri-menopausal	.016			-.162*			-4.131		
Education									
Post-graduate level	-.068			.011			-.088		
Graduate level	-.042			.032			-.088		
College graduate level	.055			-.003			.036		
Technical school level	.036			-.153			-.170		
Peri-menopausal	.020			-.176			3.805		
Post-menopausal	-.048			.635			3.073		
Internal locus of control	.009			.009			.038		
External locus of control	.029			-.056			-.059		
Chance locus of control	-.278**			.008			-.165		
Age	.018			-.114			.323		
Health belief attitudes	.115			.001			.119		
Age x post-menopausal	-.049			-.179			-3.407		

*Significant at $p \leq .05$.
**Significant at $p \leq .01$.
***Significant at $p \leq .001$.

This result implies that there is an inverse correlation between age and change in supplemental calcium intake for peri-menopausal women. This correlation implies that the older women in peri-menopausal status were less likely to change the amount of calcium they took as supplements compared to younger ones. When change in total calcium intake was regressed on the independent variables, none of the variables examined in this study were significant.

In general, as shown in Table 13, the health belief attitudes predicted pre- and post-intervention supplemental and total calcium intake, while chance locus of control predicted post-intervention dietary and total calcium intake. College education in comparison to high school education was a predictor of post-test total calcium intake. After the intervention, post-test external locus and chance locus of control predicted changes in dietary calcium intake. Age interacted with peri-menopausal status predicted change in calcium supplemental intake.

Health belief attitudes as a predictor of calcium intake

In this study, the health belief attitudes significantly predicted calcium supplement intake both pre- and post-intervention. However, the amount of variance in calcium supplement intake explained by the health belief attitudes was quite small, and the predictive power was low. This result is consistent with Kegeles' (1981) findings which indicated that the amount of variance in behavior explained by the Health Belief Model is generally small. Langlie (1977), in his study of social networks, also found the predictive power of the Health Belief Model for studying health beliefs and preventive health behavior to be very low.

Table 13. Pre- and post-intervention calcium intake predictors

Measurement	Calcium: Dietary	Supplemental	Total
Pre-test	-	Health belief attitudes	Health belief attitudes
Post-test	Chance LOC	Health belief attitudes	Chance LOC College education Health belief attitudes
Pre- to post-test change	Chance LOC Post-test external LOC	Age x peri-menopause	-

Likewise, Calnan (1984) did not find Health Belief Model variables very useful for predicting the use of different types of services for the early detection of breast cancer. However, other studies (Kim et al., 1991; Dittus et al., 1995; Contento and Murphy, 1990) found perceived barriers, a variable in the Health Belief Model, an important construct in explaining dietary changes. The participants in this study had positive health attitudes based on the Health Belief Model both pre- and post-intervention. This result implies that they perceived few barriers and many benefits to high dietary and supplemental calcium intake. They also perceived osteoporosis as a serious disease, even though they did not perceive themselves as susceptible. This perception could be explained by the fact that they appeared to be a highly motivated group of participants who also possessed high internal locus of control and, therefore, felt in control of their health.

Multidimensional health locus of control as a predictor of calcium intake

None of the multidimensional health locus of control (MHLC) variables predicted calcium intake before the intervention. However, after the intervention chance locus of control was a significant predictor for dietary calcium, total calcium, and pre- to post-change in calcium intake, although the variance explained by chance locus of control was small. This result is in agreement with Eden et al. (1984) who found that though the locus of control theory was useful in examining individuals' perceptions of their nutrition behavior, it was too narrow a construct to entirely explain the subjects' responses and beliefs.

Unlike the study by Falconer et al. (1993) which found internal locus of control an important predictor of dietary knowledge, disease, and/or compliance with diet, this study did not find internal locus of control directly predictive of any measure of calcium intake. However, chance locus of control negatively correlated with both internal locus of control and dietary calcium intake, suggesting a possibility of an indirect association between internal locus of control and dietary calcium intake. Post-test external locus of control was predictive of pre- to post-intervention change in dietary calcium intake.

Results of this study agree with Wallston et al. (1978), who state that there is no reason to expect MHLC scale scores alone to explain much of the obtained variance in health behaviors. Only in interaction with one or more contributing factors will locus of control play a significant role in the explanation of health behavior. In this study, chance locus of control was useful in explaining dietary calcium intake, while the health belief attitudes were more useful in explaining calcium supplement intake. Both measures predicted total calcium intake after the intervention.

Demographic characteristics as predictors of calcium intake

Three demographic variables were included in the regression models to test prediction of calcium intake. These variables were age, menopausal status, and education level. In this study, age was not a predictor of calcium intake or change in calcium intake. This result is to be expected due to the study design which limited the participants to those between 45 and 54 years of age. Likewise, menopausal status alone did not predict calcium intake. But when age and menopausal status were interacted, age and peri-menopausal status significantly predicted change in calcium supplement intake. Although this group of participants were generally highly educated, only college graduate level in relationship to high school graduate level was a predictor of post-intervention total calcium intake.

Effects of the Educational Intervention

The main purpose of the intervention was to increase awareness of the relationship between menopause, osteoporosis, and calcium intake, and to provide information on calcium sources, with the hope that the participants would increase their total calcium intake. The evidence suggests that it did. Total calcium intake increased from a mean of 1,423 mg daily to 1,582 mg daily, a total calcium increase of 159 mg/day and dietary calcium intake increased from a mean of 992 mg daily to 1,085 mg daily, an increase of 93 mg/day. Similarly, more participants consumed milk, waffles and/or pancakes, and calcium-fortified juice on at least a weekly basis after the intervention compared to before the intervention. Likewise, there were other significant behavioral changes after the intervention. For example, there was a significant increase in frequency of exercise and a decrease in the consumption of caffeine-containing beverages after the intervention. These findings are consistent with the study by Constans et al. (1994), who found that a brief nutrition education intervention resulted in significant increase in dietary calcium intake among 60 year old and older subjects. Likewise, Walker and Ball (1993) found that giving standardized information to 50 women 40-65 years old on the importance of calcium intake significantly increased mean calcium intake assessed three months after the intervention.

It is, therefore, reasonable to conclude that in this study the intervention may have been responsible for changing some aspects of the participants' dietary and lifestyle behavior. However, both multidimensional locus of control and the Health Belief Model attitudes were relatively unchanged. These results could be due to the fact that the participants had relatively positive health belief attitudes and relatively high internal locus of control prior to the intervention. As a result, little change in these variables was possible from pre- to post-test.

CHAPTER 5

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

Osteoporosis is a major cause of morbidity and mortality in post-menopausal women. Factors that may increase the risk of the disease can be divided into two categories: physiological and behavioral. Assessing behavioral factors is of great importance since they are open to intervention.

Overall, it appears that the dietary factor that has the most potential for reducing the risk of osteoporosis in post-menopausal women, regardless of their ingestion of estrogen, is calcium intake. According to the *Third Report on Nutrition Monitoring in the United States* (Interagency Board for Nutrition Monitoring and Related Research, 1995), many Americans are not getting the calcium they need to maintain optimal bone health to prevent age-related bone loss. However, no research is available suggesting factors related to either calcium intake among 45 to 54 years old women or increasing the intake of calcium among these women. The objective of this study was to investigate selected factors related to calcium intake and change in calcium intake after an intervention among a sample of 45-54 year old women.

Descriptive characteristics, multidimensional health locus of control, and health belief attitudes were considered as factors that affect calcium intake and change in calcium intake. The theoretical bases for the research were the Health Belief Model (Rosenstock, 1974) and the health locus of control theory (Rotter, 1954, 1966).

A total of 167 women between the ages of 45 and 54 years met the criteria and participated in the pre-intervention study. Two-hour informational meetings were held in seven locations in Iowa during Fall, 1995. Prior to the intervention, participants completed a five-part questionnaire which provided information on estimates of dietary and supplemental calcium intakes, demographic and lifestyle characteristics, health locus of control, and health beliefs.

Approximately six weeks after the intervention, a four-part post-test questionnaire was mailed to the participants. A total of 152 women (91% return rate) completed and returned usable questionnaires. The items regarding demographic characteristics of the participants from the pre-test questionnaire were eliminated, but all other variables measured prior to the intervention were remeasured. An additional part of the questionnaire assessed changes in lifestyle and behavior that might have occurred after the intervention.

The participants who completed the pre-intervention were well distributed within the 45 to 54 years age range. All but three participants were white, and all were well educated. A majority of the women were married, and over half had given birth to children. Although a majority of the participants were peri-menopausal, the sample appeared to have women from all four menopausal status categories. Very few participants had had a bone fracture in the last five years, and very few smoked. Over half indicated that they exercised more than twice a week. Among selected caffeine-containing beverages, coffee was the most popular. A majority of the participants indicated that they seldom or never drank alcohol.

According to the multidimensional health locus of control results, this group of participants had relatively high scores for internal locus of control compared to external or chance locus of control. Similarly, the participants' attitudes related to the Health Belief Model were highly positive. Health belief attitudes were positively correlated with internal locus of control, but negatively correlated with chance locus of control.

Results of the food frequency questionnaire used to measure calcium intake revealed that milk and bread were the most popular items consumed by one-half or more of the participants on a daily basis. Cheese, cheese dishes, broccoli, ice-cream, and chocolate candy were popular items consumed by one-half or more of the participants on a weekly basis. Although yogurt, calcium-fortified juice, and calcium-fortified cereal are good sources of calcium and are readily available, very few participants reported consuming them on either a daily or weekly basis.

Based on the results of the food frequency questionnaire and the information on supplemental intake, pre-intervention dietary calcium intake averaged 992 mg/day. The mean supplemental intake was 812 mg/day, while the total calcium intake averaged 1,423 mg/day. After the intervention, mean daily dietary calcium increased by 93 mg/day, while the supplemental calcium intake decreased by 28 mg/day. The total calcium intake increased to a mean of 1,582 mg/day. Most of the participants consumed over 75% of the National Institutes of Health (Optimal Calcium Intake, NIH Consensus Statement, 1994) recommended optimal calcium intake. The Pearson test of correlation showed that post-intervention dietary calcium intake was negatively correlated to chance locus of control, while supplemental calcium intake was positively correlated to the health belief attitudes. Similarly, the total calcium intake was positively correlated to health belief attitudes both pre- and post-intervention, and negatively correlated to chance locus of control.

Multiple regression analyses were used to determine those variables which were the best predictors of dietary, supplemental, and total calcium intakes. The health belief attitudes significantly predicted supplemental calcium intake both pre- and post-intervention. Chance locus of control was a significant predictor of dietary calcium intake post-intervention. College graduate level education in comparison to the high school graduate level, external locus of control, chance locus of control, and age interacted with peri-menopausal status significantly predicted change in calcium intake pre- to post-intervention.

Limitations

Although this study elucidates important associations between health beliefs, locus of control, and calcium intake among 45-54 year old women, several limitations have been identified.

1. Generalizability of these results is limited due to the homogeneous nature of the sample and the sample selection procedures. Participants were derived from a non-probability sample that volunteered to participate in the study. They were generally white, well-educated, and from one geographic area of the country. Therefore, the applicability of the study findings is necessarily restricted to the sample and perhaps to women with similar demographic characteristics as the sample.
2. The sampling frame for this study was designed to sample women whose estimated ages were within five years of the average age of menopause in the United States--age 50. However, the sample may have included women from all four menopausal status

categories since biological indicators of menopausal status were not determined. The findings of this study may, therefore, reflect middle-aged white women more than just peri- and post-menopausal women.

3. This study is limited by the use of self-reported data. Self-reported behavior and behavioral change may be biased by social desirability.

4. The Health Belief Model (HBM) was employed as a single scale because the number of items used to construct the scale was small--only eight. This number may have limited the possibility of finding the influence of the individual HBM variables, namely, susceptibility, seriousness, benefits, or barriers, on calcium intake.

5. A major limitation of this study is the use of the food frequency method for estimating calcium intake. Inaccuracies may result from an incomplete listing of all possible foods (Thompson and Byers, 1994). The estimates of calcium intake in this study should, therefore, be treated only as approximations rather than an absolute level of calcium intake.

Conclusions and Implications

Despite the above limitations, a number of conclusions can be drawn based on the findings of this study. Although recent evidence suggests that maintaining optimal calcium intake will slow osteoporosis among peri- and post-menopausal women, national nutrition surveys report that American women are not getting the calcium they need to obtain bone health to reduce the risk of osteoporosis. Furthermore, educational interventions related to osteoporosis have consisted primarily of programs aimed at changing dietary and lifestyle behaviors. Therefore, it is important that the health educators working with women at risk of osteoporosis know more about the influence of psychosocial variables in effecting behavior change. Such information will help in identifying those elements that make nutrition education more effective.

This study demonstrates the associations between demographic and lifestyle characteristics, health locus of control, and health beliefs related to osteoporosis and calcium intake. The demographic and lifestyle results of this study show that the participants were active, motivated women who had adopted a relatively healthy lifestyle. Most of the participants exercised more than once a week and were not heavy consumers of caffeine-containing beverages or alcohol. These lifestyle factors are consistent with decreased risk for osteoporosis.

The participants had relatively high scores for internal locus of control compared to external or chance locus of control. Participants whose locus of control related strongly to internal factors may be more amenable to a preventive regime that requires active participation by the individual. This disposition results from their perception of being in control of their health. However, internal locus of control inversely correlated with age, suggesting that more younger participants than older ones possessed high internal locus of control.

A majority of the participants perceived many benefits and few barriers in taking calcium, either in the diet or as a supplement. The linkage between the participants' health belief attitudes and calcium intake is evident in this study--participants had relatively high calcium intakes even before the intervention. Although a majority of the participants perceived osteoporosis as a serious disease, only one-third perceived themselves as susceptible to osteoporosis. Few of the participants had experienced the symptoms of osteoporosis, and hence may have found it difficult to conceptualize themselves as susceptible.

The participants' health belief attitudes were positively correlated with internal locus of control, but negatively correlated with chance locus of control. This result implies that the participants who had positive health belief attitudes also felt in control of their health.

Milk and bread were the two most popular items consumed by one-half or more of the participants on a daily basis. Cheese, cheese dishes, broccoli, ice-cream, and chocolate candy were popular items consumed by one-half or more on a weekly basis. Although yogurt, fortified juices, and fortified cereal are good sources of calcium and are readily available, very few participants reported consuming them on either a daily or a weekly basis. However, a test of significant change in proportions revealed that there was a significant decrease in the proportion of participants who either infrequently consumed or did not consume milk, waffles or pancakes, and calcium-fortified juice pre- and post-intervention. In all of these cases, there were significantly fewer participants who did not consume these items after the intervention than before the intervention. This result implies that the intervention may be considered as a possible cause of the change.

After the intervention, the participants significantly increased their dietary and total calcium intakes, but slightly reduced their supplemental calcium intake. These results suggest that the intervention may have influenced the participants' dietary behavior and calcium intake. The mean total calcium intake of this group of participants was over 50% higher in both pre- and post-intervention than the latest national mean intake for women of the same age group, as reported in the *Third Report on Nutrition Monitoring in the United States* (Interagency Board for Nutrition Monitoring and Related Research, 1995). Most of the participants consumed over 75% of the National Institutes of Health (Optimal Calcium Intake, NIH Consensus Statement, 1994) recommended optimal calcium intake pre- and post-intervention, while 58.1% and 72.4% of the participants exceeded the recommended intake level pre- and post-intervention, respectively. These percentages show a significant increase in calcium intake after the intervention.

After the intervention, dietary calcium intake was negatively correlated to chance locus of control. This result suggests that the higher the participants scored on chance locus of control, the less calcium from food they consumed, while high health belief attitude scores positively correlated with high supplemental intake both pre- and post-intervention. This result is to be expected since individuals with positive health belief attitudes are likely to change behavior toward a more healthful lifestyle.

Total caffeine and alcohol intake was negatively correlated with pre-intervention dietary and total calcium intakes, but positively correlated with chance locus of control. A possible explanation for this result is that individuals who possess high chance locus of control replace beverages that are good dietary sources of calcium with beverages containing caffeine and/or alcohol. This association between caffeine and alcohol intakes, chance locus of control, and calcium intake has significant implications for health educators.

In the regression analysis, health belief attitudes related to osteoporosis and calcium intake predicted supplemental calcium intake both pre- and post-intervention. This result suggests that participants who perceived more benefits and few barriers to consuming calcium were more likely to increase their calcium intake by taking calcium supplements than those who did not.

A lower chance locus of control post-intervention was associated with higher dietary calcium intake from diet. This result is to be expected because individuals who possess high chance locus of control and do not feel in control of their health, attribute their health status to chance or fate. Therefore, they are less likely to change behavior to adopt a more healthful lifestyle than individuals with low chance locus of control.

Results from this study support the use of the Health Belief Model and multidimensional locus of control theory in predicting calcium intake and change in calcium intake. However, it should be remembered that although the attitudes contained in these models are relevant, they are just one of a number of factors determining the health behavior studied in this research.

College level of education, chance locus of control, and health belief attitudes were all significant predictors of total calcium intake after the intervention. Chance locus of control and post-intervention external locus of control significantly predicted change in dietary calcium intake, while age and peri-menopausal status predicted change in supplemental calcium intake. These results show that dietary behavior, specifically calcium intake in this case, is influenced by multiple factors. It is, therefore, important not only to be aware of the factors but also to identify the most important ones in the process of striving to change individuals' dietary behaviors.

Based on these findings, it is reasonable to conclude that in this study the intervention may have been responsible for changing some of the participants' dietary and lifestyle behaviors.

Practical Applications for Interventions

The purpose of this investigation was to understand behavioral factors that influence calcium intake and promote positive change. Hence, results from the participants' health locus of control scores, health belief attitudes, and calcium intake have some implications that could be applied to guide future interventions. For example, the locus of control measurement could be used to determine appropriate subjects for initiating successful behavior therapy (Eden et al., 1984). Behavior modification seems to work well for those who believe that change of behavior and consequent goal attainment are truly possible (Paine, 1980). In this study, possessing a high chance locus of control negatively predicted dietary calcium intake. Those whose locus of control relates strongly to chance are less likely to believe that preventive measures influence disease. It would, therefore, be beneficial if participants with a strong chance locus of control could be empowered to gain control and, hopefully, increase their dietary calcium intake. Participants' control of their diet might be enhanced by an inventory of current food intake followed by setting small, attainable goals for food intake change. On the other hand, participants with a strong external locus of control should be encouraged to set goals and engage in activities as a group (Paine, 1980). When possible, significant family members and peers should be included in the group.

In this study, a majority of the participants had positive attitudes about the benefits of calcium intake for reducing osteoporosis risk related to the Health Belief Model. However, only about one-third perceived themselves as susceptible to osteoporosis even after the intervention. A possible intervention to enhance their perception of susceptibility is to take bone density measurements. However this intervention is an expensive and somewhat invasive and not widely available.

Although the mean calcium intake for this group was within the recommended intake level, the minimum calcium intakes were undesirably low (170 mg/day and 301 mg/day) pre- and post-intervention, respectively. At the same time, yogurt, a rich source of calcium that is easily available and relatively inexpensive, was poorly consumed by a majority of the participants. Increased marketing on this product could improve calcium intake, especially by participants who have a dislike for milk.

Active participation perhaps would enhance behavior change. For example, participants should set their own goals and evaluate their diets. Other activities which would require an active role from the participants include: 1) guided tours to grocery stores, 2) tours of eating establishments, 3) tours of drug stores for supplement users, and, 4) tasting new calcium-rich food items. These activities could be effective in producing informed consumers and possibly changing purchasing behavior.

Changing the dietary behavior of individuals and communities is a long term project. Therefore, educational interventions should be long term and tailored to the audience in such a way that they address specific issues of relevance to individuals.

Recommendations for Future Research

Findings of this study can be validated by conducting further research on a more heterogeneous, randomly selected sample. Such research could be strengthened by using an experimental design and more accurate methods for estimating calcium intake such as food records. Such research could more accurately measure the effectiveness of intervention than was possible in this study.

Since the factors selected for this study for influencing calcium intake explained a very small percentage of the variance, further research is needed to investigate other factors that may influence calcium intake in peri- and post-menopausal women. Finally, although this study and related literature demonstrate that nutrition education may result in dietary behavior changes, there is need for a longitudinal study to assess the maintenance of the behavior changes and their influence on osteoporosis among the participants.

APPENDIX A:

PRE-INTERVENTION QUESTIONNAIRE

IOWA STATE UNIVERSITY
OF SCIENCE & TECHNOLOGY

Department of Food Science
and Human Nutrition
1127 Human Nutritional Sciences Bldg.
Ames, Iowa 50011-1120
515-294-7316

A Study On Menopause:

Nutrition Facts Every Woman Needs To Know

Thank you for agreeing to take part in this study. This booklet contains a questionnaire for you to complete. It should take about 15 minutes. Your responses will remain *entirely confidential.*

Subject number:________

If you eat a food below daily, write the number of times you eat the amount given each day in the Daily column.
If you eat a food below each week but not daily, write the number of times you eat the amount given each week in the Weekly column.
If you do not eat a food below at least once a week, do not write anything.

EXAMPLE:

Mary usually has two large pancakes for breakfast every Sunday morning, but does not eat waffles Therefore, under the column for waffle or pancake below , she would write 2 under weekly. This indicates that each week she has twice the amount listed (1 large).

Mary takes 1 cup of cottage cheese to work for lunch about once per week. How will she fill out the second column below?

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Waffle or pancake	1 large		
Cottage cheese	1/2 cup		

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Milk (all types) - whole, 2%, 1%, or skim	1 cup		
American cheese slices or spread, blue cheese	1 oz.		
Cottage cheese	1/2 cup		
Natural cheese - cheddar, swiss, mozzarella, etc. (not cream cheese)	1 oz.		
Macaroni & cheese, quiche, pizza, cheese soufflé, lasagna, cannelloni	1 serving		
Egg McMuffin®, cheeseburger	1		
Baked beans	1 cup		
Canned salmon with bones	1/2 cup		
Sardines, herring, or smelts	1/2 cup		
Haddock, cod, or flounder	3 oz.		

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Cream soup or chowder made with milk	1 cup		
Calcium fortified orange juice	1/2 cup		
Broccoli	1 cup		
Beet greens or spinach	1/2 cup		
Bread - white or whole grain	1 slice		
Waffle or pancake	1 large		
Muffin, biscuit, or cornbread	1 medium		
Calcium fortified cereal like calcium fortified Total®	3/4 cup		
Yogurt, plain or flavored	1 cup		
Frozen yogurt	1 cup		
Ice cream or ice milk	1 cup		
Pudding made with milk	1/2 cup		
Chocolate candy	1 oz.		

Please circle the number that represents the extent to which you disagree or agree with the statement. These items measure your personal beliefs, so there are no right or wrong answers.

Please answer all of the items, and answer according to your actual beliefs, not according to how you think you should believe.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
If I get sick, it is my own behavior which determines how soon I get well again.	1	2	3	4	5	6
No matter what I do, if I am going to get sick, I will get sick.	1	2	3	4	5	6
Having regular contact with my physician is the best way for me to avoid illness.	1	2	3	4	5	6
Most things that affect my health happen to me by accident.	1	2	3	4	5	6
Whenever I don't feel well, I should consult a medically trained professional.	1	2	3	4	5	6
I am in control of my health.	1	2	3	4	5	6
My family has a lot to do with my becoming sick or staying healthy.	1	2	3	4	5	6
When I get sick I am to blame.	1	2	3	4	5	6
Luck plays a big part in determining how soon I will recover from an illness.	1	2	3	4	5	6
Health professionals control my health.	1	2	3	4	5	6
My good health is largely a matter of good fortune.	1	2	3	4	5	6
The main thing which affects my health is what I myself do.	1	2	3	4	5	6
If I take care of myself, I can avoid illness.	1	2	3	4	5	6

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
When I recover from an illness, it's usually because other people, (for example, doctors, nurses, family, friends) have been taking good care of me.	1	2	3	4	5	6
No matter what I do, I'm likely to get sick.	1	2	3	4	5	6
If it's meant to be, I will stay healthy.	1	2	3	4	5	6
If I take the right actions, I can stay healthy.	1	2	3	4	5	6
Regarding my health, I can only do what my doctor tells me to do.	1	2	3	4	5	6
I am worried about getting osteoporosis.	1	2	3	4	5	6
I think I will be less likely to have osteoporosis if I take calcium supplements.	1	2	3	4	5	6
Since there are so many health problems that I could have, it is silly for me to worry about osteoporosis.	1	2	3	4	5	6
It is not realistic for me to eat a diet high in calcium.	1	2	3	4	5	6
I think it is very likely that I will get osteoporosis.	1	2	3	4	5	6
I do not think that osteoporosis is a very serious disease.	1	2	3	4	5	6
It is not realistic for me to take calcium supplements.	1	2	3	4	5	6
I think I will be less likely to have osteoporosis if I have a lot of calcium in my diet.	1	2	3	4	5	6

Please answer each of the questions below.

1. How old were you on your last birthday? __________ years old

2. Which racial group do you belong to?

   ______ White
   ______ Black
   ______ American Indian
   ______ Asian or Pacific Islander

3. What is the highest level of education that you have completed?

   ______ Grade school (grades 1-8)
   ______ Some high school (grades 9-11)
   ______ High school graduate
   ______ Technical or trade school
   ______ Some college
   ______ College graduate
   ______ Post-graduate study

4. What is your present marital status?

   ______ Single, separated, widowed, or divorced
   ______ Married

5. How many children have you given birth to? _______

6. What is your menopausal status?

   ______ Pre-menopausal (menstrual cycle has not noticeably changed over the last five years)
   ______ Peri-menopausal (menstrual cycle has noticeably changed over the last five years, such as changes in length of cycle, amount of flow, regularity of cycle, etc.)
   ______ Natural Post-menopausal (have not had a natural menstrual period for at least one year)
   ______ Surgical Post-menopausal (menstrual periods have stopped because both ovaries have been surgically removed)

7. Have you had a bone fracture in the last five years?

   ______ Yes ______ No

   If yes, what location or type? (check all that apply)
   ______ wrist
   ______ hip
   ______ vertebrae
   ______ other (specify: ________________________)

8. Are you presently taking hormone replacement therapy for menopause?

_____ Yes _____ No

If yes, what type?
_____ estrogen only
_____ estrogen and progesterone
_____ other (specify: _____________________________)

9. Do you smoke cigarettes?

_____ Yes _____ No

If yes, about how many cigarettes do you smoke daily? _________

10. Do you exercise at least once per week?

_____ Yes _____ No

If yes, about how many days per week do you exercise? _________

11. How often do you usually drink the following beverages? (check)

	Several times each day	About once each day	Several times each week	Seldom or never
Brewed or instant coffee (containing caffeine)				
Alcoholic beverages				
Regular or diet cola soft drinks or Mountain Dew®				
Regular tea (black tea)				

12. Do you take calcium supplements, antacids like Tums® that contain calcium, or a multi-vitamin or multi-mineral supplement that contains calcium?

______ Yes ______ No

<u>If yes,</u> fill out the chart below.

Please fill out the chart below if you use a calcium supplement, calcium antacid, and/or other supplement that contains calcium. Please fill out a different row (left to right) for each different type you take. If you do not know the answer to one of the questions, please write "Do Not Know" in the blank.

	What is the brand name of the supplement?	How many of these supplements do you take in one day or in one week?	How much calcium does each supplement contain (1,000 mg, for example)	What kind of calcium does this supplement contain (for example, calcium carbonate)
First type of supplement that I take		_____ per day or _____ per week		
Second type of supplement that I take		_____ per day or _____ per week		
Third type of supplement that I take		_____ per day or _____ per week		
Fourth type of supplement that I take		_____ per day or _____ per week		

APPENDIX B:

POST-INTERVENTION QUESTIONNAIRE

IOWA STATE UNIVERSITY
OF SCIENCE & TECHNOLOGY

Department of Food Science
and Human Nutrition
1127 Human Nutritional Sciences Bldg.
Ames, Iowa 50011-1120
515-294-7316

A Study On Menopause:

Nutrition Facts Every Woman Needs To Know

Thank you for participating in the recent meeting on menopause and nutrition. The information you provided at the meeting is very valuable, but it is not complete without this follow-up questionnaire.

It should take about 10 minutes to complete this questionnaire. If you have questions, you may contact me at 515-294-7316. Your responses will remain entirely confidential.

Please return the questionnaire in the enclosed envelope **within the next week**. Thank you for your participation. I truly appreciate it!

Sincerely,

Mary Murimi
Doctoral Candidate

Subject number:________

If you eat a food below daily, write the number of times you eat the amount given each day in the Daily column.
If you eat a food below each week but not daily, write the number of times you eat the amount given each week in the Weekly column.
If you do not eat a food below at least once a week, do not write anything.

EXAMPLE:

Mary usually has 2 slices of toast and a sandwich made from two slices of bread each day. Therefore, she has four times the amount listed for bread (1 slice) each day. She writes 4 under daily for the bread row.

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Bread - white or whole grain	1 slice		

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Milk (all types) - whole, 2%, 1%, or skim	1 cup		
American cheese slices or spread, blue cheese	1 oz.		
Cottage cheese	1/2 cup		
Natural cheese - cheddar, swiss, mozzarella, etc. (not cream cheese)	1 oz.		
Macaroni & cheese, quiche, pizza, cheese soufflé, lasagna, cannelloni	1 serving		
Egg McMuffin®, cheeseburger	1		
Baked beans	1 cup		
Canned salmon with bones	1/2 cup		
Sardines, herring, or smelts	1/2 cup		
Haddock, cod, or flounder	3 oz.		

FOOD TYPE	SERVING AMOUNT	DAILY	WEEKLY
Cream soup or chowder made with milk	1 cup		
Calcium fortified orange juice	1/2 cup		
Broccoli	1 cup		
Beet greens or spinach	1/2 cup		
Bread - white or whole grain	1 slice		
Waffle or pancake	1 large		
Muffin, biscuit, or cornbread	1 medium		
Calcium fortified cereal like calcium fortified Total®	3/4 cup		
Yogurt, plain or flavored	1 cup		
Frozen yogurt	1 cup		
Ice cream or ice milk	1 cup		
Pudding made with milk	1/2 cup		
Chocolate candy	1 oz.		

Please circle the number that represents the extent to which you disagree or agree with the statement. These items measure your personal beliefs, so there are no right or wrong answers. Please answer all of the items, and answer according to your actual beliefs, not according to how you think you should believe.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
If I become sick, I have the power to make myself well again.	1	2	3	4	5	6
Often I feel that no matter what I do, if I am going to get sick, I will get sick.	1	2	3	4	5	6
If I see an excellent doctor regularly, I am less likely to have health problems.	1	2	3	4	5	6
It seems that my health is greatly influenced by accidental happenings.	1	2	3	4	5	6
I can only maintain my health by consulting health professionals.	1	2	3	4	5	6
I am directly responsible for my health.	1	2	3	4	5	6
Other people play a big part in whether I stay healthy or become sick.	1	2	3	4	5	6
Whatever goes wrong with my health is my own fault.	1	2	3	4	5	6
When I am sick, I just have to let nature run its course.	1	2	3	4	5	6
Health professionals keep me healthy.	1	2	3	4	5	6
When I stay healthy, I'm just plain lucky.	1	2	3	4	5	6
My physical well-being depends on how well I take care of myself.	1	2	3	4	5	6
When I feel ill, I know its because I have not being taking care of myself properly.	1	2	3	4	5	6

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
The type of care I receive from other people is what is responsible for how well I recover from an illness.	1	2	3	4	5	6
Even when I care for myself, it's easy to get sick.	1	2	3	4	5	6
When I become ill, it's a matter of fate.	1	2	3	4	5	6
I can pretty much stay healthy by taking good care of myself.	1	2	3	4	5	6
Following doctor's order to the letter is the best way for me to stay healthy.	1	2	3	4	5	6
I am worried about getting osteoporosis.	1	2	3	4	5	6
I think I will be less likely to have osteoporosis if I take calcium supplements.	1	2	3	4	5	6
Since there are so many health problems that I could have, it is silly for me to worry about osteoporosis.	1	2	3	4	5	6
It is not realistic for me to eat a diet high in calcium.	1	2	3	4	5	6
I think it is very likely that I will get osteoporosis.	1	2	3	4	5	6
I do not think that osteoporosis is a very serious disease.	1	2	3	4	5	6
It is not realistic for me to take calcium supplements.	1	2	3	4	5	6
I think I will be less likely to have osteoporosis if I have a lot of calcium in my diet.	1	2	3	4	5	6

Please respond to the items below.

1. Since the meeting about six weeks ago, which statement best describes any changes you have made in hormone replacement therapy? (Check one.)

   ______ I did not use hormone replacement therapy either then or now.

   ______ I have made no change in the type or amount of hormone replacement therapy I take since the meeting.

   ______ I have started taking hormone replacement therapy since the meeting.

   ______ I have stopped taking hormone replacement therapy since the meeting.

   ______ I have changed the type or amount of hormone replacement therapy I am taking since the meeting.

2. Since the meeting about six weeks ago, please check the blank that best indicates any changes you have made in the following behaviors. Please check one box beside each behavior

Behavior	**No change since the meeting**	**More since the meeting**	**Less since the meeting**
Have you changed the number of cigarettes you smoke each day?			
Have you changed the number of days per week that you exercise?			
Have you changed the amount of brewed or instant coffee (containing caffeine) that you drink?			
Have you changed the amount of alcoholic beverages that you drink?			
Have you changed the amount of regular or diet soft drinks or Mountain Dew® that you drink?			
Have you changed the amount of regular tea (black tea) that you drink?			

3. Do you take calcium supplements, antacids like Tums® that contain calcium, or a multi-vitamin or multi-mineral supplement that contains calcium?

_____ Yes   _____ No

<u>If yes,</u> fill out the chart below.

Please fill out the chart below if you use a calcium supplement, calcium antacid, and/or other supplement that contains calcium. Please fill out a different row (left to right) for each different type you take. If you do not know the answer to one of the questions, please write "Do Not Know" in the blank.

	What is the brand name of the supplement?	How much calcium does each supplement contain (1,000 mg, for example)	How many of these supplements do you take in one day or in one week?
First type of supplement that I take			_____ per day or _____ per week
Second type of supplement that I take			_____ per day or _____ per week
Third type of supplement that I take			_____ per day or _____ per week
Fourth type of supplement that I take			_____ per day or _____ per week

APPENDIX C:

TABLE OF SPECIFICATIONS

Table of Specifications

Susceptibility to osteoporosis

• *Personal concern about getting osteoporosis*

I am worried about getting osteoporosis.

• *Perceived likelihood of getting osteoporosis*

I think it is very likely that I will get osteoporosis.

Seriousness of osteoporosis

• *Perceived seriousness of osteoporosis*

I do not think that osteoporosis is a very serious disease.

• *Perceived seriousness of osteoporosis relative to other health problems*

Since there are so many health problems that I could have, it is silly for me to worry about osteoporosis.

Benefits of preventing osteoporosis by calcium intake

• *Benefits of calcium in diet*

I think I will be less likely to have osteoporosis if I have a lot of calcium in my diet.

• *Benefits of taking calcium supplements*

I think I will be less likely to have osteoporosis if I taking calcium tablets or pills

Barriers to preventing osteoporosis by calcium intake

• *Barriers to calcium in diet*

It is not realistic for me to eat a diet high in calcium.

• *Barriers to taking calcium supplements*

It is not realistic for me to take calcium tablets or pills.

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