IMPACT OF LIFESTYLE INTERVENTION FOR FREE-LIVING ADULTS ON BONE-RELATED KNOWLEDGE AND BEHAVIORAL INDICATORS

BY

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DISSERTATION

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ABSTRACT

The purpose of this research was to measure and evaluate lifestyle changes affecting bone health. Osteoporosis is a public health concern. Improving bone health, thereby preventing osteoporosis and fractures, can lead to a reduction in health care costs. Calcium is a key player in bone health. With an increase in calcium-fortified foods an objective was to develop a food frequency questionnaire that assesses both natural and fortified sources of calcium. A validation study in which the Calcium-Focused Food Frequency Questionnaire (CFFFQ) was tested against a 24-hour recall in adult females (pilot study, n=15) and college-aged females (primary study, n=300). In *the pilot study*, no significant differences in calcium intake for total calcium or food group category was found except for calcium from "foods with dairy" (t=2.23, p=.043) and "vegetable" (t=-3.106, p=.008). In *the primary study* and after removal of outliers (n= 187), significant correlations (r=.155 to.74, p<.04) were found between calcium (mg) in CFFFQ and 24-hour recall for "dairy", "foods with dairy", "fruit", "vegetables", "grains" groups and total calcium. In the *reliability study*, all groups were significantly correlated (r=.155 to .96, p<.034) except for the dairy. In using the CFFFQ with post-menopausal women [46 black and 139 white post-menopausal women (age 69.4 $\pm$5.8 years)], as daily calcium intake increased, the 24-hour recall increasingly underreported calcium (r = .41, p<.001). Per cross-tabulation and Chi-square analyses, the CFFFQ had greater specificity for lower calcium intakes. For calcium classified by food groups, there was moderate correlation for dairy (r = .56, p<.001) and fruit groups (r = .434, p<.001). Dairy was the primary calcium source for both groups (55% and 57% of intake for black, white women, respectively). The CFFFQ can be used to identify those with inadequate calcium intakes

(<800 mg/day) and to identify key sources of dietary calcium. The CFFFQ was used in part of the larger bone-health community program (8 weeks) addressing disease risk and lifestyle changes within the framework of behavior constructs ($n=69$). There was significant increases in calcium intake ($p<.027$) and vitamin D intake ($p<.015$), with calcium from the fruit group ($p<.005$, 24-hour recall) and grain group ($p<.042$, CFFFQ). There was a significant change ($p<.01$) in 3 of 5 items related to susceptibility; 3 of 3 items related to perceived severity ($p<.03$); in 5 of 5 items related to benefits of nutrition changes ($p<.001$); in 1 of 7 items related to nutrition barriers ($p<.05$); in 4 of 4 nutrition self-efficacy items ($p<.01$); in 4 of 6 items related to subjective norm ($p<.05$); in 4 of 5 nutrition attitudes ($p<.05$) and 3 of 4 intentions ($p<.01$) [Wilcoxon Signed Rank]. This theory-based program was successful in improving calcium intake, vitamin D intake and Health Belief Model (HBM) and Theory of Reasoned Action (TRA) constructs related to bone-healthy diets, implying effective program applications to clinic and community-based practice.

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CHAPTER 1

INTRODUCTION

Osteoporosis is a systemic skeletal disease portrayed by low bone mass and structural weakening of the bone material that leads to reduced bone strength and increase susceptibility to fracture. Although all bones can be affected, the hip, vertebra and wrist bones are at high risk. Osteoporosis is commonly referred to a "silent disease" as there are no symptoms until the fracture occurs (NOF, 2007).

Osteoporosis is a debilitating chronic disease that is a public health problem. It is estimated that 10 million individuals have osteoporosis while another 34 million suffer from low bone density. An estimated 61 million individuals will have osteoporosis or low bone density by 2020 (NOF, 2007). In 2002 dollars, annual direct care expenditures for osteoporotic fractures reached almost 18 billion dollars (Carmona, 2004; Tosteson, 1999). Beyond costs, there is the physical burden of living with osteoporosis and its impact on daily living, including restrictions in daily activities, loss of confidence (due fear of fall and fracture) and loss of independence (Pasco et al, 2005).

With people living longer, fracture risk is expected to increase. Each year an estimated 1.5 million individuals suffer a fracture due to bone disease. For those over 50 who suffer a hip fracture, approximately 4% will die in the hospital and 24% will die within the year. The risk of a fracture increases with age and is greatest in women. Approximately 1 in 2 women and 1 in 4 men age 50 or older in the United States will experience an osteoporotic-related fracture sometime during the remainder of their lives.

As people live longer, the lifetime risk of fractures will increase for all ethnic groups. (Carmona, 2004). Even though osteoporosis is often considered an older person's disease, it can strike at any age. With the high costs of treating osteoporosis (Burge et al, 2005) effective preventive interventions are needed.

Osteoporosis is primarily viewed as a women's disease. However, after age 50, 6% of all men will experience a hip fracture and 5% will have a vertebral fracture as a result of osteoporosis (NOF, 2007; Carmona, 2004). Bone loss occurs rapidly in women at menopause, for men the loss still occurs but later in their late 60's and in their 70's. The area of bone health and osteoporosis in men is not well studied, but often occurs due to secondary causes, such as corticosteroid therapy (Al Attia, 2007).

Risk factors for low bone density, osteoporosis and fractures include both unchangeable and modifiable types of factors. Conditions increasing the chance for developing osteoporosis include: fracture history after age 50, family history, female gender, small bone frame, advanced age, estrogen deficiency, amenorrhea, low testosterone levels, some medications, certain chronic diseases, long-term low intake of calcium, vitamin D deficiency, inactivity, cigarette smoking and excessive alcohol (Poole and Compston, 2006). Fortunately, there are many modifiable lifestyle factors (diet and activity) along with drug treatment to prevent or slow the loss of bone.

The National Osteoporosis Foundation developed five steps to optimize bone health. These include:

1. Get the daily recommended amounts of calcium and vitamin D
2. Engage in regular weight-bearing and muscle-strengthening exercise
3. Avoid smoking and excessive alcohol
4. Talk to your healthcare provider about bone health
5. Have a bone density test and take medication when appropriate

Clinical studies have reported increases in calcium intake and physical activity with supplementation and intense supervision (Carmona, 2004; Gass et al, 2006; Tussing and Chapman-Novakofski, 2005). Resistance exercise combined with aerobic weight-bearing activity has been shown to improve bone mineral density (BMD) in postmenopausal women without a history of fractures. Calcium and vitamin D supplementation have been shown to increase BMD, but even within clinical trials adherence to taking supplements is not optimal. In fact, one large trial found no change in BMD in women enrolled in the supplement arm of the trial. However, when only those who actually took the supplements on most days were analyzed a significant improvement in hip BMD was found (Shea et al, 2004). There is an inverse relationship between physical activity and future hip fracture risk for both women and men (Schmitt et al, 2009; Thomas-John et al, 2009). Clearly, exercise and diet can have a positive impact on bone health. However, for clinical studies to be applicable to real people, the ability to translate the clinical study into a community program has to be investigated.

This research proposal addresses the important problem of having effective lifestyle modification programs that can be used as evidence for establishing community guidelines for osteoporosis prevention.

The achievement of my research objectives advances professional knowledge by evaluating intervention length and content that can be adopted by other professionals in the field.

SCOPE OF RESEARCH

As the prevalence of osteoporosis continues to increase, interventions targeting modifiable risk factors receive more emphasis from researchers, clinicians and public health professionals. Although adequacy of numerous nutrients is important to bone health, many interventions focus on calcium intake (Shea et al, 2004).

Calcium-focused rapid assessment tool

Determining calcium intake has become more difficult with increases in food fortification. The goal was to develop and evaluate the validity of a calcium-focused food frequency questionnaire (CFFFQ) that incorporates both natural and fortified sources of calcium.

Current FFQ list no or minimal fortified sources of calcium, missing a key calcium source and potentially underestimating calcium intake. FFQ focus primarily on total calcium vs. key sources of calcium. This tool was used to evaluate both total calcium and identify key food groups. This information can be useful in designing future research/intervention studies or community programs. Although any method of food frequency validation has limitations, this initial step in FFQ validation used a comparison with 24-hour recalls.

CFFFQ Hypothesis: There is no difference in calcium intake between a 24-hour recall and the CFFFQ.

Intervention program: Goals and Objectives

Education is a key component to behavior change and lifestyle optimization for chronic disease risk reduction. Therefore, the goal was to test the effectiveness of a comprehensive bone health program. The program focused on risks and lifestyle habits within a behavioral theory framework. The National Osteoporosis Foundation's five steps to osteoporosis prevention were incorporated into the program (NOF, 2007). The nutrition coverage focused on calcium and vitamin D but did address all nutrients related to bone health. Physical activity discussions included both weight-bearing and resistance training, along with preventing falls. Measuring these will provide insight into deficiencies in knowledge and behavior leading to improved educational programs.

A secondary goal was to measure the impact of the osteoporosis education intervention on both men and women. Few studies have evaluated the impact of different interventions. Those that have typically focused on diet and women. This study will provide data on perceived barriers, nutrition and activity in men and women.

The current study will in part address limitations in the Tussing study (2002):

> "The Calcium-rich Food Frequency Questionnaire used in the program may not have been the most accurate tool for assessing dietary calcium intake because it does not account for calcium-fortified foods or calcium supplement use. Future research needs to be performed to create a tool that is accurate in estimating not only natural sources of calcium like milk and cheese but also fortified foods and supplements. Although we stressed dietary calcium in our program we were unable to distinguish if participants had increased their dietary calcium using fortified foods, this may have greatly impacted the results."
>
> Although pedometers were used as a mean of determining weight-bearing activity, some individuals may have participated in weight-bearing activity that may not be detectable by pedometer like weight lifting or yoga. Future research should focus on more accurate assessment of all types of weight-bearing activity."

Objectives of the intervention included:

1. To determine how well the clinical control trial translates into the "real world" of community and public health education in terms of bone health. Specific outcomes to be measured include assessment of motivators of participants to enroll; attrition rates; program process evaluation; and end of program evaluation concerning desirability of program, value of program to participants in terms of future cost recovery and as a model for public health professionals.

2. To determine the effectiveness of a theory-based lifestyle intervention to enhance physical activity and nutritional behaviors in community-dwelling older adults over an 8-week period. Specific outcomes to be measured include dietary and supplemental calcium and vitamin D; physical activity (weight bearing and resistance-training), pedometer steps, and heel drops; indices of self-efficacy for dietary and physical activity changes; knowledge of osteoporosis risk factors; and susceptibility and severity of osteoporosis.
    a. To measure comprehension of risk factors
    b. To measure calcium intake, including natural and fortified sources of calcium, and vitamin D
    c. To assess supplement intake
    d. To measure physical activity changes

Intervention program: Hypotheses

The following hypotheses were tested:

1. There is an improvement in bone health behaviors, including calcium, vitamin D, activity and knowledge and learning constructs.
2. There is no difference between men and women related to bone health behaviors.

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CHAPTER 2

REVIEW OF LITERATURE

Bone Health and Physiology

The bone is composed of a matrix of inorganic components (calcium phosphate crystals and salts comprising approximately 65% of bone dry weight) and organic compounds (35% bone dry weight) (Chan and Duque, 2002). Many of the organic compounds are collagen fibers. Calcium, phosphate and hydroxyl ions are embedded within the collagen fibers.

The two main types of bone are: cortical and trabecular. Cortical (compact) bone is a densely packed matrix that forms the shafts of long bone and the protective outer layer on other bones. Cortical bone comprises about 80% of the skeletal bone (Ott, 1998). Trabecular bone is made of spikes, or trabeculae, arranged in a honeycomb pattern. Trabecular bone is lighter in weight than cortical bone but has tensile strength and is filled with red bone marrow (Ott, 1998). Bone strength is influenced by the quantity of bone and the quality of bone (material, microarchitecture) (Bouxsein, 2005). Mechanical loading can lead to changes in bone's size, shape/geometry or matrix architecture (Bouxsein, 2005).

Bone is constantly adjusting to mechanical stressors and hormonal changes as well as changes through modeling/remodeling. Skeletal turnover is due to the action of osteoblasts and osteoclasts. Osteoblasts are cells involved in bone formation. Osteoclasts are involved with bone resorption. Osteoblasts follow osteoclasts, after osteoclasts have cleared or resorbed part of the bone. The osteoclast/osteoblast working together form a unit, referred to as a basic multicellular unit (BMU) (Weinstein and

Manolagas, 2000). Modeling refers to changes that occur when formation and resorption are separate from each other, whereas remodeling is formation and resorption processes are in balance. Remodeling allows the skeleton to maintain structural integrity and is ongoing.

Bone mass is accumulating when formation exceeds resorption (modeling phase). Long bones stop growing around the age of 20, with bone density reaching its maximum somewhere between 25 and 30 years of age. During this time, the goal is to maximize bone mass and quality. During middle adult years, there is a balance in turnover. As aging continues there is a gradual loss of bone; therefore the goal is to maintain bone mass and slow the rate of loss. When resorption exceeds formation the process is uncoupled, resulting in net bone loss. When osteoblast activity is unable to keep pace with the osteoclast activity at which time osteoporosis develops.

Osteoporosis: Definition and Diagnosis

Osteoporosis is a loss of bone strength (bone density and bone quality) leading to an increased risk of fracture (NOF Conference, 2002, NOF), particularly of the spine, hip and wrist.

The level of bone mass is assessed by mean BMD and measured by different bone scans. T-scores, a standardized score of BMD to a reference population, are used to “diagnose”. A T-score is used, vs. absolute BMD as BMD is measured differently by different scans. With dual x-ray absorptiometry (DXA) a 1-unit change in T-score equals a 1 standard deviation to the reference group, young-normal populations (Gass and Dawson-Hughes, 2006). According to the World Health Organization (WHO), normal

BMD is > -1 T-score, low bone mass is a T-score between -1 to -2.5, osteoporosis is classified at < -2.5 T-score with severe osteoporosis being < -2.5 and at least one fragility fracture (WHO, 1994; Gass and Dawson-Hughes, 2006).

A study by Siris, et al (2004), looked at BMD thresholds to determine the level of drug intervention to prevent fractures. This study revealed that 82% of postmenopausal women with fractures had T scores that were classified as low bone mass or normal. This indicates a need for a more proactive and aggressive approaches in assessing bone health risks and promoting bone health behaviors. The authors in the Siris study concluded that to decrease overall fracture incidence in postmenopausal women will need lifestyle changes. In addition, protocols for identification and treatment are needed for women with less severe low bone mass but who are still at increased risk for future fractures.

Osteoporosis: Prevalence

The prevalence of osteoporosis is a public health problem with an estimated 8 million women and 2 million men suffering from osteoporosis and an additional 34 million people in the United States with low bone mass (NIH, 2009). Each year, there are over 2 million osteoporosis-related fractures in men and women of the age of 50 (Burge et al, 2007).

Osteoporosis: Economic Impact

Current costs of osteoporosis-related fractures are estimated at approximately $17 billion in medical expenses (Burge et al, 2007), greater than 500,000 hospital admissions, 2.6 million doctor visits, 800,000 emergency room visits, more than 180,000 extended care admissions (Carmona, 2004). A projected cost of treatment by 2025 is $25.3 billion

(Burge, 2007). Indirect cost of the disease includes lost productivity and harmful impact on mental status (Gass and Dawson-Hughes, 2006).

Osteoporosis: Contributing/Risk factors

Non-modifiable risk factors include heredity (affects peak bone mass), frame size (small frame has less mass), age (with reduced levels of gender hormones thereby increasing resorption rate), gender (females have less bone mass to lose), and race. With Caucasian and Asian women over 50 having a higher incidence (20%) as compared to Latinas (10%) and African Americans (5%) (NOF, 2007). However, both Latinas and African Americans fall under the high risk category as these populations are more likely to develop diabetes with can lead to osteoporosis (NOF, 2007). An additional risk factor is estrogen loss at early age.

Secondary osteoporosis results from another disease and/or treatment of a disease. Diseases recognized as possible causes/contributors of osteoporosis fall into a variety of categories and include genetic disorders (e.g., cystic fibrosis, glycogen storage disease), hypogonadal conditions (e.g., androgen insensitivity, anorexia nervosa, bulimia, and athletic amenorrhea), endocrine disorders (e.g., adrenal insufficiency, Cushing's syndrome, and diabetes), gastrointestinal disorders (celiac disease, gastric bypass, malabsorption, pancreatic disease, cirrhosis), blood disorders (hemophilia, multiple myeloma), rheumatic ailments (lupus, rheumatoid arthritis) and renal disease (Carmona, 2004).

Modifiable risk factors include: low intake of calcium and vitamin D, lack of physical/weight bearing activity, smoking, excessive and alcohol consumption.

In addition to risks for osteoporosis, there are risk factors for falls. These include environmental (lack of rails in rooms, throw rugs, poor lighting, obstacles, slippery conditions), medical (malnutrition, impaired vision, medications causing drowsiness), physical (poor balance, weak muscles), and psychological (fear of falling) (NOF, Professional's Guide 2008).

Treatment/prevention

Universal strategies are a public health approach to disease prevention using recommendations which are supportive of general good health as well as disease prevention/treatment. Universal strategies for bone health include: instruction on adequate daily intake of calcium and vitamin D, regular weight-bearing and muscle strengthening activity, fall prevention, no smoking or excessive alcohol (Carmona, 2004; NOF, 2007). According to the Surgeon General Report on bone health (2004), the next step after universal strategies includes treating the secondary causes of osteoporosis and finally utilizing drugs to specifically treat osteoporosis.

Treatment/prevention: Calcium

Calcium intake is an integral component of bone health (Nordin, 1997; Carmona, 2004). The skeleton contains 98-99% of the body's calcium (Weaver et al, 2006). If calcium intake is inadequate and absorption is decreased, a reduced serum level of calcium signals an increase in the parathyroid hormone (PTH). PTH has bone-resorbing properties. Calcium is pulled from the skeleton to supply the body with calcium for its metabolic functions. With a chronic poor intake of calcium, effects of PTH can lead to major bone loss. Calcium is also needed for the normal remodeling process of bone. Calcium is the material used in the bone formation component of remodeling.

Inadequate calcium intake is exaggerated with a low vitamin D intake. Calcium is absorbed by both active and passive transport. Moderate or less intakes (<500 mg) of calcium are primarily absorbed by active transport which is supported by active vitamin D ($1,25(OH)_2D_3$) via the calcium-binding protein (Heaney, 2008; Norman, 2008). Calcium absorption efficiency declines with age, which may be due to a decrease in and/or less effective vitamin D receptors.

The adequate intake (AI) for calcium for adults 19-49 is 1000 mg/day and for adults over 50 is 1200 mg/day (IOM, 1997). The source of dietary calcium intake may differ across cultures and ethnicities according to food preferences and tolerances. For example, blacks and Asians may have a higher prevalence of lactose intolerance leading to a reduced dairy intake but also have cultural food preferences, including not drinking milk at meals, that impact calcium intake (Jarvis, 2002). Common tools for assessing calcium intake are 24-hour recalls or food frequency questionnaires (FFQ) (Cameron and Van Stavenen, 1998). Each of these tools has advantages and limitations. Twenty-four recalls are limited by not estimating usual intake. Food frequencies are limited by the food items included on the survey (Cameron and Van Stavenen, 1998). A FFQ that specifically addresses calcium-rich sources, including calcium-fortified foods, will be helpful in dietary assessments of osteoporosis risk.

Previous studies have included either no calcium-fortified foods (Magkos et al, 2006; Hertzler et al, 1994; Cook AJ et al, 2003; Yanek et al, 2001; Jensen, et al, 2004; Blalock SJ et al, 1998), calcium-fortified mineral water (Montomoli et al, 2002) calcium-fortified juice alone (Harnack et al, 2006) calcium-fortified juice and a grain product (Ward et al, 2004), or are unclear on the inclusion of calcium-fortified foods in the assessment tool (Angus et al, 1989; Musgrave et al, 1989; Smith, et al, 1991; Brown et al, 1993; Taitano et al, 1995; Angbratt et al, 1999; Xu et al, 2000; Bell et al, 2002; Chee et al, 2002; Blalock SJ et al, 2003; Sebring et al, 2007).

Treatment/prevention: Vitamin D

A primary role of vitamin D is to maintain serum calcium and phosphorus levels within a constant range. Vitamin D undergoes two hydroxylations: first at the liver, then at the kidney to become its active form of $1,25(OH)_2D_3$ Levels of $1,25(OH)_2D_3$ are increased by PTH to increase calcium absorption. By interacting with the vitamin D receptor (VDR), the biological action of vitamin D mainly occurs at various target organs. Tissues with VDR include bone, bone marrow, intestine and osteoblast (Norman, 2008) Intestinal calcium transport is stimulated by vitamin D ($1,25(OH)_2D_3$ or calcitriol) by increasing active transport via the calcium-binding protein. The net desired effect is to increase calcium availability. However, if vitamin D is inadequate, calcium absorption efficiency is reduced, even if calcium intake is adequate.

Vitamin D is obtained from food and supplements and from synthesis in skin by exposure to ultraviolent (UV) radiation, with 7-dehydrocholesterol serving as a precursor to vitamin D. As people age, the levels of 7-dehydrocholesterol decline impacting the body’s ability to synthesize vitamin D. This is exaggerated by seasonal effects limiting production, avoiding sun exposure or using sun block. In contrast to calcium where there is no good biomarker, circulating vitamin D, 25(OH)D has shown to be useful. Evidence suggests that serum vitamin D, 25(OH)D, levels in the range of <30 to 80 nmol/L in elderly adults is associated with bone loss (Dawson-Hughes et al, 2005).

A recommended daily intake for those under 50 years is 200 IU/day, for adults between 51-70, 400 IU is recommended and for those over 71, 600 IU are recommended (IOM, 1997). These values were based on maintaining adequate levels of vitamin D to prevent rickets and osteomalacia, not specifically for bone health. The National Osteoporosis Foundation (NOF) recommends 800-1000 IU/day for bone health. If intake of milk or other vitamin D-fortified foods are limited, a vitamin D supplement is advisable, especially if sunlight exposure is limited or if the person lives above a 40º latitude.

Treatment/prevention: Bone-Healthy Eating Plan

Many nutrients play a role in optimizing skeletal mass. In addition to vitamin D and calcium, deficiency, and in some cases excesses, of other nutrients can impact bone mineral density. These nutrients are commonly obtained in following the US Dietary Guidelines.

Inadequate protein intake has been shown to be a problem in building bone mass as well as maintaining bone mass. Excessive protein or sodium increases urinary calcium losses. Negative effect of high sodium (Nieves, 2005) and protein (Weikert et al, 2005) appears to occur when calcium intake is inadequate. Following a lower sodium plan is consistent with Dietary Guidelines along with the Dietary Approach to Stop Hypertension (DASH) diet (NIH, 2009).

Several micronutrients have been found to play a role in bone health. These are boron, fluoride (involved in bone matrix), magnesium, phosphorus, potassium, vitamin

A, vitamin C and vitamin K (Nieves, 2005). These nutrients are commonly found in fruits, vegetables and whole grains which follow national guidelines.

Following MyPyramid, its food groups, servings and portions promote meeting these nutritional requirements for bone-health nutrients. Recommendations for a bone-healthy eating plan follow other disease prevention guidelines, including eating whole foods, choosing fruits and vegetables and whole grains and moderate in sodium.

Treatment/prevention: Exercise

Benefits from physical activity in preventing osteoporosis or fractures include: improved balance/reduced risk of falling, maintenance of muscle and bone strength, improved bone mass, increased flexibility. Weight training and resistance training is recommended (ACSM, 2004). For those with osteoporosis, certain precautions need to be made. In addition to exercise, balance training plays a role in preventing falls (NOF, 2007; Carmona, 2004).

For targeted loading on bones, different types of forces can be used: ground, joint and repetitive. According to the American College of Sports Medicine (ACSM), to see an increase in bone mass (or reduced loss) the activity needs to produce an overload on the bone (ACSM, 2004). In the Erlangen Fitness Osteoporosis Prevention Study, post-menopausal women, consuming calcium and vitamin D supplements, in the exercise group (aerobic, weight-bearing, strength training and stretching) increased lumbar spine BMD by 1.3% vs. those only taking supplements which showed a 1.2% decrease in lumbar spine BMD (Kemmler et al, 2002).

The recommendations of the American College of Sports Medicine (ACSM, 2004) for physical activity and bone health to help maintain bone are:

- Mode: weight-bearing endurance activities, jumping-requiring activities, and resistance exercise
- Intensity: moderate to high
- Frequency: weight-bearing endurance activities 3-5 times per week and resistance exercise at 2-3 times per week
- Duration: 30-60 minutes with combination of different modes

In addition to improving general fitness levels, bone health benefits have been seen with walking and leisure time activities. In a prospective cohort study of postmenopausal women, those engaged in walking and leisure activities were 55% less likely to experience a hip fracture vs. those who were sedentary (Feskanich et al, 2002). This could be in part due to improved fitness levels and improved flexibility, and therefore, less chance to fall and consequently, reducing risk for fracture.

Treatment/prevention: Pharmacological

Drugs for osteoporosis fall into two categories: antiresorptive (acting on osteoclasts) and anabolic (targeting osteoblasts). Even with evidence that the drugs improve bone mass, compliance/adherence to the regimen is poor in part due to various side effects (Gass and Dawson-Hughes, 2006). Regardless of the use of pharmacological treatment, lifestyle factors (diet, activity, fall prevention) serve as the primary treatment base.

Antiresorptive: Bisphosphonates (Aledronate/Fosamax, Ibandronate/Boniva, Risedronate/Actonel, Zoledronic acid/Reclast) act by blocking the enlistment and action of osteoclasts. These have a strong affinity for the bone apatite (Gass and Dawson-Hughes, 2006). Bisphosphonates have been shown to increase bone mass and reduce vertebral and hip fractures (MacLean et al, 2008; NOF, 2008). Calcitonin (Fortical) is a peptide that restricts osteoclast activity. It has been shown to be effective in reducing vertebral fractures (MacLean et al, 2008). Estrogen Agonist/Antagonist (formerly called SERMs) (Raloxifene/Evista) is another category of drugs impacting bone resorption. Raloxifene acts as competitor on bone (and lipid) metabolism. It has shown to reduce vertebral fracture risk (MacLean et al, 2008).

Anabolic: Teriparatide/Forteo is a formulation of the parathyroid hormone and has been shown to increase bone mass and improve skeletal architecture, including reducing both vertebral and nonvertebral fractures(MacLean et al, 2008).

Estrogen/hormone therapy is approved for prevention, not treatment, but with increased breast cancer and cardiovascular risks, non-estrogen drugs are encouraged regarding osteoporosis(MacLean et al, 2008).

Prevention Strategies:

There are three different levels/strategies to disease prevention and treatment: primary, secondary and tertiary. Primary interventions involve lowering the risk in a population for developing a particular disease. This is geared towards the well individual and involves knowledge and preventative behavior. Common tactics include screenings and community programs. Secondary interventions involve identifying and targeting at risk populations/persons. The goal at this level would be to minimize or reverse progression of the disease; this may be more individualized. Examples for bone health would be education intervention geared towards calcium intake or exercise. Tertiary interventions are more clinical and target individuals that have been diagnosed with the condition. The goal at this stage is to minimize progression of the disease and to decrease the incidence of an acute complication (i.e., fracture). Tertiary intervention is more individualized (Poole and Compston, 2006; Silverman, 2009). For public health, primary interventions are the goal in that they are targeting lifestyle behaviors to promote bone health and reduce osteoporosis risk.

Behavior

Knowledge does not always translate into behavior change. Improving compliance with recommendations is critical to improving bone health and fracture rates. To evaluate mediating variables and their relationships to desired outcomes, various behavioral learning theories exist. Each theory has its own constructs to evaluate different influences on learning and, consequently, behavior change. According to the American Dietetic Association (ADA), it is recommended that "to increase the effectiveness of nutrition education in promoting sensible food choices, food and nutrition professionals should utilize appropriate behavioral theory and evidenced-based strategies" (ADA, 2007).

Using two different behavioral/psychological models, the Health Belief Model (HBM) and the Theory of Reasoned Action (TRA), will measure different beliefs, attitudes and motivators in behavior change. This will lead to better designed messages and education to improve compliance with bone health recommendations. Using both HBM and TRA provides a better indication of the effects that normative pressure can have on an individual's intended outcome behavior (Poss, 2001).

The HBM model measures a person's willingness to continue if the perceived benefit will avoid a negative health condition. Variables measured by HBM include

(Rosenstock, 1974): perceived susceptibility to the health condition, perceived severity of the health condition, perceived barriers to overcome to perform a health behavior, perceived benefits of performing a health behavior, self-efficacy (Bandura, 1977) and cues to action (e.g., education, media, or symptoms of the illness).

The HBM has been used as a component in osteoporosis prevention research. Recently, one study that used the HBM as the basis of an intervention with peri-/post-menopausal women found that osteoporosis was believed to be a severe disease, but few felt susceptible to the condition (Hsieh et al, 2001). Manios et al (2007) used HBM in conjunction with the social cognitive theory in a nutrition education program for post-menopausal women which resulted in improvement in calcium and vitamin D.

The theory of reasoned action (TRA) addresses individual motivational factors as determinants of the likelihood of performing a specific behavior (Montano et al, 1997). Variables measured by TRA include: attitudes about the behavior, subjective norms' perceived attitudes about the behavior and the weight given to these attitudes, and intention to perform the behavior.

Research in our lab has used both HBM and TRA constructs in relation to bone-health behavior resulting in significant improvements in osteoporosis knowledge and calcium intake (Tussing and Chapman-Novakofski, 2005).

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CHAPTER 3

VALIDATION AND RELIABILITY OF A CALCIUM-FOCUSED ASSESSMENT TOOL

INTRODUCTION

Osteoporosis is a health problem of global proportions. In the US alone, an estimated 44 million Americans are affected. Ten million individuals are estimated to have the disease and approximately 34 million more are estimated to have low bone mass (NOF, 2006). Osteoporosis affects both men and women of all ages and ethnicities. In 2002 dollars, annual direct care expenditures for osteoporotic fractures reached almost 18 billion dollars (Carmona, 2004; Tosteson, 1999). Beyond costs, there is the physical burden of living with osteoporosis and its impact on daily living.

Calcium intake is an integral component of bone health. Common tools for assessing calcium intake are 24-hour recalls or food frequency questionnaires (FFQ) (Cameron, 1988). Each of these tools has advantages and limitations. Twenty-four recalls are limited by not estimating usual intake. Food frequencies are limited by the food items included on the survey (Cameron, 1988). A FFQ that specifically addresses calcium-rich sources, including calcium-fortified foods, will be helpful in dietary assessments of osteoporosis risk.

Foods are being fortified with calcium at an astounding rate and at varying levels. Consequently FFQ need to be updated with food lists including calcium-fortified items. Total calcium and calcium intake for specific food group food sources are needed to identify key calcium sources. The purpose of this study was to develop a calcium-focused food frequency survey, which was both valid and reliable.

METHODS

Development of the Calcium-Focused Food Frequency Questionnaire

The calcium-focused food frequency questionnaire (CFFFQ, Appendix 1) was a modification of an earlier food frequency checklist (Chapman et al, 1995). The earlier checklist asked seven questions regarding the frequency of consuming specific dairy foods and a question addressing the intake of any calcium-fortified foods and other calcium sources. For the CFFFQ, foods were listed by food group. Therefore all the foods from the original checklist were included in the Dairy food group. Each food group from the Food Guide Pyramid (USDA, 1992) was included and higher calcium foods specific to each food group were identified: Dairy (6 items), Fruits (6 items), Vegetables (3 items), Grains (10 items), Meats (8 items) and Others (8 items). A Foods with Dairy (5 items) group was added to account for combination foods. Foods were included if they contained a minimum of 50 mg of calcium per serving (Hands, 1990; Pennington, 1998) which is half the calcium amount required for a food to be labeled as a "good source of calcium" according to the Nutrition Labeling and Education Act (NLEA) (FDA, 2006). Calcium-fortified foods were added to the CFFFQ based upon identification of these foods during an osteoporosis prevention program (Tussing and Chapman-Novakofski, 2005) and monitoring of new foods introduced at local supermarkets. Calcium-fortified foods included juices, cereals, grain products, and non-juice beverages. The study protocol was approved by the University of Illinois Institutional Review Board.

Participants

Fifteen adult females were recruited for the pilot study to determine face and content validity of the CFFFQ. Participants were recruited by informal solicitation though workplace and leisure groups, providing written consent (Appendix 2). Each participant provided demographic information as well as feedback related to the format and clarity of the CFFFQ.

For the reliability study, college students in a community health summer school course were recruited. Students completed the CFFFQ and provided informed consent. A total of 16 students completed the CFFFQ twice, receiving a gift certificate as compensation for time. College students from a non-majors nutrition course were also selected for the primary validation study because they were accessible and also a key target research group for the authors. College-age students have just begun making independent food choices and are also in the final stages of maximizing bone mass. Since females are the predominant target group and to minimize gender differences, data from only the female students were analyzed. For course extra credit, students completed the CFFFQ and 24-hour recall (Appendix 3) along with informed consent forms (Appendix 4). Suggested CFFFQ format changes from the pilot study were incorporated into the questionnaire. A total of 414 students (female: 300, male: 114) volunteered and 408 satisfactorily completed the assignment.

Study Design

To validate the CFFFQ, a pilot and primary study was conducted. Each participant completed the CFFFQ. In addition to completing the CFFFQ, participants completed a self-administered 24-hour recall. Participants in the pilot study were given both verbal and written instructions in completing the 24-hour recall. The subjects in the primary study received written instructions only.

Comments from participants in the pilot study indicated no modifications to the survey were needed. However, completion errors suggested format changes. These included: opening column headings to minimize data entry in this location, expansion of fortified cereals list, separation of fortified cereals into rows based on similar calcium content, addition of soup made with milk to the foods within the dairy group and the addition of Slim Fast® products and chocolate to the Others food group.

In the pilot study, foods from the 24-hour recall were categorized into the same groups as used on the CFFFQ. For some foods (e.g., sandwich), the individual items were used, if possible. Once categorized into the appropriate CFFFQ groups, the foods were entered in Nutritionist V version 2.3 (First DataBank, San Bruno, CA, 2000). To evaluate reliability, a test and retest format was utilized with three intervening weeks. A total of 16 students completed both forms.

For the primary validation study, foods from the 24-hour recall were categorized into the same food groups (Dairy, Foods with Dairy, Fruit, Vegetables, Grains, Meat, and Others) as the CFFFQ. Foods and servings were entered into a database program (Microsoft Access, Redmond, Washington, 2003) that calculated calcium content on a daily basis as in the pilot study. Double entry was used for quality assurance. The primary study data set was analyzed for outliers and skewness. Those cases where the differences between CFFFQ and 24-hour recall total calcium intake were more than double were omitted (n=113) from the primary analysis but further investigated as "outlier data." This outlier dataset (n= 113) was analyzed to determine possible reasons for remaining large difference between CFFFQ and 24-hour recall. A random sample of the cases with outlying values of those remaining on campus (n=22, 10% of total on campus at the time) was contacted twice to further evaluate possible discrepancies in a follow-up interview. Upon completion of the interview, participants received a nutritional analysis and gift card (n=6).

Statistical Analyses

To determine the number of subjects required for the pilot study, a power analysis (medium effect size) was conducted based on total calcium intake data from a previous study (Tussing and Chapman-Novakofski, 2005). With a population mean difference of 644.0 $\pm$748.4 mg of calcium per day, $\alpha = 0.05$, two-tailed power of 87.2% would be achieved with 15 pairs (Sample Power 2, SPSS, Inc., 2000).

Paired t-tests and correlations were completed between the CFFFQ and 24-hour recall for pilot data (Statistical Package for Social Sciences (SPSS) version 14.0 Inc., 2005). Because of the large variation in mean calcium intake per food group, a larger sample size was determined to be needed for sufficient power in the analysis. Power analysis was conducted based on mean calcium for each food group and total calcium from the pilot study. With α 0.05, two-tailed power of 80% would be achieved with 70 pairs (Sample Power 2, SPSS, Inc., 2000).

The Kolmogorov-Smirnov test was used to determine normal distribution of the data. Correlations using Spearman's rho for data not normally distributed were computed for the total and for the group with the smaller difference between CFFFQ and the recall. To assess the influence of calcium-fortified foods on total calcium, the food groups of the CFFFQ containing all or primary fortified foods (Fruits, Grains) were excluded and paired t-tests were performed comparing CFFFQ derived calcium intake with all foods vs. CFFFQ derived calcium intake without fortified foods.

RESULTS

Pilot study and reliability

Overall, there was no significant difference in means between the CFFFQ and 24-hour recalls with the exception of the means of Foods with Dairy ($p=.043$) and Vegetable ($p=.005$) groups (Table 1). For the Vegetable group, the calcium mean was lower in the CFFFQ. Correlations between the two methods were significant for both Dairy and total calcium (Table 1).

Variability was large in all food groups except Dairy and resulted in a lack of correlation between the 24-hour recalls and CFFFQs (figure). Therefore, additional subjects were required to determine if significant differences existed between the two methods. These results led to the primary validation study as described.

In the reliability study, total calcium and all food groups calcium from initial CFFFQ vs. 3-week follow-up CFFFQ were significantly correlated ($p \leq .034$) except Dairy ($p=.371$) (Table 2). Additional analysis of the Dairy group revealed poor reliability for cheese products. Reliability was good for milk, yogurt and ice cream (Table 3).

Primary Validation Study

According to Kolmogorov-Smirnov test, data were found to be not normally distributed. In the primary validation study dataset ($n= 187$) (Table 4), significant correlations ($p<.04$) were found between calcium (mg) in CFFFQ and 24-hour recalls for Dairy, Foods with Dairy, Fruit, Vegetables, Grains groups and total calcium. Correlations were not significant for calcium found in the Meat or Others food groups. Items in the Others food group contained fats and sweet foods which were not consumed daily but more often on a weekly/monthly time frame.

The Fruit and Grain groups contained the majority of calcium-fortified foods. To determine the impact of calcium-fortified foods on total calcium intake, total calcium intake from all groups vs. total calcium intake excluding Fruit and Grain groups on the CFFFQ was compared. A significant difference was found between total calcium intake from all groups (1368.3 $\pm$ 697.9) vs. total calcium intake excluding Fruit and Grain groups (892.6 $\pm$ 487.3) on the CFFFQ ($t = 18.063$, $p \leq .001$).

Major discrepancies between the CFFFQ and 24-hour recalls were investigated in a review of outlier CFFFQ data with focused interviews and record review. Over-reporting often included CFFFQ's increased intake of milk (39% of cases), cheese (25%), and calcium-fortified juice (27%), cereals (13-22%), and bread (21%). Table 5 lists foods that were commonly over-reported on the CFFFQ compared to the 24-hour recall.

DISCUSSION

The most important finding of this study was that the CFFFQ is both valid and reliable in evaluating calcium intake for Total Calcium, Dairy, Foods with Dairy, Fruits, Vegetables and Grains groups. The CFFFQ also specifically addressed the mixed-food calcium sources versus assigning these combination foods to individual food groups.

To accurately assess calcium intake, several food frequency questionnaires focusing on calcium have been developed, but include limited, if any, fortified foods (Hertzler and Frary, 1994; Blalock et al, 2003; Ward et al, 2004; Jensen et al, 2004). Brief questionnaires have been used to quickly assess calcium intake but these also use natural sources of calcium and limit the number of food items (Blalock et al, 2003; Ward et al, 2004). Recently, Jensen, et al, (2004) validated a FFQ targeting youth, 10-18 years of age, which addressed ethnic-specific foods and fortified foods commonly consumed by youth. This tool used food groups including beverages, dairy products, combination foods, vegetables/grains/nuts, seafood and other foods. Three fortified food sources were included but limited to choices for adolescence or not specified as fortified (e.g. brand of cold cereal was in the open-question format). In contrast, this CFFFQ included 14 fortified food choices including 1 in the Fruit group, 8 in the Grains group and 5 in the Others group.

Similar to the present study, early calcium FFQ, Rapid Assessment Method (RAM) separated calcium sources into basic food groups, including milk-yogurt-cheese, fruits and vegetables, breads-cereals-rice-pasta, meat-fish-poultry-dry beans-nuts and fat-sugar-alcohol (Hertzler and Frary, 1994). Although validated against a 1-day food recall as in the present study, the Hertzler and Frary (1994) instrument did not include fortified foods, probably as so few were on the market at the time.

The RAM instrument was modified by Ward et al (2004) to focus on athletes and was validated against food records. This revised RAM included the calcium-fortified products of orange juice, bread and light bread. Similar to the current pilot study, there was no significant difference in means in the Dairy group and total calcium intake. In the modified RAM, calcium intake was overestimated in the fruits/vegetable group and sugars/fat group but underestimated in the meat/legume group. In the current pilot study, the CFFFQ overestimated calcium intake in Foods with Dairy, Fruits, and Grains groups while underestimated in the Vegetable, Meat and Others groups. The RAM was also shown to be moderately reliable which also compares to the current study, with the exception of cheese products.

In measuring calcium intake and supplement use in older women of different ethnic backgrounds living in rural communities, Bell's group assessed calcium intake using the Oregon Dairy Council Calcium Score Sheet (Bell et al, 2005). This tool grouped foods based on their calcium content but focused sole on naturally occurring calcium food sources. Using this tool today would underestimate total calcium intake.

In validating OsteoCalc (Smith et al, 1999), a computer-based food frequency, the Calcium Score Sheet and Health Habits and History Questionnaire (HHHQ) were used. Similar to the CFFFQ, HHHQ is organized according to food groups. This study used the same frequency ranges (daily, weekly, monthly, and yearly) as the current study. Higher calcium intakes were seen with the use of OsteoCalc or HHHQ as these tools measured not only foods consumed on a daily basis but also weekly and monthly basis. With the exception of calcium-fortified juice, none of the tools in this study addressed fortified foods.

Using the Continuing Survey of Food Intakes by Individuals (CSFII) database, Cook and Friday (2003) studied the effect of using different food group protocols (e.g., traditional, epidemiological, Pyramid, or commodities) to determine total calcium intake and where calcium sources would be placed when assessing calcium sources. Fortified foods were not included as not many calcium-fortified foods were available when the CSFII was completed between 1994 and 1996. Cook and Friday's study evaluated the same groupings as in the present CFFFQ although the CFFFQ included Foods with Dairy as well. In the CFFFQ, combination foods are listed in Foods with Dairy thereby minimizing the chance of calcium-rich foods being overlooked.

In summary, the tools that have been used in published trials have included either no calcium-fortified foods or limited to calcium-fortified juice (Ward et al, 2004; Smith et al, 1999), bread and light bread (Ward et al, 2004); or cereal, NutriGrain or NutriGrain Twist bars, oatmeal (Jensen et al, 2004). The current study indicated that omitting calcium-fortified foods can greatly underestimate total calcium intake.

The CFFFQ does result in higher intakes of calcium when compared to 24-hour recalls. Other studies have found similar tendencies but not to the same degree (Hertzler and Frary, 1994; Yanek et al, 2001). Possible explanation for the higher estimates from the CFFFQ include the CFFFQ prompting participants to remember foods that are fortified but not recording this on the recall. Subar and Bowering (1989) showed that consumers' knowledge of whether a food is fortified or not is influenced by promotion of the fortified nutrient and consumers reading the label. Therefore, study participants may not have noticed if a product was fortified with calcium. Even if consumed on a weekly basis, heavily fortified foods significantly impacted the average calcium intake.

In reviewing the outlier data for possible explanations for the much higher intake values with CFFFQ vs. the 24-hour recalls, foods that regularly appeared on the CFFFQ but not the 24-hour recalls included fortified foods, particularly fortified juice, cereals (Total brand and Special K Plus), and breads. The over-reporting of milk and cheese on the CFFFQ compared to the 24-hour recalls in the outlier data was surprising. This could be due to the recall not being a typical day in some cases. Daily consumption of milk may also be seen as socially acceptable. Cheese products may have been consumed with other foods versus being listed separately or portions may be inaccurately reported. This area of dietary assessment deserves further investigation.

LIMITATIONS

A limitation of this study is the fluidity of the calcium-fortified food market. One possible reason for the limited inclusion of calcium-fortified foods may be due to the rapidly changing foods that are being fortified with calcium. Since the CFFFQ was developed and evaluated, two fortified soft drinks and waffles were added to the market. Also, levels of fortification are not standardized or regulated. The standard fortification for orange juice was 300mg/serving. Recently, this was increased in certain products.

Based on the current findings, the CFFFQ can be used to evaluate calcium intake, both total and from specific food groups. However, calcium derived from the Meat or Other foods groups was not significantly correlated with 24-hour recalls, suggesting that the CFFFQ may not adequately represent calcium from these two groups specifically. However, the 24-hour recall only covers one day. Foods that are commonly eaten but not on a daily basis are missed by the 24-hour recall but can be identified in the CFFFQ.

CONCLUSIONS

Accurate assessment of calcium is critical in evaluating bone health risks. Calcium-fortified sources can go unreported in 24-hour recalls and diaries leading to an underestimation of calcium intake. When 24-recalls are used to assess and quantify calcium intake, dietetic and nutrition professionals need to clarify with clients regarding calcium fortification in foods that may be missed in the typical food record.

The CFFFQ may be used to better quantify calcium intake, including both natural and fortified sources. However, when using the CFFFQ, detailed instructions or interviews will strengthen the collection of data. The inconsistent reporting of dairy, cheese and some fortified foods reinforce the need to use more than one assessment tool when evaluating calcium intake. In future studies, using the CFFFQ will enable more data collection on the amount and type of calcium-fortified foods being consumed.

Table 3.1: Paired Samples of Food Frequency Questionnaire vs. 24-Hour Recall Calcium and Correlations of Pilot Study (n=15)

Pair	Mean + SD	T-test	P	R	P
CFFFQ[a] Dairy to 24-hour recall Dairy	669.7 + 718.32 663.2 + 931.98	0.049	.962	.835	<.001*
CFFFQ Foods with Dairy to 24-hour recall Foods with Dairy	382.7 + 270.53 197.4 + 333.41	2.227	.043*	.446	.095
CFFFQ Fruit to 24-hour recall Fruit	121.8 + 145.05 45.8 + 95.88	2.000	.065	.307	.266
CFFFQ Vegetable to 24-hour recall Vegetable	8.6 + 10.04 37.4 + 32.87	-3.306	.005*	0.071	.803
CFFFQ Grain to 24-hour recall Grain	194.7 + 143.19 143.5 + 101.57	1.088	.295	-0.081	.774
CFFFQ Meat to 24-hour recall Meat	11.4 + 22.74 69.2 + 104.92	-2.028	.062	-0.144	.609
CFFFQ Others to 24-hour recall Others	40.2 + 37.50 117.5 + 224.28	-1.324	.207	0.034	.904
CFFFQ total calcium to 24-hour recall total calcium	1429.1 + 826.93 1284.5 + 1053.78	.682	.507	0.642	.010*

CFFFQ [a] = Calcium-focused food frequency questionnaire
*significant at p <0.05

Figure 3.1. Sample of Variability of Data from Pilot Study Using the Grains Group

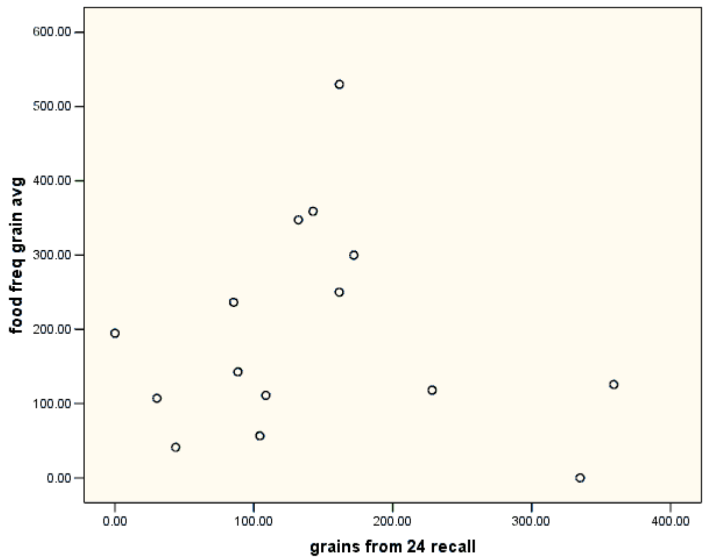

Table 3.2: Reliability of CFFFQ Using Test/retest after 3 Weeks (n=16)

Food Group	R	P value
Dairy	.240	.371
Foods with dairy	.620	.010*
Fruit	.555	.026*
Vegetables	.955	$\leq$.001*
Meats	.532	.014*
Grains	.599	.034*
Others	.638	.008*
Total calcium	.676	.004*

CFFFQ = Calcium-focused food frequency questionnaire
*significant at $p \leq 0.05$
R=correlation between time points

Table 3.3: Reliability within Dairy Group Using Test/retest after 3 Weeks Using CFFFQ (n=16)

Dairy food	R	P value
Milk	.818	$\leq$.001*
Yogurt	.825	$\leq$.001*
Cheese	.024	.930
Cheese food	.349	.185
Cottage cheese	.354	.179
Ice cream	.633	.009*

CFFFQ = Calcium-focused food frequency questionnaire
*significant at $p \leq 0.05$
R=correlation between time points

Table 3.4: Correlation (Spearman’s rho) between CFFFQ and 24-hour Recall (n=187)

Pair	R	P
CFFFQ Dairy to 24 hour-recall Dairy	0.738	≤.001*
CFFFQ Foods with Dairy to 24-hour recall Foods with Dairy	0.155	.035*
CFFFQ Fruit to 24-hour recall Fruit	.330	<.001*
CFFFQ Vegetable to 24-hour recall Vegetable	.287	<.001*
CFFFQ Grains to 24-hour recall Grain	.255	<.001*
CFFFQ Meat to 24-hour recall Meat	.117	.110
CFFFQ Others to 24-hour recall Others	0.011	.880
CFFFQ Total Calcium to 24-hour recall Total Calcium	.645	<.001*

CFFFQ = Calcium-focused food frequency questionnaire
*significant at $p \leq 0.05$
R=correlation between time points

Table 3.5: Foods Reported in CFFFQ on a Daily Basis vs. Listed on 24-hour Recall in Outlier Data (n=113)

Food	**Number of cases in CFFFQ**	**Percentage of misreporting**
Dairy		
Milk	44	38.9
Aged cheese	28	24.8
Cheese food	28	24.8
Fruit		
Calcium fortified orange juice	31	27.4
Vegetable		
Greens	12	10.6
Grains		
Total brand cereal	19	16.8
Other fortified cereals	15	13.3
Cereal	25	22.1
Fortified bread	24	21.2
Meats		
Legumes	11	9.7
Others		
Crystal Light	11	9.7

CFFFQ = Calcium-focused food frequency questionnaire

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CHAPTER 4

APPLICATION OF CALCIUM-FOCUSED FOOD FREQUENCY QUESTIONNAIRE

Assessing Calcium Intake with a Calcium-Focused Food Frequency Questionnaire (CFFFQ) and an Interview for 24-Hour Recall of Calcium Intake in Black and White Postmenopausal Women (accepted for publication for the journal *Preventing Chronic Disease: Public Health Research, Practice, and Policy* (*PCD*), released October 2009).

INTRODUCTION

As the prevalence of osteoporosis continues to increase, interventions targeting modifiable risk factors receive more emphasis from researchers, clinicians, and public health professionals. Although numerous nutrients are important to bone health, many interventions focus on calcium intake (Nordin, 1997; Carmona, 2004). A common strategy is to prescribe a calcium supplement and pay limited attention to dietary sources of calcium intake (Prince et al, 2006; Reid et al, 2006). Other interventions may target only dairy calcium (Daly et al, 2006; Sebring et al, 2007). However, calcium fortification of foods broadens the possible sources of calcium so that adequate calcium intake may be achieved through a diverse diet.

Sources of dietary calcium intake may differ across cultures and ethnicities according to food preferences and tolerances. For example, blacks and Asians may have a higher prevalence of lactose intolerance leading to a reduced dairy intake but also have cultural food preferences, including not drinking milk at meals, that impact calcium intake (Jarvis and Miller, 2002). White women have been found to consume more cheese and milk than do black or American Indian women (Bell et al, 2002). However, research specifically targeting calcium intake and food source is scarce. Previous research from our group investigating the role of socioeconomic status on calcium intake determined that black women consumed fortified grain products more frequently than did white women (Mojtahedi et al, 2006). Because fortified foods are available, the calcium content of calcium-fortified foods may not be adequately captured in traditional assessments of dietary intake, such as dietary records analyzed with commercially available software.

OBJECTIVES

The primary aim of this study was to develop and evaluate the feasibility of a calcium-focused food frequency questionnaire (CFFFQ, Appendix 1) that incorporates both natural and fortified sources of calcium. Because determining calcium intake has become more difficult with increases in food fortification, this study compared 2 methods: an interview for 24-hour recall of calcium intake and the CFFFQ. Although supplements can be an important source of calcium, this project focused on food-derived calcium. A secondary aim was to compare food source of calcium between black and white women aged 60 years or older and evaluate the adequacy of calcium intake as assessed using the 24-hour recall and the CFFFQ. Postmenopausal women were studied because they are at high risk for osteoporotic-related fractures (Nordin, 1997; Poole and Compston, 2006).

METHODS

Subjects

A convenience sample of postmenopausal women aged from 60 to 80 years was recruited from those enrolled in a parent study (McAuley et al, 2007) assessing body composition, bone health, physical activity, physical function, and self-efficacy to complete additional nutritional assessments. Exclusion criteria for the parent study included neurological illness, orthopedic limitations, or cognitive limitations that precluded completion of all study testing procedures. All those in the parent study were invited to participate in the current study of evaluation of calcium intake. The Human Subjects Institutional Review Board of the University of Illinois approved the research protocol, and all participants completed an informed consent form before data collection began.

Calcium intake

The CFFFQ and a self-reported 24-hour recall were completed on the same day to assess calcium intake and food source. The CFFFQ is a 46-item food frequency survey focusing on calcium-rich foods. Foods on the questionnaire were chosen based on calcium content and those found in previous studies to be commonly consumed. Foods on the CFFFQ were categorized and presented according to representative food groups: dairy (6 foods), foods with dairy (5 foods), fruits (6 foods), vegetables (3 foods), grains (10 foods), meats (8 foods), and other foods (8 foods). The CFFFQ is in the Appendix. Inclusion of fortified foods was based on availability of purchase and those reported in previous studies of calcium intake to have been consumed. Fortified foods were noted as such on the CFFFQ. A standard portion size was included for each specific food item. Participants entered quantity of food relative to daily, weekly, monthly, or yearly consumption. "Not eaten" was given as an option. We entered foods and servings into a database program (Microsoft Access 2003, Redmond, Washington) that calculated calcium content (mg) on a daily basis. Double entry was used for quality assurance.

Participants met with researchers to complete the 24-hour recall. The researchers used a multiple-pass interview style to elicit complete information (Dwyer et al, 2003).

Foods from the 24-hour recall were categorized into the same food groups as on the CFFFQ. Once categorized into the appropriate CFFFQ groups, the foods were entered in Nutritionist Pro version 2.3 (First DataBank, San Bruno, California) to obtain calcium values (mg/day).

Statistical analysis

The data were analyzed using SPSS (SPSS version 14.0, SPSS, Inc., Chicago, Illinois). On the basis of the findings of the Kolmogorov-Smirnov test, the primary variables of interest were not normally distributed. Nonparametric tests were subsequently used to evaluate group or intake assessment differences (Spearman rank correlation and Mann-Whitney). The adequacy of calcium intake was assessed by using each of the two assessment methods and comparing the findings to two-thirds of the adequate intake amount for women aged 51 years or older as determined by the Institute of Medicine (IOM, 1997). Comparison of the adequacy classification as a measure of specificity of each calcium intake method was completed using cross-tabulation to demonstrate the relationship between the 2 variables. Chi-square analysis was performed on the cross-tabulated variables. Significance was determined at an alpha level of .05.

RESULTS

Of 245 eligible women from the parent study, 185 chose to participate in our study. Of the 185, 46 were black (mean ±standard deviation age, 68.0 ± 4.85 years) and 139 were white (70.0 ± 6.0 years).

Comparison of CFFFQ to 24-recall

Calcium from CFFFQ compared with 24-hour recall was significantly correlated for all food groups ($P < .001$) except for vegetables ($P = .08$) (Table 1). Although we found significant positive correlations between the 2 methods for assessing calcium intake, the 24-hour recall method was significantly lower than CFFFQ estimates of total daily calcium, dairy, foods with dairy, fruits, and vegetables (Table 2). There was no significant difference between the CFFFQ and 24-hour recall methods for calculated calcium intake for grains, meats, and other foods. This pattern was consistent for the total group and for black and white women separately (Table 2). The Bland-Altman plot illustrates the lack of agreement between methods of assessment for total daily intake (Figure). The positive correlation between the lack of agreement (error score on the Y axis) and the daily intake indicates that as daily calcium intake increases, the 24-hour recall of calcium intake increasingly underestimated calcium intake compared with the CFFFQ ($r = 0.41$, $P < .001$).

Calcium adequacy assessment

The prevalence of inadequate intake (<800 mg) was 56% (n = 103) using the 24-hour recall and 45% (n = 83) using the CFFFQ method. Examining the cases where intake would be inadequate as measured by both tools, 64 (35%) women would be classified as having inadequate calcium intake. However, 39 (21%) women who would be classified as adequate by the CFFFQ would be classified as inadequate by the 24-hour recall method. Only 19 (10%) would be classified as inadequate by the CFFFQ who would be adequate as classified by the 24-hour recall. Compared with the self-reported 24-hour recall, the CFFFQ indicates a greater specificity for lower intakes.

Mean calcium intake and calcium source between black and white women

Regardless of dietary assessment method used, white women had higher calcium intakes than black women. When using the CFFFQ, white women reported consuming approximately 43% more calcium than did black women (mean ± SD of 1104 ± 632 mg for white women vs. 768 ± 531 mg for black women; $P < .001$). When using the 24-hour recall method, mean calcium intake for white women was approximately 53% greater than intake for black women (875 ± 429 mg compared with 573 ± 365 mg; $P < .001$).

From the CFFFQ, the primary calcium source was dairy products (55% for black women and 57% for white women). White women obtained more calcium (630 ± 423 mg) from dairy than did black women (424 ± 373 mg, $P < .004$). Grains were the second highest calcium source, although grains provided a much lower percentage than dairy (13% of total calcium for each racial group). Calcium from grains primarily came from fortified foods. Dairy was also the primary calcium source when the 24-hour recall data were analyzed, and a significant difference in mean dairy calcium intake between racial groups was found (243 $\pm$ 273 mg for black women, 444 $\pm$ 360 mg for white women, $P < .001$).

DISCUSSION

Calcium intake has received increased attention in the last decade because of its role in bone health and as a modifiable risk factor for osteoporosis. The number of calcium-fortified food products being developed and marketed has increased substantially (Heaney et al, 2005). Although labeling for “excellent” (>200 mg/serving) and “good” (100-200 mg/serving) sources of calcium are regulated by the Food and Drug Administration (FDA), there is no federal regulation regarding which foods can be fortified with calcium or the degree of fortification (FDA, 2007). Together, these factors make discerning calcium intake difficult for researchers, clinicians, dietitians, and consumers. The primary findings of this study are that the CFFFQ identifies low calcium intakes and identifies key sources of calcium, including calcium-fortified foods.

Other studies have included either no calcium-fortified foods (Magkos et al, 2006; Cook et al, 2003; Yanek et al, 2001; Jensen et al, 2004; Blalock et al, 1998), calcium-fortified mineral water (Montomoli et al, 2002), calcium-fortified juice alone (Harnack et al, 2006), calcium-fortified juice and a grain product (Ward et al, 2004), or did not provide details regarding the inclusion of calcium-fortified foods in the assessment tool (Sebring et al, 2007; Bell et al, 2002; Blalock et al, 2003; Musgrave et al, 1989; Chee et al, 2002; Taitano et al, 1995; Xu et al, 2000). In contrast, this CFFFQ includes 14 fortified food choices including 1 in fruits, 8 in grains, and 5 in other foods. Fortification of foods can contribute greatly to total calcium intake. From our data, inclusion of calcium-fortified breads, cereals, juices, and miscellaneous foods, such as margarine and powdered beverages, has the potential to increase total daily calcium intake by 1,000 mg or more. Because calcium fortification of food products is not federally regulated, food items being fortified and levels of fortification vary at the discretion of the manufacturer. The lack of regulation may hinder the role that these foods can play in dietary calcium intake by affecting the consistency of the calcium content of the product.

The second unique feature of this study is the categorization of calcium intake estimates into food groups. Although total calcium intake is the primary focus in nutritional assessment studies, nutrition education and osteoporosis interventions can enhance their effectiveness by focusing on calcium intake from the food groups the participants usually get their calcium. This information can be used to design more realistic and targeted nutrition education messages. In our study, the largest percentage of total calcium for both white and black women came from dairy, followed by grains and fruits. Although grains contained several fortified food items, fruits contained only 1 fortified food item.

Even with fortified foods, dairy was still the primary calcium source in this study. Cook et al (2003) reported analyses of food intake from the US Department of Agriculture's 1994-1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII), finding that dairy contributed 42% of total calcium intake. A higher percentage of dairy contribution would have been expected from that study, because it included no competing calcium-fortified foods. In addition, the CSFII reported 21% of total calcium from calcium-rich mixed foods (including two or more items). In our study, this category contributed only 4% to 5%. Ward et al (2004) also reported that most calcium intake was derived from dairy, but a comparable calcium-rich mixed foods group is not identified.The food frequency assessment tool used by Ward et al (2004) also ranked the fruits and vegetable group and grains as contributing 11% to 15% of total calcium, whereas the diet records used in the study estimated this contribution at 6% to 13%. Cook et al (2003) included no calcium-fortified foods and the Ward et al (2004) study was limited to calcium-fortified juice and two grain products.

There is a scarcity of information in the literature regarding calcium intake for black and white women. In our study, mean total calcium intake among black women did not meet the adequate intake value whereas it did among white women. Other studies conclude that calcium intake is greater in white women than black women (Pereira et al, 2002; Lee et al, 2004). However, an article published from the parent study of our study using the same CFFFQ found no difference in total, daily, dietary, or supplemental calcium (Mojtahedi et al, 2006). In that analysis, black and white women were matched on age, socioeconomic status (SES), and education level (n = 33/group). The findings suggested that racial differences in calcium intake are somewhat impacted by SES and education level. Similarly, a comparison between black, white, and American Indian women also reported no significant difference in dietary calcium intake between black and white women (Bell et al, 2002).

In our study, grains were the second highest calcium source, for both black and white women. Grains are predominately calcium-fortified sources. This is consistent with findings from our previous work, which determined that dairy was the greatest source of calcium but more for white women, whereas black women consumed greater amounts of calcium-fortified grains (Mojtahedi et al, 2006). The prominent role of calcium-fortified foods in these studies reinforces the need for these sources to be carefully evaluated when measuring calcium intake.

LIMITATIONS

The values from the CFFFQ were typically higher than the 24-hour recall, with the exception of vegetables and other foods. This may be due in part to the limitations of using a 24-hour recall. Women may have identified foods in the CFFFQ but did not happen to consume those foods on the specific day of the recall, except for vegetables. However, Chee et al (2002) found a similar trend in comparing a calcium-rich food frequency questionnaire to a 3-day diary for postmenopausal Malaysian women.

Assessing dietary intake by any method has inherent limitations. Validating food frequency questionnaires can be complicated without biomarkers for comparison. Because most nutrients do not yet have reliable biomarkers, 24-hour recalls or food records are the usual standard instruments. Correlations between these methods are considered adequate within the range of 0.4-0.7 (Subar, 2004). Although most of the correlations between total calcium and calcium from food groups when comparing CFFFQ to 24-hour recalls are significant, only total calcium intake, dairy calcium intake, and fruits fall within this acceptable statistical range.

Differences in reported calcium intake when comparing the CFFFQ and 24-hour recall could be attributed to a lack of consumer awareness of calcium fortification when responding to the 24-hour recall and a positive respondent bias on the CFFFQ. For example, participants could have responded more positively concerning calcium-fortified foods if consumption of that food was seen as a positive health behavior. Because calcium-fortified foods can essentially double calcium intake, consumer awareness of their own calcium-fortified food product consumption and interviewer probe for each of these food items is essential for an accurate estimate of calcium intake. To assist both the researcher and clinician, software for dietary assessment needs to be updated to include the calcium-fortified foods.

Several food frequency questionnaires assessing calcium intake have shown strong correlation with total calcium of the compared food record (Montomoli et al, 2002; Blalock et al, 2003; Musgrave et al, 1989; Chee et al, 2002; Taitano et al, 1995; Green et al, 2002; Pasco et al, 2000). However, many studies report correlations but no difference between means or report findings regarding only total calcium intake and not calcium intake by individual food groups. In addition, many rapid assessment tools include either no or very limited sources of calcium-fortified foods, and these foods may or may not be probed for on 24-hour recalls.

CONCLUSIONS

Our results suggest that the CFFFQ could be used to determine inadequate intakes of calcium. Primary calcium sources for all women were dairy and grains, respectively and the calcium intake is higher in white women compared to black women. The CFFFQ can be used to more accurately identify calcium intakes and usual calcium source, which is of interest because of the rapid increase in availability of calcium-fortified foods. Calcium-fortified sources can go unreported in 24-hour recalls and diaries, leading to an underestimation of calcium intake. When 24-hour recalls are used to assess and quantify calcium intake, researchers and clinicians need to clarify with clients regarding calcium fortification in foods that may be missed in the typical food record. The CFFFQ may be used to better quantify calcium intake, including both natural and fortified sources. Accurate assessment of calcium is critical in evaluating bone health risks. This information can aid in the development of effective interventions to increase calcium intake.

Table 4.1. Correlation of Calcium-Focused Food Frequency Questionnaire to Interview for 24-Hour Recall of Calcium Intake for Black and White Women

	All Women (n=185)		**Black Women (n = 46)**		**White Women (n = 139)**	
Food Group	**r[a]**	***P* value**	**r[a]**	***P* value**	**r[a]**	***P* value**
Dairy	0.56	<.001	0.42	.004	0.56	<.001
Foods with dairy	0.18	.015	0.03	.83	0.20	.02
Fruits	0.43	<.001	0.32	.03	0.48	<.001
Vegetables	0.13	.078	0.10	.52	0.14	.09
Grains	0.25	.001	0.25	.10	0.27	.002
Meats	0.18	.013	0.05	.76	0.22	.008
Other foods	0.27	<.001	0.04	.77	0.28	.001
Total calcium	**0.53**	**<.001**	**0.29**	**.05**	**0.53**	**<.001**

[a] Spearman rank correlation.

Table 4.2. Mean Difference Between Calcium-Focused Food Frequency Questionnaire (CFFFQ) and Interview for 24-Hour Recall of Calcium Intake for All Women (n = 185), Black Women (n = 46), and White Women (n = 139)

Food Group	**CFFFQ Mean (Interquartile Range), mg**	**24-Hour Recall Mean (Interquartile Range), mg**	***P* value**[a]
Dairy			
All women	579 (257-812)	394 (108-580)	<.001
Black women	424 (184-519)	243 (7-365)	<.001
White women	630 (310-891)	444 (153-659)	<.001
Foods with dairy products			
All women	40 (16-55)	40 (0-0)	<.001
Black women	33 (5-44)	29 (0-0)	.001
White women	43 (20-60)	43 (0-0)	<.001
Fruits			
All women	99 (8-159)	57 (6-58)	.002
Black women	99 (3-165)	44 (4-44)	.03
White women	99 (8-156)	62 (7-62)	.03
Vegetables			
All women	24 (6-30)	64 (19-95)	<.001
Black women	24 (5-30)	47 (6-58)	.01
White women	24 (6-30)	71 (24-100)	<.001
Grains			
All women	132 (17-153)	103 (35-119)	.73
Black women	103 (18-125)	85 (26-116)	.99
White women	142 (16-167)	109 (37-122)	.72
Meats			
All women	93 (14-121)	82 (29-100)	.98
Black women	63 (5-74)	83 (24-109)	.11
White women	103 (18-127)	82 (31-100)	.39
Other foods			
All women	54 (7-75)	59 (10-65)	.41
Black women	23 (3-27)	44 (5-38)	.29
White women	64 (11-77)	64 (13-71)	.75
Total calcium			
All women	1021 (542-1323)	800 (460-1057)	<.001
Black women	768 (381-956)	573 (311-695)	.04
White women	1104 (592-1449)	875 (551-1112)	<.001

[a] Mann-Whitney.

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CHAPTER 5

BONE HEALTH INTERVENTION PROGRAM

INTRODUCTION

Osteoporosis is a systemic skeletal disease portrayed by low bone mass and structural weakening of the bone material that leads to reduced bone strength and increase susceptibility to fracture. It is estimated that 10 million individuals have osteoporosis while another 34 million suffer from low bone density (LBD). An estimated 61 million individuals will have osteoporosis or LBD by 2020 (NOF, 2007). Approximately 1 in 2 women and 1 in 4 men age 50 or older in the United States will experience an osteoporotic-related fracture sometime during the remainder of their lives. In 2002 dollars, annual direct care expenditures for osteoporotic fractures reached almost 18 billion dollars (Carmona, 2004; Tosteson, 1999). Beyond costs, there is the physical burden of living with osteoporosis and its impact on daily living. Osteoporosis is a debilitating chronic disease that is a public health problem.

Key lifestyle habits can be utilized to strengthen bone health and reduce fracture risk. The National Osteoporosis Foundation (NOF, 2007) developed five steps to optimize bone health. These include:

1. Get the daily recommended amounts of calcium and vitamin D.
2. Engage in regular weight-bearing and muscle-strengthening exercise.
3. Avoid smoking and excessive alcohol.
4. Talk to your healthcare provider about bone health.
5. Have a bone density test and take medication when appropriate.

While adopting new lifestyles geared toward bone health has been shown to be beneficial, there are many influences that can determine if knowledge will translate into behavior change. Knowledge of the disease and its risk factors play a role in altering behavior. For instance, when 203 healthy post-menopausal women were given their DXA results, there were increases in calcium intake, especially if the woman's DXA result were scored at the osteopenia or osteoporosis ranges, but not in exercise (Estok et al, 2007). One study evaluated osteoporosis knowledge as well as calcium intake and weight-bearing physical activity in three different age groups of women (Terrio and Auld, 2002). These researchers found that knowledge about osteoporosis was limited while average calcium intake met recommendations and weight-bearing activity was included most days. These findings were in part due to fortified juice or supplements in terms of calcium, and housework, standing or walking in terms of weight-bearing activity. Johnson et al (2008) used the Osteoporosis Health Belief Scale (OHBS), focusing on health belief model and self-efficacy constructs, to assess beliefs of different age groups for both men and women. Women more susceptible vs. men. Similar results were shown with older adults scoring higher on susceptibility (Johnson et al, 2008).

As with the OHBS, theoretical framework models are used to measure aspects or constructs which impact or influence behavior change. There are several different models. The Health Belief Model (HBM) has been used as a component in osteoporosis prevention research. One study that used the HBM as the basis of the intervention with peri-/post-menopausal women found that osteoporosis was believed to be a severe disease, but few felt susceptible to the condition (Hsieh et al. 2001). Manios et al (2007) used HBM in conjunction with the social cognitive theory in a nutrition education program for post-menopausal women which resulted in improvement in calcium and vitamin D intakes.

However, there is paucity of theoretically-based, behaviorally-focused programs addressing osteoporosis. A primary prevention program targeting knowledge, calcium and exercise showed that women who participated in the three-hour program increased their knowledge of osteoporosis and were more likely planning to improve their calcium intake. In a follow-up phone call, the participants indicated that they were making calcium changes (Brecher et al, 2002). However, many interventions focus on medication efficacy rather than lifestyle change. As the prevalence of osteoporosis continues to increase, interventions targeting modifiable risk factors should receive more emphasis from researchers, clinicians and public health professionals.

This research project was a randomized educational intervention targeting bone health behaviors for adults within the context of a community education program.

OBJECTIVES

3. To determine how well the clinical control trial translates into the "real world" of community and public health education in terms of bone health. Specific outcomes to be measured include assessment of program process evaluation and end of program evaluation concerning desirability of program, value of the program to participants in terms of future cost recovery and as a model for public health professionals.
4. To determine the effectiveness of a theory-based lifestyle intervention to enhance physical activity and nutritional behaviors in community-dwelling older adults over an 8-week period.

METHODS

Program Design: The bone health program was originally developed and tested for use in community-based settings. The program is based on two behavioral change theories: the Health Belief Model (HBM) (Janz and Becker, 1984) and the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975; Montano et al, 1987). TRA addresses individual motivational factors as determinants of the likelihood of performing a specific behavior (Montano et al, 1997). Variables measured by TRA include: attitudes about the behavior, subjective norms' perceived attitudes about the behavior and the weight given to these attitudes, and intention to perform the behavior. Previous work in our lab has shown that both HBM and TRA constructs are useful instruments in measuring bone health-related behavior (Chapman et al, 1995; Tussing and Chapman-Novakofski, 2005).

Timeline of study and data collection:

	1st 8 weeks			**2nd 8 weeks**		
	Baseline measures	**Program**	**Post-program measures**	**Baseline measures**	**Program**	**Post-program measures**
Control	x		x	x	x	x
Treatment	x	x	x			x

The program originally included a review of osteoporosis susceptibility and severity; the role of diet and physical activity in bone health; overcoming barriers to increasing calcium intake; overcoming barriers to increasing physical activity; beliefs and facts about medications, hormone replacement therapies; and self-efficacy enhancing activities for label reading, menu development, grocery shopping, and goal setting (Tussing and Chapman-Novakofski, 2005). For this project, the lessons were updated with new recommendations. Additional material included the role of protein and sodium in bone health; calories for optimal weight and role of optimal weight in bone health; a focus on aerobic and resistance exercises, as well as flexibility, balance and posture. The program was eight weeks long (syllabus, Appendix 1). Each class lasted approximately one hour/week. The educational program included lecture and hands-on active learning for each session. Activities were targeted to address key knowledge, nutritional behavior, physical activity recommendations and/or attitude/self-efficacy aspects. Supplemental handouts were provided with each session. These were used to reinforce the main points of the respective lesson. At the end of the program, participants had a binder of materials as a resource for bone-health.

All PowerPoint presentations, handouts, and activities were developed prior to the intervention, reviewed for content validity by a panel of experts in osteoporosis and bone health (professor in nutrition, professor of exercise physiology, clinician). State-of-the-art classrooms at the newly built Osher Lifelong Learning Institute (OLLI) were used. OLLI is located in the research park area of the University of Illinois. It was used in part to its facilities but also the location, including free parking, to encourage participation. This research protocol was approved by the university's Institutional Review Board.

Background Information:

A Demographic/Health and Personal History (Appendix 2) form was used. This 16-item form was used previously in the lab. Information on bone health history and supplement use was available from this survey. Heel ultrasound was used as a screening tool and to collect data on T-scores and BMD scores at the initiation (week one session) of the program. The heel ultrasound was performed using the Hologic-Sahara heel ultrasound unit (Hologic Inc. 2007). Information from the ultrasound was immediately shared with participants.

Knowledge/Attitudes:

A survey (Appendix 3), entitled "*Attitudes and Thoughts About Osteoporosis, Calcium, Vitamin D and Exercise"* was completed pre and post-intervention. The survey incorporated both Health Belief Model (HBM) and Theory of Reasoned Action (TRA) constructs. HBM areas measured included: susceptibility, severity, barriers to change, and benefits to change, along with self-efficacy. Theory of Reasoned Action (TRA) constructs to be measured included: subjective norm, intention, attitude related to calcium vitamin D and exercise. The original survey was based on the Osteoporosis Health Belief Scale (OHBS) (Kim et al, 1991) that used HBM and then was modified in our lab (Chapman et al, 1995). The TRA constructs were added (Tussing thesis, 2002). For the current study, vitamin D questions were added to the survey to better reflect current research in nutrient needs for bone health. These questions paralleled the calcium-related questions. The 62-item survey asked the participant to rate their responses questions using a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). An option rating of 6 was given if the statement did not apply.

Dietary Intake:

The Calcium-Focused Food Frequency Questionnaire (CFFFQ) was used (Plawecki, 2009). In addition to the CFFFQ, 24-hour recalls were used to measure overall intake, including calcium and vitamin D. Repeated 24-hour recalls were completed following the United States Department of Agriculture (USDA) multi-pass system of diet recall (Dwyer et al, 2003). Participants were allowed to recall all foods eaten, probed to recall foods forgotten and portions and offered food models for comparison, and receive the "final probe" of any missing information. Diet records were collected at orientation, week 4 (immediately following the nutrition-based sessions) and week 8 (final week). Those in the control group completed diet records during week 1 to account for any possible intake changes due to increased awareness from orientation and/or while waiting to start the course. Those in the intervention group completed diet records eight weeks post-completion of the course. Data were analyzed using commercial software (Nutritionist V, 2000) for macro- and micronutrients. The Nutritionist V program was updated as specific calcium or vitamin D-fortified food items were reported on the recalls. The CFFFQ was analyzed using an ACCESS program (Microsoft Office 2007) specifically developed for this questionnaire during a previous research project. For those participants drinking soymilk as a milk alternative, soymilk was recorded with dairy foods for both the 24 recalls and CFFFQ.

Activity:

The different activity outcomes were self-reported via an activity log (Appendix 4). Steps via pedometers and heel drops measured ground force activity. Resistance bands were used in part to improve balance as well as provide a joint-force activity. Pedometers were distributed the third week of the course. A baseline measure was recorded for that week. Proper wear and use of the pedometer was demonstrated to increase self-efficacy. Step-taking was recorded for 7 days at baseline, mid-program (after each exercise session) and final week of the program. Instruction was given on performing heel drops. These were practiced in class. Participants with self-reported osteoporosis were instructed not to do heel drops. For those who opted not to do heel drops due to being uncomfortable or due to physician order were told to opt out of the heel drops but to record the reason. Heel drop records were returned mid-program and at the final week. Balance activity was recorded at week six (immediately following the related topic) and at week eight. Those in the treatment group completed the activity log at eight weeks post-program.

Subject Recruitment:

Participants, men and women over age 50, were recruited through a variety of campus and community routes, including: a campus email announcement, posters in community locations, the Osher Lifelong Learning Institute (OLLI) course offering promotions and the Lifetime Fitness Program (LFP). OLLI promotes community outreach to people over 50 and LFP is a service program for older adults through the Department of Kinesiology. The recruitment was limited to the local area. Randomization was to either treatment or control group, blocked on gender and availability. Couples were assigned the same section. The program was targeted to men and women over 50, no other exclusion criteria were in place. The control group received the class but *after* the treatment group completed the program (delayed treatment). Participants in the first group were instructed not to share information with the control group. The number of participants needed was based on a power analysis using variance of calcium intake as the principal variable and the one with greatest variance. Alpha = 0.05, power = 0.87 indicated 15 people would be needed per group (medium effect size), for a total of 60 [treatment, control, men, women]. Considering a 30% attrition rate as seen in other similar studies, each group was increased by 1/3 for an n=20 per group, total of 80. An informational meeting was used to describe the program, answer questions, complete informed consent and relevant paperwork (health surveys, diet records, attitude surveys) before the program started.

Post-intervention:

Dual Energy X-ray Absorptiometry (DXA) bone scans were completed by the Kinesiology Bone lab under the direction of Dr. Evans. The DXA served as compensation to participants and as cross-sectional bone density data of this population.

Statistical methods:

Normalcy of data was assessed via P-P plots and Kolmogorov-Smirnov test. Nonparametric tests were used for data not normally distributed. Week one means for each time period were tested to determine if treatment groups could be combined. Possible nutritional changes (calcium, vitamin D) were compared between control (eight weeks of no treatment) vs. eight weeks of intervention (delayed treatment). The General Linear Model procedure provided repeated measures analysis, regression analysis and analysis of variance for each dependent variable (calcium intake, vitamin D, weight bearing and balance exercises) by grouping factor (treatment) (SPSS, version 17). Related two-sample non-parametric tests were used to measure behavioral constructs changes at pre/post-intervention. The internal consistency of the attitude/knowledge scores was assessed using Cronbach alpha coefficients. This was done on pre-intervention surveys. Coefficients between .70 - .80 were considered acceptable (DeVillis, 1991). Stepwise regression analysis for the TRA constructs pertaining to calcium and exercise intention (regarding specific calcium and exercise statements) was the dependent variable and the attitude and subjective norm constructs were the independent variables. The assumption was that this was a random sample from a normal population with all cell variances the same, but the analysis of variance is robust to departures from normality. To assure that the dependent variable data were symmetric, homogeneity of variances test was used (Levene's).

In addition, total calcium for both food records (24-hour recall and CFFFQ), dairy, fruit and grain groups were measured due to dairy's prevalence and the fruit and grains group using fortified sources contributing a fair percentage to total. The fruit group included the one fortified food that is also fortified with vitamin D.

Measurement and evaluation of the program itself was assessed by analyzing the descriptive values for each and comparing how each topic, activity and tool was ranked.

RESULTS

Following Kolmogorov-Smirnov analysis demonstrated that data were primarily not normally distributed. Power analysis indicated a sample of 60 was needed to determine significance at .05 level.

Demographics:

Participants (n=69) were randomized into treatment (n=35) or control (n=34). Reasons for those not finishing the program are listed in Table 1. There was no difference in demographics (Table 2), except for gender (p=0.01). Mean age was 65.5 $\pm$ 9.6 years; mean BMD was 0.52 $\pm$0.1 g/cm2. Most were female (83%), white (90%), retired (53%), with some college education (77%), non-smoking (99%), and took supplements (90%). Of those who took supplements (Table 3), most chose a product with calcium (89%). Although most had no history of osteoporosis (67%), almost all previously had a bone scan (81%). Heel ultrasound results included 26% with T-scores < -1 and 6% > 1.

Nutrition:

Those in the control group who received the delayed treatment showed no significant difference in calcium and vitamin D intake, except for calcium from food in the “others” group in the 24-hour recall (p< 0.036) (Table 4) and based on the CFFFQ, significant decreases during the control period in foods with dairy (p <0.019) and grains (p<0.007) (Table 5). Comparison of mean calcium intake for separate treatment groups for week 1 for both diet records (24-hour recall and CFFFQ) (Tables 6 and 7) showed no significant differences, except for the vegetable group (p <0.044) and others group (p<0.022) in the 24-hour recall. There was also no significant difference between females and males for both 24-hour recall and CFFFQ (Tables 8 and 9). Treatments were combined into one group for dairy, fruit, grains, total calcium and vitamin D as stated in methods section. At baseline between control group and combined treatment group (Tables 10 and 11) no significant difference was found, except for grains in the CFFFQ (control mean: 285.7 + 274.9mg vs. combined treatment mean 254.5 + 373.2mg, $p<0.007$).

Nutrition: Calcium Intake

Repeated measures analysis (Table 12) indicated a positive increase in calcium from baseline with a significant increase for fruit and total calcium ($p<0.005$) from the 24-hour recall. Mean calcium intake in the 24-hour recalls exceeded the adequate intake (AI) of 1200 mg/day for those over 51 years. Those meeting or exceeding the AI of calcium were: 26% at week one, 44% at week four, 35% at week eight and 25% eight weeks after the program ($p<0.142$) (Figure 1). Average intake immediately following the nutrition sections (week 4) was 1158.7 mg and at the end of the program was 1080.3 mg. Following eight weeks after completing the program (Table 13), the only significant change was an increase in calcium intake from grains (69.6 ± 54.7mg to 168.7 ± 338.7mg, $p<0.042$).

According to the CFFFQ, the general increase in calcium is also shown (Table 14). There were no significant changes in the CFFFQ after eight weeks of program completion (Table 15). Mean calcium intake exceeded the AI from the start of the program. Unlike data derived from 24-hour recalls, the percent of those that met or exceeded the AI steadily increased from week 1 (47%) to week 4 (54%) to week 8 (56%), and at eight weeks post-program 39% exceeded the AI ($p<0.634$) (Figure 2).

Nutrition: Vitamin D Intake

Vitamin D significantly increased ($p<0.015$) at each time point during the intervention (Table 12) and following the program (Table 13). Week one was 108.4±130.7 IU. Week four, immediately following the nutrition-focused sessions, was 150.7±123.5 with a final intake was 190.2±246.5. No significant difference in the eight weeks following the intervention.

Activity

No significant differences were noted in steps, heel drops or balance activities (Tables 16 and 17). Several participants reported not being able to do heel drops. Reasons for not doing heel drops included: osteoporosis, physician order, osteoarthritis in knees, back pain and back problems.

Knowledge/Attitude/Belief Constructs: Disease, Diet, Activity

Reliability of the different constructs is found in table 18. Susceptibility to osteoporosis, benefits of diet, barriers of diet, self-efficacy of diet and benefits of exercise were shown to be moderately reliable. There were significant increases in susceptibility, benefits of diet changes, self-efficacy of making diet changes and benefits of exercises.

Comparison of construct changes is shown in Tables 19 (merged constructs) and 20 (individual constructs). There was a trend that if participants agreed (or disagreed) with a statement before the intervention then they more strongly agreed (or disagreed) with the statement.

For the osteoporosis-specific constructs, significant susceptibility changes were greater agreement with osteoporosis can happen ($p<0.0001$) and chances of developing osteoporosis are good ($p<0.026$). There was a greater disagreement with it being too late to improve bone health ($p<0.001$). All severity statements significantly increased in agreement ($p<0.026$).

From the diet measures, benefits of nutrition statements were all significantly increased ($p<0.0001$). Participants generally disagreed with the nutrition barriers. The one significant change in the barriers is that more strongly disagreed with the statement that calcium-fortified foods were expensive. Self-efficacy statements concerning making diet changes all showed a significant improvement in agreement with the specific construct ($p<0.006$). Subjective norms of significance were: serving milk to friends/family ($p<0.013$) but average value was 3.08 (undecided); choosing calcium-fortified foods ($p<0.0001$) and doctor speaking to person about vitamin D (increased from 2.8 to 3.2, $p<0.006$). There was a significant difference in increasing intention to consume and promote calcium-rich foods and lower risk ($p<0.002$).

For the activity-related constructs, benefits of exercise all significantly increased in agreement ($p<0.003$). Of the barriers to exercise, there was a slight, but significant ($p<0.036$) increase in disagreeing with not liking exercise. There was also a significant increase ($p<0.004$) in agreeing with the statement that making exercise part of their life was easy. Participants agreed more strongly with the self-efficacy construct ($p<0.033$) of doing at least 20 minutes of activity 3-5 times/week. Attitudes for exercise increased in agreement ($p<0.033$) in importance of exercise and more strongly disagreed with daily activities were enough ($p<0.001$). The subjective norm of friends and family encouraging exercise increased in agreement ($p<0.009$). There was a significant increase in the intention to increase daily activity within the next 3 months ($p<0.0001$).

Theory of Reasoned Action Constructs: Intention to Change vs. Attitudes and Subjective Norms

Six intention statements were measured, with three addressing calcium (supplement, foods and promote to family/friends), one measuring reducing risk, and two addressing activity (exercise with family/friends and increase daily activity). Stepwise regression in measuring promotion of calcium intake intention with attitudes and subjective norms can be found in Table 21. Three significant equations ($p<0.001$) were found to explain the variance in behavior of dietary calcium intake. The response to the statement reflecting attitude of adequate diet calcium being important ($p<0.001$) explained 23% of the variance. The response to the statement reflecting the attitude of dietary calcium being important and subjective norm of choosing calcium-fortified foods over non-fortified versions accounted for 33.5% variance in intention of consuming more calcium-rich foods ($p<0.001$). Knowing someone with osteoporosis explained 9% variance for those intending to take a calcium supplement ($p<0.048$).

In measuring intention to include exercise with friends/family, two equations were found to be significant (Table 22). The subjective norms of "family/friends encouraging activity" and "daily activities being enough" account for 38.7% of the variance ($p<0.008$) with the intention to include exercise with family/friends in the next three months. With the dependent variable being the intention to increase daily activity within the next three months, a person's daily activities, family and work are enough account for 26.3% of the variance ($p<0.012$).

A statistically significant equation was found for the intention to lower osteoporosis risk ($p< 0.021$) (Table 21). The attitude of vitamin D dietary intake being important explained 13.6% of the variance for lowering disease risk. No significant equations occurred with exercise-based attitudes and subjective norms.

Program Evaluation

Participants' scores and comments on the program are found in Tables 22 to 24. The program was well-received. From the scores and written comments, an aspect that people would change is more time on activities. On average, all activities were at least "somewhat likely" to be helpful. Those receiving "very likely to be used" scores include: calcium and food label, pedometers, meal reflected bone healthy foods (natural and fortified), balance activities, taste tests of calcium-rich foods, and serving size estimation/food models.

DISCUSSION

Osteoporosis is a major public health issue annually costing billions as well as negatively impacting quality of life. While several risk factors cannot be modified, nutrition, primarily calcium and vitamin D, and activity, including weight-bearing and fall prevention play a key role in bone health and prevention and treatment of osteoporosis. The current intervention is unique in behavioral theory-based bone health programs. In contrast to the current program covering a comprehensive bone-health approach over eight sessions, other programs either measured influence of DXA values on health belief model constructs (Estok et al, 2007; Sedlak et al, 2007) or one-day instructions (Tung and Lee, 2006; Chan et al, 2005; Brecher et al, 2002) or used a person's health beliefs and bone-health behaviors to tailored an intervention that was given via the telephone (Sedlak et al, 2005).

The current intervention showed positive effects in calcium intake, and vitamin D intake, and knowledge/behavior constructs, but not in activity. These findings parallel the earlier study by Tussing and Chapman-Novakofski (2005) where there was an increase in calcium intake but not activity. This is similar to a study by Manios, et al, (2007) who studied BMD changes in those on calcium supplements vs. fortified dairy vs. control groups over a 12-month period. The intervention included nutrition education twice a week but also recommended physical activity (measured via questionnaires). Combining fortified dairy and nutrition education improved serum markers and BMD but there was no improvement in activity. Others reported improvement in knowledge of osteoporosis and risks (Brecher et al, 2002; Tung and Lee, 2006). Previous studies showed similar results in that participants either planned to increase or increased their calcium intake but no change in exercise was reported (Brecher et al, 2002; Sedlak et al, 2005).

Nutrition: Calcium Intake

The most significant finding of this study was that during the intervention, calcium intake showed a significant increase ($p<0.005$). The foods in the dairy group, including fortified soymilk, were the primary source of calcium for all time points. From the 24-hour recalls, the amount of calcium from dairy was 65.5% for week one, 56.7%

for week four, 58.1% for week eight and 61.8% eight weeks post-program. However, while the majority of calcium was from dairy, the increase in calcium during the intervention came primarily from the fruit group, as per 24-hour recall, and grains, as per CFFFQ. Both fruit and grain groups contain fortified foods, with all grains being fortified on the CFFFQ except for cornbread. Fortified foods play a key role in reaching calcium goals. This is supported by the improvement of the subjective norm construct of choosing fortified foods vs. non-fortified foods.

Nutrition: Vitamin D Intake

At the completion of the program, dietary vitamin D increased. This is addition to self-reported vitamin D supplement use per initial health survey (see Table 3). At eight weeks post-completion, there was no increase in dietary vitamin D intake but the intake level was maintained. The increase, however, was still below the NOF's recommendation of 800-1000 IU per day. These results are similar to national trends. A study using 1999-2000 NHANES data showed that dietary intakes of vitamin D were 212 IUs for men and 164 IUs for women over 50 years (Moore, 2005). When including supplements, only approximately 30% of men and 32% of women over 50 met the AI for vitamin D (Moore, 2005). While supplements can play a key role in filling the gap between diet and recommended levels of vitamin D, compliance with supplements is a common concern. In a study measuring compliance with vitamin D and calcium supplement in elderly hip fracture patients, 23.8% were following the supplement regimen after three months with the primary reason for dropping out was due to noncompliance (Segal, 2009). Authors of this study suggested the possibility of using periodic high dose of vitamin D, particularly for those with hip fractures.

Fortified foods, primarily milk and cereals, provide the majority of vitamin D in the US diet (Moore, 2005). The importance of monitoring fortified foods is demonstrated in that the fruit group (contains calcium and vitamin D fortified orange juice) was significantly increased. The fortified orange juice in the fruit group provided the highest percentage of calcium vs. the other options in the group. An increase in calcium from the fruit group is probable due to increased orange juice consumption and consequently, an increase in vitamin D. Chan, et al, (2005) showed an increase in soy milk or dairy, both being fortified, following a community education program. Careful food selection and meal planning is critical to optimize vitamin D intake. Until more foods are fortified, use of vitamin D supplements needs to be considered. In the current study, 44 out of 69 people reported taking a supplement with vitamin D.

Based on analysis of behavior constructs related to vitamin D, the constructs highlighting the benefits with vitamin D and lowering disease risk significantly improved, along with the self-efficacy constructs. Targeting these areas may be useful to explore improving vitamin D intake. In the study by Chan (2005), there was an improvement in intentions to increase vitamin D.

Activity:

Participants reported intending to increase activity, both at the beginning and at the end of the intervention. While participants were able to maintain the respective activities, there was no significant increase during the program in activity in steps, heel drops or balance activities. This could be due to that the participants only recorded actual steps and no other activity and consequently, other activities were not converted to steps. Heel drops were chosen as an overloading option vs. other high impact options, such as running or jumping rope. Prior to the program, no participants were doing heel drops. Several could not do the heel drops; however, those that could were enthusiastic about this option. The smaller sample of those doing heel drops may have negatively impacted the significance. However, while no significance was seen in the current study, a multi-component exercise program has been seen to be beneficial in maintaining functional capacity and preventing skeletal fragility (Karinkanta et al, 2007). In this study, elderly women improved physical functioning and balance via a combined resistance and balance/jumping training program in three weekly sessions for a year.

A possible reason that there was no increase in activity could be that there was not enough time devoted to physical activity and a balance (session #5 and #6). In addition to the Karinkanta et al (2007) study mentioned earlier, a study by Tolomio (2008) looked at similar activities including walking, balance activities, small jumps and then aerobics and strength training over 20 weeks in supervised sessions meeting three times per week. While this study showed an increase in bone quality (via hand phalanges) and leg strength, it was an organized program with supervision vs. measuring a person's day-to-day activity level. Carter et al, (2002) studied the effect of an exercise program (twice weekly, 20 weeks) in a community-based program setting. In this study, women with osteoporosis showed improvement in strength and balance. A similar finding occurred in women with osteopenia who participated in a 20-week exercise program (Hourigan, 2008). In a balance-related study (Gunendi et al, 2008) that measured the effect of a 4-

week aerobics program on balance and found that after 4-weeks, there was a significant improvement in balance scores. Another balance study (Madureira, 2007) evaluated the effect of a "Balance Training Program" (12-month long with weekly sessions and prescribed home exercise program) on women with osteoporosis and found improvement in balance and fall prevention.

While there was no significant change in activity in the current study, according to the behavior constructs, there was greater disagreement with daily activities being adequate to meet recommendations. This is an opening for more discussion on how other activities/exercises can be incorporated into a person's specific lifestyle. A study used the transtheoretical change model (TTM) to assess the effect of a 12-week home-based, tailored strength training and walking intervention in women 40-65 years (Shirazi et al, 2007). In this study, education was targeted to each participant's specific stage of change. Those in the intervention group showed an improved in TTM measures used in this study along with physical activity and balance measures. TTM constructs have benefit in identifying shifts prior to a behavior change occurring. Utilizing TTM with HBM and TRA may help to measure progress between self-efficacy and intention to change.

Educational tools:

Educational activities involving active learning helped to shape/strengthen habits. Previous studies have demonstrated using relevant and common techniques and materials in strengthening bone health behavior change. Studies stressing specific food (Chan et al, 2005; Manios et al, 2007) have shown an increase in calcium and vitamin D. A study by Young, et al, (2007) demonstrated the benefit of in-line dancing, especially combined with squats and foot stamping, in slowing bone loss, improving muscle strength and lowering risk for falls in independent-living, post-menopausal women. Stretch bands were used by Shirazi, et al, (200) to help improve muscle strength and improve balance.

In the current intervention, each session involved an application with the goal of either reducing the resistance in changing the behavior or increasing confidence, and consequently the intention, in carrying out the change. Practicing in class also brought discussion with participants offering additional ideas to incorporate the recommendations. Participants voluntarily found and brought in food labels to share with others. These led to more personal and relevant options for the participants. Per participant evaluations, the relevance of content and time spent on activities scored high (Table 23).

Different tools, particularly pedometers and stretch bands, were also used with some activities. These tools can be readily used outside of class by participants. Overall, the specific activities/tools were well received by participants (Table 24). The top three applications include: critique food label in identifying calcium; pedometers use; consuming a meal using calcium and vitamin D rich meal with naturally-rich and fortified sources. Tools such as how to quickly identify the calcium amount on the label, provided an easy-to-use fact to identify and purchase calcium-rich foods. Pedometers, or possible other tools providing immediate feedback, may also be useful in promoting bone healthy habits. Taste-testing food samples also made a strong impact in allowing participants to try foods without purchasing as well as showing the ease of incorporating calcium and vitamin D sources. Finding tools or recommendations that can be easily incorporated into a person’s lifestyle can improve/strengthen the behavior change.

LIMITATIONS

Lifestyle changes are the basis for improving bone health. This study showed improvements in calcium and vitamin D dietary intakes. Addressing the limitations can strengthen the cost effectiveness of the program.

Participants:

There was a small sample of men which fell below the power sample needed for evaluating statistical significance. Difficulty in recruiting men for the study could be due to osteoporosis being considered a women's disease.

Being that the program was set-up as a community program targeting those over 50, this could have lead to a more motivated and/or knowledgeable group of participants. This may have minimized the level of behavior change.

Nutrition:

Supplements use was measured as a demographic but not measured as an outcome. It is unclear if supplement intake changed. Since a soymilk does not have a separate category in the CFFFQ, it was classified with dairy as nutritionally comparable to milk, especially regarding calcium and vitamin D levels. By being with dairy, we were unable to distinguish and quantify contribution from soymilk.

An increase in calcium-fortified foods was reported. It is unclear if this was due to actual increase or if the participants were more aware that they were already consuming a fortified food.

Vitamin D fortified yogurt was new to the market during the intervention and is only available with certain brands. On 24-hour recalls, yogurt was commonly consumed by participants but it was not reported as fortified with vitamin D. This may have led to an underestimation of dietary vitamin D. Also, no measure was made of UV exposure to quantify this source of vitamin D.

Activity:

There was trouble in collecting activity records from week to week. This led to difficulty in tracking progress or changes being made. While the pedometers were a favorite of the participants, no other daily physical activity was measured. Several participants could not manage the heel drops which impacted the power of the sample. However, no participant did heel drops prior to the program.

CONCLUSIONS

A community setting is a viable option in promoting and improving bone health behaviors. Few studies have provided a look into comprehensive bone health behaviors. The eight week program length and format, including passive and active learning, may have been more effective in improving calcium and vitamin D intake vs. exercise habits. While there was no measured increased in physical activity, it cannot be ruled out whether this was the intervention or that the measurement tools were not sensitive to determine an effect. The biggest increase in fruit and grain fortified products suggests that additional dietary calcium from dairy may not be probable. This has food marketing, product development as well as nutrition education implications.

Using behavior theories as a basis for each lesson is not often used. Framing results within either TRA or HBM provided insight into whether changes were made or not. Using the TRA constructs helped to identify key attitudes, including diet being adequate in calcium and vitamin D and daily activity levels being enough, and subjective norms, choosing fortified foods and activity at work, to address in future interventions. HBM showed that knowledge about susceptibility to osteoporosis was strongly recognized by the participants. Participants also readily agreed with the benefits of diet and activity as well as that stated barriers can be overcome. This is helpful in program planning to optimize the group's time in strengthening self-efficacy to lead to positive diet and activity behaviors.

Table 5.1: Reasons Given by Participants for Dropping Out of Program

Participant	Reason
1. April/May	Canceled before orientation; after code assigned
2. April/May	Canceled at week 2 due to illness
3. April/May	Dropped out midway due to broken foot; hard to travel
4. April/May	No show
5. April/May	Dropped later due to chronic illness (lupus)
6. June/July	Conflict arose in beginning
7. June/July	Canceled after orientation prior to starting session
8. June/July	Canceled after orientation prior to starting session

Table 5.2: Demographics of Control, Treatment and Both Groups

	Control (n=34)	Treatment (n=35)	All (n=69)
Age (years)	67.2 ± 9.8	63.9 ± 9.3	65.5 ± 9.6
Gender[a]	24 females, 10 males	33 female, 2 male	57 female, 12 male
Ethnicity	31 Caucasian 2 Asian 1 not specified	31 Caucasian 2 Asian 1 Hispanic 1 Native American	64 Caucasian 4 Asian 1 Hispanic 1 Native American 1 not specified
BMD[b] (g/cm^2)	0.52 ± 0.1	0.52 ± 0.1	0.52 ±0.1

[a]significant difference p=0.01
[b]BMD, bone mineral density as tested by heel ultrasound

Table 5.3: Reported Supplement Use in Control, Treatment and Both Groups.

	Supplement	Calcium/ Women's formula	Calcium with Vitamin D
Control	30	20	24
Treatment	32	24	20
All	62	44	44

Table 5.4: Calcium (mg) and Vitamin D (IU) Intake via 24-hour Recall of Control Group during First Intervention Period

	Orientation			Program Initiation			
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	P[a]
Calcium							
Dairy	31	546.64	359.81	30	648.55	502.99	.501
Foods with Dairy	6	211.41	231.50	8	344.40	179.82	.285
Fruit	27	74.77	104.37	26	61.72	76.07	.808
Vegetable	28	57.90	30.056	25	45.73	25.14	201
Grain	32	116.83	95.074	32	122.20	100.68	.910
Meat	32	80.49	65.37	28	70.71	63.77	.341
Other	33	40.37	33.51	32	83.47	100.55	.036
Total Calcium	34	854.04	423.58	32	1052.38	599.90	.197
Vitamin D	34	151.54	236.69	32	107.027	94.92	.379

[a]Mann-Whitney

Table 5.5: Calcium (mg) Intake via CFFFQ of Control Group during First Intervention Period

	Orientation			Program Initiation			
Calcium	n	Mean	Std. Deviation	n	Mean	Std. Deviation	P[a]
Dairy	34	726.08	379.95	31	711.55	474.45	.531
Foods with Dairy	34	57.05	39.65	31	40.82	35.50	.019
Fruit	34	109.97	120.88	31	100.00	108.15	.781
Vegetables	34	24.39	19.88	31	30.94	29.46	.436
Grains	34	285.65	274.93	31	209.73	312.96	.007
Meats	34	160.39	172.18	31	129.73	137.89	.349
Others	34	103.76	399.30	31	46.29	85.24	.125
Total Calcium	34	1376.63	581.64	31	1269.058	764.43	.126

CFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]Mann-Whitney

Table 5.6: Comparison of Week 1 Mean Calcium (mg) and Vitamin D (IU) Intakes from 24-hour Recalls between April/May and June/July Groups

	April/May session			June/July session			
Group	n	Mean	Std. deviation	n	Mean	Std. deviation	P
Dairy	29	489.82	293.58	30	648.55	502.99	.225[a]
Foods with Dairy	7	249.25	221.178	8	344.40	179.82	.375[b]
Fruit	26	55.05	79.40	26	61.72	76.07	.534[a]
Vegetable	32	77.67	56.61	25	45.73	25.14	.011[b]
Grains	33	112.15	125.74	32	122. 20	100.688	.227[a]
Meats	30	100.08	114.52	28	70.71	63.77	.641[a]
Other	31	36.67	33.13	32	83.47	100.55	.022[a]
Total calcium	34	810.60	454.112	32	1052.37	599.90	.068[b]
Vitamin D	34	121.89	160.99	32	107.03	94.92	.521[a]

[a]Mann-Whitney
[b]t-test

Table 5.7: Comparison of Week 1 Means Calcium (mg) Intake from CFFFQ between April/May and June/July Groups

	April/May session			June/July session			
Group	N	Mean	Std. deviation	N	Mean	Std. deviation	P[a]
Dairy	35	603.66	473.08	31	711.56	474.45	.147
Foods with Dairy	35	43.76	36.79	31	40.82	35.50	.822
Fruit	35	102.39	123.97	31	99.00	108.15	.974
Vegetable	35	30.21	26.40	31	30.94	29.46	.928
Grains	35	294.05	420.06	31	209.73	312.96	.250
Meats	35	168.90	154.90	31	129.73	137.89	.156
Other	35	27.44	29.84	31	46.29	85.24	.822
Total calcium	35	1270.42	749.38	31	1269.06	764.43	.842

CFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]Mann-Whitney

Table 5.8: Calcium Intake (mg) and Vitamin D (IU) via 24-Hour Recall for Dairy, Fruit, Grains, Total Calcium and Vitamin D: Female and Male Comparison.

	Females			Males			
	Mean	Std. Deviation	n	Mean	Std. Deviation	n	P [a]
Dairy week 1	590.46	434.90	37	498.510	297.14	10	.484
Dairy week 4	679.01	384.03	37	575.79	241.68	10	
Dairy week 8	672.55	378.55	37	465.47	205.25	10	
Fruit week 1	54.56	76.98	36	71.95	83.920	8	.218
Fruit week 4	116.37	148.71	36	30.86	16.06	8	
Fruit week 8	137.99	138.86	36	116.24	150.35	8	
Grain week 1	109.41	99.63	42	189.09	181.82	10	.300
Grain week 4	90.75	80.85	42	227.11	218.89	10	
Grain week 8	99.36	104.94	42	319.77	474.78	10	
Total Calcium week 1	894.99	556.45	44	911.27	487.89	11	.348
Total calcium week 4	1192.50	483.89	44	1023.40	296.41	11	
Total calcium week 8	1129.42	400.88	44	883.75	371.42	11	
Vitamin D week 1	106.13	134.45	44	117.56	119.726	11	.800
Vitamin D week 4	154.13	129.66	44	136.86	99.23	11	
Vitamin D week 8	196.33	251.11	44	195.68	238.50	11	

[a]GLM Repeated Measures

Table 5.9: Calcium Intake (mg) and Vitamin D (IU) via CFFFQ for Dairy, Fruit, Grains, and Total Calcium: Female and Male Comparison.

	Females			Males			
	Mean	Std. Deviation	n	Mean	Std. Deviation	n	P[a]
Dairy week 1	730.14	479.64	41	508.64	394.99	7	.310
Dairy week 4	802.30	412.65	41	646.57	291.09	7	
Dairy week 8	817.47	469.89	41	497.17	244.04	7	
Fruit week 1	97.40	122.92	41	145.13	131.76	7	.801
Fruit week 4	127.38	137.14	41	206.89	147.60	7	
Fruit week 8	143.23	210.41	41	207.86	143.67	7	
Grain week 1	223.80	290.20	41	154.12	260.09	7	.398
Grain week 4	234.13	292.54	41	264.61	528.88	7	
Grain week 8	328.20	358.78	41	499.40	669.51	7	
Total Calcium week 1	1326.24	754.03	41	971.54	745.16	7	.703
Total calcium week 4	1477.73	731.83	41	1341.94	406.38	7	
Total calcium week 8	1586.52	749.84	41	1455.09	712.83	7	

CFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]GLM Repeated Measures

Table 5.10: Baseline Calcium Intake (mg) in Dairy, Fruit, Grain and Total Calcium and Vitamin D (IU) via 24-Hour Recall: Control vs. Combined Treatment Group

	Control			Combined Treatment			
Food	n	Mean	Std. deviation	n	Mean	Std. deviation	P[a]
Dairy	31	546.64	359.81	59	570.53	417.75	.501
Fruit	27	74.77	104.37	52	58.39	77.06	.808
Grains	32	116.83	95.07	65	117.09	113.32	.910
Total calcium	34	854.04	423.58	66	927.83	539.59	.197
Vitamin D	34	151.54	236.69	66	114.68	132.33	.379

[a]Mann-Whitney

Table 5.11: Baseline Calcium Intake (mg) in Dairy, Fruit, Grain and Total Calcium via CFFFQ[a]: Control vs. Combined Treatment Group

	Control			Combined Treatment			
Food	n	Mean	Std. deviation	n	Mean	Std. deviation	P[a]
Dairy	34	726.08	379.95	66	654.34	473.18	.531
Fruit	34	109.97	120.88	66	101.27	115.92	.781
Grains	34	285.65	274.931	66	254.45	373.23	.007
Total calcium	34	1376.63	581.64	66	1269.78	750.63	.126

CFFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]Mann-Whitney

Table 5.12: Calcium Intake (mg) and Vitamin D (IU) via 24-Hour Recall for Dairy, Fruit, Grains, Total Calcium and Vitamin D: Combined Treatment Group

	Mean	Std. Deviation	n	P
dairy week 1	570.89	408.34	47	.303
dairy week 4	657.05	358.70	47	
dairy week 8	628.49	357.39	47	
fruit week 1	57.73	77.56	44	.005
fruit week 4	100.82	138.40	44	
fruit week 8	134.040	139.46	44	
grain week 1	124.73	121.74	52	.644
grain week 4	116.98	129.06	52	
grain week 8	141.75	237.33	52	
total calcium week 1	898.25	539.15	55	.005
total calcium week 4	1158.68	455.39	55	
total calcium week 8	1080.28	404.17	55	
Vitamin D week 1	108.42	130.66	55	.015
Vitamin D week 4	150.68	123.53	55	
vitamin D week 8	196.20	246.47	55	

[a]GLM Repeated Measures

Figure 5.1: Percent of participants meeting/exceeding the calcium adequate intake (AI) via 24-hour recalls (repeated measures)

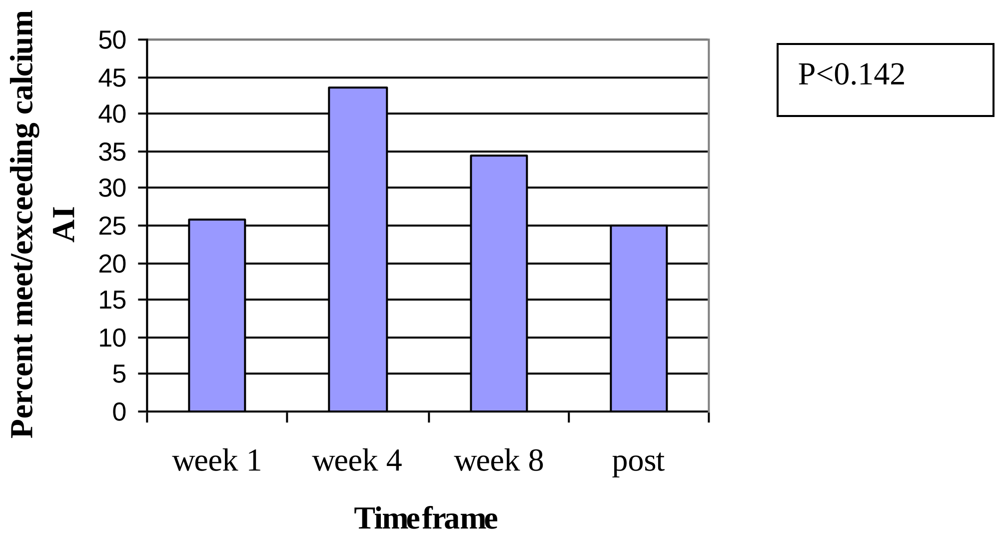


Table 5.13: Post Intervention Calcium Intake (mg) and Vitamin D (IU) via 24-Hour Recall for Dairy, Fruit, Grains, Total Calcium and Vitamin D: April/May Treatment Group

Week 8	n	Mean	Std. Deviation	Post 8 weeks	n	Mean	Std. Deviation	P[a]
Dairy	24	610.87	360.65	Dairy	24	651.55	444.78	.375
Fruit	25	124.90	148.90	Fruit	24	102.27	141.56	.099
Grain	25	69.58	54.72	Grain	23	168.69	338.69	.042
Total calcium	26	1054.22	428.19	Total calcium	24	1054.33	520.06	.903
Vitamin D	26	154.90	181.92	Vitamin D	24	210.62	264.54	.092

[a]Wilcoxon

Table 5.14: Calcium Intake (mg) via CFFFQ for Dairy, Fruit, Grains, and Total Calcium: Combined Treatment Group

	Mean	Std. Deviation	m	P[a]
Dairy week 1	697.83	471.12	48	.299
Dairy week 4	779.59	398.52	48	
Dairy week 8	770.76	456.69	48	
Fruit week 1	104.36	123.95	48	.083
Fruit week 4	138.98	139.97	48	
Fruit week 8	152.65	202.10	48	
Grain week 1	213.63	284.47	48	.042
Grain week 4	238.57	329.64	48	
Grain week 8	353.17	412.92	48	
Total Calcium week 1	1274.51	755.50	48	.027
Total Calcium week 4	1457.93	692.27	48	
Total Calcium week 8	1567.36	738.64	48	

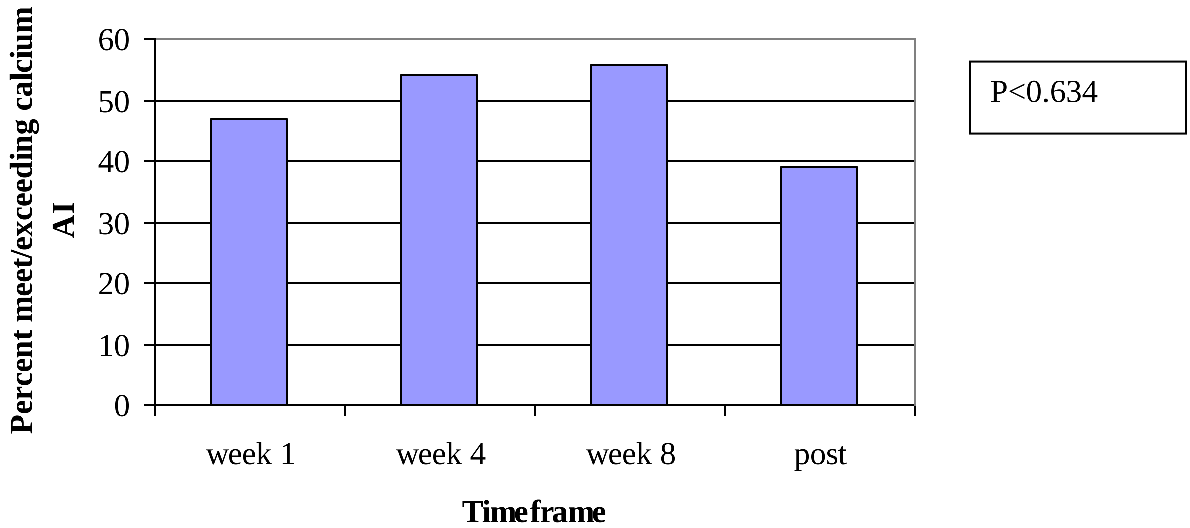
CFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]GLM Repeated Measures

Table 5.15: Post Intervention Calcium Intake (mg) via CFFFQ for Dairy, Fruit, Grains and Total Calcium: April/May Treatment Group

Week 8	n	Mean	Std. Deviation	Post 8 weeks	n	Mean	Std. Deviation	P[a]
Dairy	52	771.01	454.02	Dairy	23	735.60	366.63	.179
Fruit	52	146.038	197.67	Fruit	23	173.99	319.96	.664
Grain	52	335.73	402.86	Grain	23	227.37	321.79	.737
Total calcium	52	1542.73	741.289	Total calcium	23	1406.34	776.07	.543

CFFFQ = Calcium-Focused Food Frequency Questionnaire
[a]Wilcoxon

Figure 5.2: Percent of participants meeting/exceeding the calcium adequate intake (AI) via CFFFQ (repeated measures)



CFFFQ = Calcium-Focused Food Frequency Questionnaire

Table 5.16: Activity Including Steps (number/day), Heel Drops (number/day) and Balance (minutes/day): Combined Treatment Group

	Mean	Std. Deviation	N	P[a]
Steps, base	7176.50	3029.44	40	.327
Steps, week 5	7332.07	3403.45	40	
Steps, week 6	7510.42	3013.61	40	
Steps, week 8	7063.121	2849.791	40	
Heel drops, week 5	29.621	18.951	29	.928
Heel drops, week 6	35.67	22.98	29	
Heel drops, week 8	34.79	21.58	29	
Balance, week 6	9.64	12.16	45	.607
Balance, week 8	9.68	13.44	45	

[a]GLM Repeated Measures

Table 5.17: Post Intervention Activity Including Steps (number/day), Heel Drops (number/day) and Balance (minutes/day): April/May Treatment Group

Week 8	n	Mean	Std. Deviation	Post 8 weeks	n	Mean	Std. Deviation	P[a]
Steps	22	7394.77	3116.97	Steps	21	7745.78	3030.98	.795
Heel drops	19	29.26	22.97	Heel drops	14	25.095	12.72	.161
Balance	24	10.86	14.33	Balance	19	11.29	14.14	.408

[a]Wilcoxon

Table 5.18: Cronbach α for Pre-intervention on Beliefs, Attitude, Knowledge and Intentions towards Bone Health, Calcium, Vitamin D and Exercise Constructs

Category	Number of Questions	Cronbach α
Susceptibility	5	0.638
Susceptibility	3 (numbers 1,2,5)	0.859*
Severity	3	0.454
Benefits (diet)	6	0.621
Barriers (diet)	7	0.694
Barriers (diet)	5 (numbers 15,16,18,20,21)	0.740*
Self-efficacy (diet)	4	0.678
Self-efficacy (diet)	3 (numbers 22,24,25)	0.725*
Subjective norms (diet)	6	0.435
Intentions (diet)	4	0.655
Benefits (exercise)	5	0.912*
Barriers (exercise)	5	0.389
Attitudes (exercise)	5	0.500
Subjective norms (exercise)	4	0.460
Intentions (exercise)	2	0.329

*Cronbach α value $\geq$ 0.70 indicates reliability among items

Table 5.19: Cronbach α for Pre-intervention on Beliefs, Attitude, Knowledge and Intentions towards Bone Health, Calcium, Vitamin D and Exercise Combined Constructs

	Pre-intervention			Post-intervention			
Construct	n	Mean	Std. Deviation	n	Mean	Std. Deviation	P
Susceptibility	66	2.13	0.95	58	1.86	0.68	.001
Diet barriers	64	4.088	0.58	57	4.29	0.50	.183
Diet self-efficacy	69	1.88	0.59	58	1.44	0.44	<.001
Exercise benefits	68	1.47	0.57	59	1.23	0.40	<.001

Scale: 1=strongly agree to 5=strongly disagree, 6=not applicable

Table 5.20: Beliefs, Attitude, Knowledge and Intentions Constructs about Osteoporosis, Calcium, Vitamin D and Exercise

Construct Measure	Construct	n (pre)	Mean (pre)	Std. deviation (pre)	n (post)	Mean (Post)	Std. deviation (post)	P
1. Osteoporosis can happen to me	Susceptibility	69	1.56	0.812	60	1.20	0.403	<.001
2. Developing osteoporosis is something I worry about	Susceptibility	67	2.40	1.27	58	2.07	1.07	.002
3. It's too late to improve my bone health	Susceptibility	69	4.17	0.84	60	4.62	0.67	.001
4. I'm too young to worry about osteoporosis.	Susceptibility	63	4.56	0.62	57	4.75	0.47	.073
5. My chances of developing osteoporosis in future are good.	Susceptibility	67	2.37	1.085	59	2.32	1.058	.429
6. If I had osteoporosis it would affect my life.	Severity	69	1.77	0.94	60	1.53	0.83	.026
7. Osteoporosis would lead to money problems	Severity	68	3.13	1.11	59	2.32	1.12	<.001
8. Osteoporosis can lead to broken bones.	Severity	68	1.32	0.47	59	1.12	0.30	.002
9. Calcium intake now will affect my bone health.	Benefits	69	1.58	0.69	59	1.17	0.42	<.001
10. Vitamin D intake now will affect my bone health.	Benefits	69	1.54	0.70	60	1.17	0.42	<.001
11. Eating calcium-rich foods will help keep my bones strong.	Benefits	69	1.49	0.56	60	1.15	0.36	<.001
12. Eating vitamin D-rich foods will help keep my bones strong.	Benefits	69	1.55	0.58	60	1.20	0.40	<.001

Table 5.20 (cont.)

13. Eating calcium-rich foods reduces the risk of broken bones.	Benefits	69	1.57	0.56	60	1.18	0.39	<.001
14. Eating vitamin D-rich foods reduces the risk of broken bones.	Benefits	69	1.67	0.66	60	1.27	0.63	<.001
15. Calcium-rich foods are too expensive.	Barriers	69	4.087	0.84	58	4.34	0.66	.145
16. Calcium-fortified foods are too expensive.	Barriers	67	4.01	0.83	58	4.3	0.71	.031
17. Drinking milk will cause me to gain weight.	Barriers	67	4.030	0.82	58	4.12	0.88	.586
18. Eating calcium-rich (natural and fortified) foods requires me to change the way I eat, which is difficult.	Barriers	68	3.82	0.85	60	3.93	1.071	.795
19. I don't like milk.	Barriers	68	3.78	1.38	59	3.86	1.34	.207
20. I do not like dairy products.	Barriers	68	4.37	0.79	59	4.54	0.57	.138
21. I do not like calcium-fortified products.	Barriers	67	4.18	0.83	60	4.30	0.908	.351
22. I can find the calcium content of foods by reading food labels.	Self-efficacy	69	1.97	0.77	59	1.37	0.49	<.001
23. I use food labels to make shopping decisions.	Self-efficacy	69	1.90	0.88	59	1.54	0.57	.006
24. I am sure I can increase the amount of calcium in my diet.	Self-efficacy	69	1.83	.71	58	1.45	0.50	<.001
25. I am sure I can increase the amount of vitamin D in my diet.	Self-efficacy	69	1.86	.71	58	1.48	0.54	.001
26. My family does not like milk.	Subjective Norm	51	4.10	1.06	47	3.98	1.17	.650

Table 5.20 (cont.)

27. My diet has enough calcium for health.	Attitude	68	3.15	0.80	59	2.80	1.11	.016
28. My diet has enough vitamin D for health.	Attitude	68	3.13	0.73	57	2.72	1.065	.007
29. Dairy products are hard for me to digest.	Attitude	67	3.84	1.21	54	3.85	1.27	.273
30. Adequate calcium intake from my diet is important to me.	Attitude	69	1.67	0.63	59	1.44	0.57	.005
31. Adequate vitamin D intake from my diet is important to me.	Attitude	69	1.75	0.65	59	1.49	0.65	.004
32. I serve milk to my friends and family at most meals.	Subjective Norm	56	3.66	1.13	50	3.08	1.28	.013
33. I choose calcium-fortified foods vs. foods not fortified in calcium.	Subjective Norm	68	2.78	0.97	61	2.23	0.94	<.001
34. My doctor has talked to me about the importance of calcium.	Subjective Norm	68	2.49	1.17	59	2.63	1.36	.158
35. My doctor has talked to me about the importance of vitamin D.	Subjective Norm	68	2.81	1.24	59	3.17	1.30	.006
36. I know someone with osteoporosis.	Subjective Norm	67	1.91	1.00	59	1.72	0.95	.048
37. I am taking or intend to take a calcium supplement within the next 3 months.	Intention	68	1.79	1.087	60	1.77	1.11	.651
38. I intend to consume more dairy products and calcium- rich foods in the next 3 months.	Intention	67	2.21	0.81	58	1.69	0.92	<.001

Table 5.20 (cont.)

39. I intend to promote calcium- rich foods and dairy products to my friends and family in the next 3 months.	Intention	65	2.32	0.92	58	1.71	0.82	<.001
40. I intend to lower my risk for osteoporosis.	Intention	67	1.60	0.70	58	1.38	0.56	.002
41. Exercise helps improve my balance.	Benefits	68	1.44	0.61	61	1.21	0.45	<.001
42. Exercise improves my overall health	Benefits	69	1.36	0.59	61	1.18	0.50	.001
43. Exercise reduces the risk of broken bones.	Benefits	69	1.42	0.63	61	1.23	0.56	.003
44. Exercise will help prevent osteoporosis.	Benefits	69	1.58	0.74	59	1.24	0.43	<.001
45. Exercise helps prevent injury and falls.	Benefits	69	1.57	0.72	59	1.20	0.41	<.001
46. I have trouble fitting exercise into my busy schedule.	Barriers	68	3.34	1.28	59	3.42	1.29	.803
47. I have trouble sticking to an exercise routine.	Barriers	69	3.043	1.28	59	3.24	1.34	.609
48. I don't like to exercise.	Barriers	69	3.70	1.18	59	3.95	1.11	.036
49. I'm not strong enough to exercise.	Barriers	62	4.35	0.89	57	4.53	0.76	.248
50. Making exercise part of my life will be easy or is already easy.	Self-efficacy	69	2.49	1.12	59	2.14	1.11	.004

Table 5.20 (cont.)

51. I know I can do some type of physical activity for at least 20 minutes 3-5 times per week.	Self-efficacy	69	1.70	0.83	59	1.49	0.65	.033
52. Exercise or being physically active is important to my health.	Attitudes	69	1.38	0.57	59	1.24	0.43	.033
53. I will get hurt if I exercise.	Attitudes	69	4.33	0.83	59	4.34	0.92	.326
54. I'm too old to exercise.	Attitudes	69	4.65	0.51	58	4.50	1.00	.374
55. I am too tired to exercise.	Attitudes	69	4.16	0.98	58	4.16	1.073	.910
56. My daily activities, family, and work are enough exercise for me.	Attitudes	67	3.97	0.92	61	4.26	0.77	.001
57. My family/friends encourage me to exercise.	Subjective Norm	66	2.61	1.065	56	2.29	0.95	.009
58. Many of my friends are involved in some type of exercise routine.	Subjective Norm	68	2.46	0.97	61	2.13	0.81	.044
59. My place of work encourages exercise.	Subjective Norm	28	3.46	1.23	24	3.83	0.92	.084
60. My doctor has talked to me about the importance of exercise.	Subjective Norm	65	2.48	1.24	54	2.65	1.20	.494
61. I intend to include exercise in activities with friends/family in the next 3 months	Intention	66	2.08	0.92	60	1.93	0.86	.169
62. I intend to increase my daily activity in the next 3 months.	Intention	66	2.23	0.92	59	1.76	0.75	<.001

Table 5.21: Stepwise Regression Analysis for the Theory of Reasoned Action Constructs Related to Diet (Post-Intervention)

Dependent Variable	Regression Equation	F	P
I am taking or intend to take a calcium supplement within the next 3 months	1.197 + .32(#36)	4.170	.048
I intend to consume more dairy products and calcium-rich foods in the next 3 months	.58 + .75(#30)	13.123	.001
I intend to promote calcium-rich foods and dairy products to my friends and family in the next 3 months	.105 + .611(#30) +.332(#33)	11.096	<0.001
I intend to lower my risk for osteoporosis.	.957 + .322(#31)	5.804	.021

#30: adequate calcium intake from my diet is important to me.
#31: Adequate vitamin D intake from my diet is important to me.
#33: I choose calcium-fortified foods vs. foods not fortified in calcium.
#36: I know someone with osteoporosis.

Table 5.22: Stepwise Regression Analysis for the Theory of Reasoned Action Constructs Related to Exercise (Post-Intervention)

Dependent Variable	Regression Equation	F	P
I intend to include exercise in my activities with friends/family in the next 3 months	2.105 + .540(#57) - .354(#56)	6.307	.008
I intend to increase my daily activity in the next 3 months.	3.226 -.350(#56)	7.506	.012

#56: My daily activities, family, and work are enough exercise for me.
#57: My family/friends encourage me to exercise.

Table 5.23: Program Evaluation Scoring[a] by Participants

Facilitator	n	Minimum	Maximum	Mean	Std. Deviation
Knowledge	31	3.00	5.00	4.79	.48
Organization	31	3.00	5.00	4.82	.46
Listening skills	31	3.00	5.00	4.82	.46
Enthusiasm	31	5.00	5.00	5.00	.00
Answer questions	30	3.00	5.00	4.80	.48
Presentation skills	31	3.00	5.00	4.76	.45
Effective use of material/equipment	31	3.00	5.00	4.82	.46
Program Content					
Content	31	3.00	5.00	4.77	.50
Value	31	3.00	5.00	4.74	.58
Relevance	31	3.00	5.00	4.74	.58
Handouts	31	4.00	5.00	4.81	.40
Time spent on activities	31	3.00	5.00	4.65	.66
Overall	30	3.00	5.00	4.77	.48

[a]5 = excellent and 1 = unsatisfactory

Table 5.24: Participant Feedback regarding Different Activities

Activity	N	Minimum	Maximum	Mean	Std. Deviation
Heel ultrasound	31	1.00	5.00	3.90	1.54
Frame size & risk quiz	31	1.00	5.00	3.97	1.35
Serving test	31	1.00	5.00	4.10	1.14
Label critique	31	1.00	5.00	4.58	.96
Taste tests	31	1.00	5.00	4.16	1.24
Pedometers	31	1.00	5.00	4.48	1.15
Heel drops	31	1.00	5.00	3.45	1.84
Balance	31	1.00	5.00	4.29	1.22
Stretch bands	31	1.00	5.00	3.97	1.25
Soy & smoothie taste tests	31	1.00	5.00	3.32	1.72
Jeopardy	30	1.00	5.00	3.73	1.62
Healthy meal	29	1.00	5.00	4.38	1.21

5 = likely to use and 1 = unlikely to use

Table 5.25: Written Comments from Participants

Aspect of Program	Comments
Facilitator	Any questions that were unable to answer were always followed-up and answered in the next class. Made class interesting! Love the enthusiasm & fun! Both instructors were delightful, enthused, knowledgeable. They were both great – full of enthusiasm & showed great interest in their audience needs. Excellent presenters. So much info! Sometimes overwhelming. I didn't always focus on most important content. Enthusiasm & concern were most important – Karen wanted us to be more aware of our own health. Presenters were excellent and very patient! Very practical, demonstrations can easily adapt for my lifestyle. Enjoyed the enthusiasm and interest in informing us.
Content	Excellent, very helpful. I could have used follow-up on how to do the exercises correctly. I have no critical things to say - enjoyed it. Loved the handouts of slides – made it much easier to keep notes. I have learned a lot and am sharing with anyone who will listen. Many things new to me. I learned a lot from this session & would recommend it to anyone. A lot of good material in each session. Good information. Great handouts.
Activities	These are fun-especially after work when we are groggy. Possibly include 5 min. of exercise at beginning of each class. Good interaction – loved exercises – have great affinity for pedometer now! I will reread the handouts. I'm now determined to do regular work with weights, bands, balance exercises. Jeopardy was a good way to review.

Table 5.25 (cont.)

Aspects to change	Sometimes more information about a topic would have been helpful. Wish I could do heel drops and pedometer. "?" Time to earlier afternoon, morning. Food with fish yuk. Wouldn't change anything. I liked & enjoyed it all! Wouldn't change. The class should last a little longer. Time at 5 pm, I think 5:30 pm will be better.
Favorable aspects	Excellent program content. Taste test/comparison of different foods, demonstration of exercises and providing class w/ pedometer and stretch bands so everything needed to complete course was included. Both presenters had great enthusiasm. They worked well together. Teacher being willing to answer questions. Information given. The instructors & class interaction. Enthusiasm of Karen. Very knowledgeable and able to answer all questions. Pace of each class. I liked your high energy level & enthusiasm in the class. Also liked the handouts to have for future reference. Sampled foods were enjoyable. Thanks for sharing! Liked all – especially the demo examples of food. It was really great. Thank you so much. Instructors were enthusiastic and make you really want to improve. Enthusiasm & approachability of instructors. The info in class, pedometer, bands, ideas for balance exercises. Found the handouts & all the information very helpful. Explanation of foods that are calcium and vit. D rich. Ways to build bones. Bringing attention to calcium rich foods & the importance of vit D. I enjoyed the whole class – EVERYTHING. It was all very good. All the information we received. The education should offered to younger people who can prevent osteoporosis occurrence. Prevention is the key! Enthusiasm, willingness to answer questions, chance to learn the latest. Getting up-to-date information. The enthusiasm of the instructor.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Calcium-Focused Food Frequency Questionnaire (CFFFQ): Conclusions

The CFFFQ is a useful tool in identifying calcium intake, especially those at lower levels of calcium intake. The CFFFQ is also useful in recognizing calcium sources, including fortified which can often go undetected, in using other food frequencies and food records, leading to an underestimation of calcium intake. Knowing which food sources are preferred by a client or group can help the clinicians and educators in developing recommendations more relevant to that client or group to hopefully improve adherence to recommendations.

Calcium-Focused Food Frequency Questionnaire (CFFFQ): Recommendations

While the CFFFQ is useful, further work is needed. A minor change is recommended to account for the reported intake of soy milk from the intervention program. It is recommended to adjust with adding soymilk under the dairy group as dairy alternative, similar to tofu in the meat group. This will help in being able to identify soy milk's contribution to calcium intake.

The CFFFQ is strong in identifying low intakes as compared with the 24-hour recall but there was greater disagreement between the two tools as calcium intake increase. This is not surprising as the 24-hour recall addresses only one day versus multiple days on the CFFFQ. A validation study of CFFFQ with 7-day food record is recommended to evaluate agreement and therefore strengthening CFFFQ's use in assessing calcium intake.

In addition to bone health, the CFFFQ has uses in other populations where calcium plays a role, such as renal disease and hypertension. The CFFFQ will need to be validated in those populations.

On a related note to food frequencies and bone health, a vitamin D-based food frequency, whether added to the CFFFQ or separate, needs to be developed based on more foods being fortified with vitamin D (e.g., yogurt, some cereals, and some cereal bars, in addition to milk) and these foods being in the marketplace. Using brand names is recommended for people to be able to recognize the product. An open question in the CFFFQ, used in the intervention program, asked about vitamin D-fortified foods, milk was commonly reported but not others.

Community-based Bone Health Program: Conclusions

The bone health program continues to have a more positive impact with diet vs. activity. In the original study, Lisa Tussing et al (2005) found an increase in calcium intake but not in steps. The current study, updated with vitamin D and balance/fall prevention topics, found an increase in calcium and vitamin D intake but not in any physical activity outcome. There was also improvement in behavioral constructs.

Community-based Bone Health Program: Recommendations

Future uses of the program include studying different populations as well as nutrients. The bone-health intervention has been conducted with middle-age to elderly adults. Another population to test is young adults or college-aged adults who are making independent food and physical activity choices but still building bone mass. With the program showing increases in dietary calcium and vitamin D, changes in other bone-health nutrients can also be studied.

The behavior construct survey was useful but additional constructs are recommended: 1) the current survey did not specifically ask regarding intention to increase vitamin D, either via diet or supplement. This was an oversight, especially with the increase in vitamin D-fortified foods and challenge of reaching vitamin D recommendations. 2) To help identify possible reasons for no increase in activity, develop additional exercise constructs, particularly in barriers and self-efficacy.

The facilitators highlighted calcium, vitamin D and activity at each session. Key messages from the previous week were reviewed at the start of the next session. This was done to maintain continuity in the program. It seemed to work well as participants were able to ask follow-up questions. It did take time from the current session's time and needs to be monitored. An idea is to have key points posted as people walk into the class.

In was noticed by facilitators and noted on participant feedback that more time is needed in the sessions. Adjust class time to allow more in-class activities and/or discussion time for the activities. This will allow for improved pacing in delivery of information as well as time to practice and reinforce the key behaviors. Another adjustment is week 7 (soy, supplements and medications). Week 7 had the least active learning. Consider moving soy and tasting soy milk and smoothies to diet weeks (weeks 3 and 4). Convert week 7 into overall prevention/treatment, with supplements/medications material predominately in handouts, where there will be more practice of diet simulations (planning calcium and vitamin D rich meals) and practice exercise/fall prevention or develop an activity where participants plan on building in activity in their day.

From a logistic standpoint, using web-based tools for the participants to enter diet and activity information may help improve the return rate. It could also help with data entry.

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APPENDIX A: CALCIUM-FOCUSED FOOD FREQUENCY MATERIALS

Calcium Food Frequency

Instructions: We would like to know how often you eat foods that are high in calcium. For each of these questions choose the appropriate time frame, and fill in the frequency.

For instance, if the question was -- How often do you eat cake? -- and you eat cake once per month, under" Per month" you would write "1" and leave the other columns blank.

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
cake			1		

If the question was -- How often do you eat bread? -- and you eat 4 slices of bread per day, under "Per day" you would write 4, and leave the other columns blank.

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Bread, slice	4				

Some of these questions may be hard to "guess at". Just give your best estimate.
Quick key to portion sizes:
1/2 cup = tennis ball
1 cup = closed fist
1 oz = 1 piece of string cheese

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Dairy					
Milk, 1 cup, (including milk added to cereal, shakes, coffee, etc)					
Yogurt, 1 cup					
Aged cheese, 1 oz, (e.g., cheddar, Swiss, provolone, Monterey jack, colby)					
Cheese food, 1 oz, (American, Velveeta)					
Cottage cheese, 1/2 cup					
Ice cream, frozen yogurt, 1/2 cup					
Other foods using dairy products					
Pizza, 1/8 of 15 inch pizza					
Lasagna, 1 cup or 8 oz					
Enchiladas, tacos, 1					
Macaroni & cheese, 1 cup					
Soups made with milk					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Fruits					
Orange juice with calcium, 1 cup					
Orange, whole					
Papaya, 1 cup					
Rhubarb, 1 cup					
Raisins, 1 cup					

Pear halves, dried, 10 each					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Vegetables, cooked					
Broccoli, 1/2 cup					
Bok choy, 1/2 cup					
Greens (collard, turnip, mustard, spinach), 1/2 cup					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Grains					
Total Cereal, 1 cup					
Special K Plus, 1 cup					
Other Fortified* cereal (e.g. Basic 4, Life Cinnamon), 1 cup					
Cereal, 1 cup					
Fortified* instant oatmeal, 1 cup					
Fortified* Graham crackers (e.g. Teddy Grahams), 24 pieces					
Fortified* cereal bars, 1 bar					
Fortified* bread, 1 slice					
Corn bread, 1					
Waffles (homemade or from mix), 1					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Meats & meat alternatives					
Sardines, 3.5 oz					
Oysters, clams, 20					
Crab legs, 1 cup					
Anchovies, 10					
Legumes/beans, 1/2 cup					
Almonds, 1/4 cup					
Mixed nuts, 1/4 cup					
Tofu set with calcium, 1/2 cup					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Others					
Fortified* Crystal Light, 1 cup					
Fortified* Country Crock margarine, 1 tbsp					
Cheese cake, 1/8 of cake					
Cream pies (including pumpkin), 1/8 of pie					
Chocolate bar (1.5-2.15 oz)					
Slim Fast, can					
Slim Fast, powder mixed with water					
Slim Fast, powder mixed with milk					

* fortified = with added calcium

Informed Consent for Participation in the Research Project:
Validation of a calcium intake survey

You are being asked to participate in a research project conducted by Dr. Karen Chapman-Novakofski, Department of Food Science at the University of Illinois. You will be asked to complete two questionnaires: one on the frequency and amount of calcium-rich foods you usually eat, and one on what you ate in the previous 24-hours. If you are willing to be interviewed about what you eat, enter your name, phone number, and e-mail address at the bottom of the calcium intake form. I will contact you to set up a convenient interview time and place. This interview will take about 30 to 45 minutes. You will be given a $10 gift certificate upon completion of the interview to Expresso Royale. If you choose not to volunteer to an interview, leave that section blank.

The purpose of this study is to determine the how well these surveys agree with one another. There are no right or wrong answers. No counseling will be given as to what you should or shouldn't eat. If you choose to participate in the face-to-face interview, you will be given a $10 gift certificate, and a computer printout will be sent to you reflecting the nutrient information about the food you told us you ate.

The benefits of this research study are primarily to improve methods of assessing how much calcium people consume. This could help in future preventative nutrition education interventions.

You can withdraw from this research study at any time without prejudice - your participation is voluntary. All information you provide will be kept confidential, and any publication of the results of this project will only provide anonymous, grouped data. If you have any questions you can call Dr. Karen Chapman-Novakofski at 217-244-2852, or kmc@uiuc.edu., or the Institutional Review Board at 217-333-2670 if you have questions about research subject rights. You will be given a copy of this form for your own reference.

I voluntarily agree to participate in this research project.

______________________________ ______________________________

Subject Date Investigator Date

____

Witness Date

Instructions for Recording the 24 Hour Food Recall

1. Record everything you ate or drank during the 24-hour time period indicated (12:01 a.m. → midnight).

2. To the best of your ability, describe combination or mixed dishes that were eaten. For example, what ingredients were included on that piece of pizza? Was it thick or thin crust? Include brand names if known.

3. Describe the amounts consumed in terms appropriate for that item. For example: ounces (cups) of milk, tablespoons of French dressing, slices of bread, pieces of fruit, etc. If you had a piece of pizza, how big was it in inches or sections, etc.? Record exact amounts to the best of your ability.

Sample Breakfast	
Raisin bran cereal	1 oz.
2% milk	6 oz.
Orange	1 medium size
Toast (whole wheat)	1 slice
with butter	1 pat
with strawberry jam	2 teaspoons
Black coffee	1 cup (8 oz.)

4. Remember to include beverages, and anything you may add to them, such as milk or sweetener.

5. Remember to include anything added to a food after it is prepared, such as margarine, salt, catsup, and the estimated amount.

6. If you need additional space, use the back of the paper or attach additional sheets.

7. Answer the question at the bottom of the day's record. (Does this day's record represent your usual food intake? __ Yes __ No). If your answer is no, explain why it wasn't representative. Were you ill or are you on a special diet? Did you have unexpected guests and you took them out to dinner?

8. If you have any other questions concerning the 24-hour recall, please call Karen Chapman-Novakofski, RD, LD, PhD at 244-2852.

Food or Beverage Item Consumed	**Amount Consumed**

Does this day's record represent your usual food intake?
__Yes __No. If not, please explain.

APPENDIX B: BONE-HEALTH INTERVENTION MATERIALS

Happy Bones Course Syllabus

Course objectives:

At the end of this course, participants will be able to:

- List risk factors for osteoporosis
- Identify personal risk factors for osteoporosis
- Design a healthy bone diet
- Identify balance and exercise activities that promote bone health

Early spring
Register for either Wednesday or Thursday section, 5-6 PM

Session	Date	Topic	Activity
1	April 2 or 3	Overview of Bone Health; Severity of Osteoporosis	Bone density testing
2	April 9 or 10	Susceptibility to Osteoporosis and Risk Factors	Body frame, Height measurement Risk factor quiz
3	April 16 or 17	Overcoming Barriers to Reducing Risk Factors: Healthy Bone Diet	Serving size estimation, calcium puzzle
4	April 23 or 24	Self-efficacy: Achieving Benefits from Reducing Risk Factors: Healthy Bone Diet	Food label critique “Let’s Make a Deal” Taste tests
5	April 30 or May 1	Overcoming Barriers to Reducing Risk Factors: Improving Exercise Habits	Heel drops
6	May 7 or 8	Overcoming Barriers to Reducing Risk Factors: Fall Prevention & Balance	Balance, posture exercises
7	May 14 or 15	Medications, Supplements & Soy	Supplement label critique Smoothie taste tasting
8	May 21 or 22	Better Bone Graduate	Bone healthy meal

Late spring class
Register for either Wednesday or Thursday section, 5-6 PM

Session	Date	Topic	Activity
1	June 4 or 5	Overview of Bone Health; Severity of Osteoporosis	Bone density testing
2	June 11 or 12	Susceptibility to Osteoporosis and Risk Factors	Body frame, Height measurement Risk factor quiz
3	June 18 or 19	Overcoming Barriers to Reducing Risk Factors: Healthy Bone Diet	Serving size estimation, calcium puzzle
4	June 25 or 26	Self-efficacy: Achieving Benefits from Reducing Risk Factors: Healthy Bone Diet	Food label critique "Let's Make a Deal" Taste tests
5	July 2 or 3	Overcoming Barriers to Reducing Risk Factors: Improving Exercise Habits	Heel drops
6	July 9 or 10	Overcoming Barriers to Reducing Risk Factors: Fall Prevention & Balance	Balance, posture exercises
7	July 16 or 17	Medications, Supplements & Soy	Supplement label critique Smoothie taste tasting
8	July 23 or 24	Better Bone Graduate	Bone healthy meal

Code_____________

Date _____________

All About You

Please Answer the Following:

1. How old were you on your last birthday?

____ years old
____ 1. Don't know
____ 2. Don't care to answer

2. How would you describe yourself?

____ 1. White
____ 2. African American
____ 3. Asian or Pacific Islander
____ 4. Native American/American Indian/ Alaskan Native
___ 5. Hispanic
___ 6. Mexican American
___ 7. Other _______________

3. How much schooling have you completed?

____ Less than High School Graduate
____ High School graduate or GED
____ Some college or technical school
____ College grad or higher

4. What is your employment status?

____ Employed out of home
____ Self-employed
____ Not currently employed
____ Retired
____ Homemaker
____ Other __________

5. How many people live in your household (including yourself)? _______

Health/ Personal History

6. Has anyone in your immediate family suffered from cracked bones in the hip or back?
   a. yes____ no____ not sure ____
   b. If yes who? ____

7. a. Do you smoke? yes____ no____
   b. How many cigarettes/day? ________
   c. If you ever smoked or you currently do so, how many years have you smoked for? _______

Code_____________

8. a. Do you have an exercise routine or do you regularly participate in an activity?
   yes________ no_________
   b. How often? _________________
   c. Type of Activity
   ________ walking
   ________ bicycling
   ________ weight training
   ________ swimming
   ________ tennis
   ________ golf
   ________ bowling
   ________ dancing
   ________ other _____________________
   d. Usual length of activity________________

9. a. Do you take a vitamin or mineral supplement(s)? yes_____ no_____
   b. What kind of vitamin or mineral supplement(s) do you take? (check all that apply)
   ______ multivitamin
   ______ women's formula multi-vitamin
   ______ calcium
   ______ calcium with vitamin D
   ______ vitamin E
   ______ vitamin C
   ______other ____________________________
   c. Does your multi-vitamin contain calcium? ___ yes ___ no ___ don't know
   d. How often do you take a supplement? __________________________________
   e. Why do you take a supplement? _______________________________________

10. a. Do you take a calcium containing antacid? yes ______ no _______
   b. If yes, what is the name of the one you most frequently use?
   ______ Tums
   ______ Rolaids
   ______ Titralac
   ______ Other
   c. What is the primary reason you take this antacid:
   ______ Controlling upset stomach?
   ______ For extra calcium
   Other ___________

11. Do you take oral contraceptives? yes ______ no ______

12. Are you currently on a hormone replacement therapy regimen? yes______ no _____

13. Do you take medication to improve bone density (ie. Fosamax)? yes _____ no _____

14. a. Do you consume beverages that contain caffeine? yes ______ no ______
    b. What kind? (mark all that apply)
    ______ coffee
    ______ tea
    ______ carbonated beverages
    c. If yes how many cups per day? ________

15. a. Have you ever had a bone scan? yes________ no________
    b. Year of bone scan __________________
    c. Are you attending this program due to concern about the results of your bone scan? yes ____ no____

16. Which of the following describes you?
    ______ Pre-menopausal
    ______ No periods for 6 months or more
    ______ Surgically-Induced Menopause
    Post-Menopausal

Attitudes and thoughts about osteoporosis, calcium, vitamin D and exercise

Please answer the following questions by circling:
1= strongly agree, 2= agree, 3= undecided 4= disagree, 5= strongly disagree, and 6= inapplicable.

Code: ___________

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Does not apply to me
1. Osteoporosis can happen to me.	1	2	3	4	5	6
2. Developing osteoporosis is something I worry about.	1	2	3	4	5	6
3. It's too late to improve my bone health.	1	2	3	4	5	6
4. I'm too young to worry about osteoporosis.	1	2	3	4	5	6
5. My chances of developing osteoporosis in the future are good.	1	2	3	4	5	6
6. If I had osteoporosis it would affect my life.	1	2	3	4	5	6
7. Osteoporosis would lead to money problems.	1	2	3	4	5	6
8. Osteoporosis can lead to broken bones.	1	2	3	4	5	6
9. Calcium intake now will affect my future bone health.	1	2	3	4	5	6
10. Vitamin D intake now will affect my future bone health.	1	2	3	4	5	6

Code: ___________

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Does not apply to me
11. Eating calcium-rich foods will help me keep my bones strong.	1	2	3	4	5	6
12. Eating vitamin D-rich foods will help me keep my bones strong.	1	2	3	4	5	6
13. Eating calcium-rich foods reduces the risk of broken bones.	1	2	3	4	5	6
14. Eating vitamin D-rich foods reduces the risk of broken bones.	1	2	3	4	5	6
15. Calcium-rich foods are too expensive.	1	2	3	4	5	6
16. Calcium-fortified foods are too expensive.	1	2	3	4	5	6
17. Drinking milk will cause me to gain weight.	1	2	3	4	5	6
18. Eating calcium-rich (natural and fortified) foods requires me to change the way I eat, which is difficult.	1	2	3	4	5	6
19. I don't like milk.	1	2	3	4	5	6
20. I do not like dairy products.	1	2	3	4	5	6
21. I do not like calcium-fortified products.	1	2	3	4	5	6
22. I can find the calcium content of foods by reading food labels.	1	2	3	4	5	6
23. I use food labels to make shopping decisions.	1	2	3	4	5	6

Code: ___________

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Does not apply to me
24. I am sure I can increase the amount of calcium in my diet.	1	2	3	4	5	6
25. I am sure I can increase the amount of vitamin D in my diet.	1	2	3	4	5	6
26. My family does not like milk.	1	2	3	4	5	6
27. My diet has enough calcium for health.	1	2	3	4	5	6
28. My diet has enough vitamin D for health.	1	2	3	4	5	6
29. Dairy products are hard for me to digest.	1	2	3	4	5	6
30. Adequate calcium intake from my diet is important to me.	1	2	3	4	5	6
31. Adequate vitamin D intake from my diet is important to me.	1	2	3	4	5	6
32. I serve milk to my friends and family at most meals.	1	2	3	4	5	6
33. I choose calcium-fortified foods vs. foods not fortified in calcium.	1	2	3	4	5	6
34. My doctor has talked to me about the importance of calcium.	1	2	3	4	5	6
35. My doctor has talked to me about the importance of vitamin D.	1	2	3	4	5	6
36. I know someone with osteoporosis.	1	2	3	4	5	6

Code: ___________

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Does not apply to me
37. I am taking or intend to take a calcium supplement within the next 3 months.	1	2	3	4	5	6
38. I intend to consume more dairy products and calcium- rich foods in the next 3 months.	1	2	3	4	5	6
39. I intend to promote calcium- rich foods and dairy products to my friends and family in the next 3 months.	1	2	3	4	5	6
40. I intend to lower my risk for osteoporosis.	1	2	3	4	5	6
41. Exercise helps improve my balance.	1	2	3	4	5	6
42. Exercise improves my overall health.	1	2	3	4	5	6
43. Exercise reduces the risk of broken bones.	1	2	3	4	5	6
44. Exercise will help prevent osteoporosis.	1	2	3	4	5	6
45. Exercise helps prevent injury and falls.	1	2	3	4	5	6
46. I have trouble fitting exercise into my busy schedule.	1	2	3	4	5	6
47. I have trouble sticking to an exercise routine.	1	2	3	4	5	6
48. I don't like to exercise.	1	2	3	4	5	6
49. I'm not strong enough to exercise.	1	2	3	4	5	6

Code: ___________

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Does not apply to me
50. Making exercise part of my life will be easy or is already easy.	1	2	3	4	5	6
51. I know I can do some type of physical activity for at least 20 minutes 3-5 times per week.	1	2	3	4	5	6
52. Exercise or being physically active is important to my health.	1	2	3	4	5	6
53. I will get hurt if I exercise.	1	2	3	4	5	6
54. I'm too old to exercise.	1	2	3	4	5	6
55. I am too tired to exercise.	1	2	3	4	5	6
56. My daily activities, family, and work are enough exercise for me.	1	2	3	4	5	6
57. My family/friends encourage me to exercise.	1	2	3	4	5	6
58. Many of my friends are involved in some type of exercise routine.	1	2	3	4	5	6
59. My place of work encourages exercise.	1	2	3	4	5	6
60. My doctor has talked to me about the importance of exercise.	1	2	3	4	5	6
61. I intend to include exercise in activities with friends/family in the next 3 months	1	2	3	4	5	6
62. I intend to increase my daily activity in the next 3 months.	1	2	3	4	5	6

Happy Bones Activity Log

Week of:________________________

If you are wearing your pedometer, please record the number of steps at the end of each day. If you choose to complete heel drop exercises, please record about how many heel drop exercises you’ve done each day. If you’ve practice balancing, please indicate about how many minutes you’ve practiced each day. Blanks will be recorded as no activity for that day.

Day	Steps (number)	Heel Drops (number)	Balance (minutes)
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Code: ___________

Instructions for Recording the 24 Hour Food Recall

1. Record everything you ate or drank during the 24-hour time period indicated (12:01 a.m. → midnight). Do NOT include a weekend day.

2. To the best of your ability, describe combination or mixed dishes that were eaten. For example, what ingredients were included on that piece of pizza? Was it thick or thin crust? Include brand names if known.

3. Describe the amounts consumed in terms appropriate for that item. For example: ounces (cups) of milk, tablespoons of French dressing, slices of bread, pieces of fruit, etc. If you had a piece of pizza, how big was it in inches or sections, etc.? Record exact amounts to the best of your ability.

Sample Breakfast	
Raisin bran cereal	1 oz.
2% milk	6 oz.
Orange	1 medium size
Toast (whole wheat)	1 slice
with butter	1 pat
with strawberry jam	2 teaspoons
Black coffee	1 cup (8 oz.)

4. Remember to include beverages, and anything you may add to them, such as milk or sweetener.

5. Remember to include anything added to a food after it is prepared, such as margarine, salt, catsup, and the estimated amount.

6. If you need additional space, use the back of the paper or attach additional sheets.

7. Answer the question at the bottom of the day's record. (Does this day's record represent your usual food intake? __ Yes __ No). If your answer is no, explain why it wasn't representative. Were you ill or are you on a special diet? Did you have unexpected guests and you took them out to dinner?

8. If you have any other questions concerning the 24-hour recall, please call Karen Chapman-Novakofski, RD, LD, PhD at 244-2852 or Karen Plawecki, MS, RD, LDN at 224-2884 (plawecki@uiuc.edu).

Code: ___________

Food or Beverage Item Consumed	Amount Consumed

Does this day's record represent your usual food intake? __Yes __No. If not, please explain.

Code: ___________

24-hour recall follow-up survey

Please scan the food intake and answer these questions:

1) Do you know the specific brand names for the products consumed?
   Yes ____ No_____

   If yes, please include brands on the list

2) Were any of the foods consumed known to be calcium-fortified?
   Yes ____ No_____

   If yes, please mark which foods.

3) Are there any foods that you added milk (such as, smoothies, soups)?
   Yes_____ No_____

   If yes, please mark which foods and estimate how much.

4) Are there any foods that with cheese (such as, salads, sandwiches)?
   Yes ____ No_____

   If yes, please mark which foods and estimate how much.

5) Please list any foods that were prepared with multiple ingredients (such as, smoothies, chili)

Thank you!

Calcium Food Frequency

Instructions: We would like to know how often you eat foods that are high in calcium. For each of these questions choose the appropriate time frame, and fill in the frequency.

For instance, if the question was -- How often do you eat cake? -- and you eat cake once per month, under" Per month" you would write "1" and leave the other columns blank.

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
cake			1		

If the question was -- How often do you eat bread? -- and you eat 4 slices of bread per day, under "Per day" you would write 4, and leave the other columns blank.

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Bread, slice	4				

Some of these questions may be hard to "guess at". Just give your best estimate.
Quick key to portion sizes:
1/2 cup = tennis ball
1 cup = closed fist
1 oz = 1 piece of string cheese

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Dairy					
Milk, 1 cup, (including milk added to cereal, shakes, coffee, etc)					
Yogurt, 1 cup					
Aged cheese, 1 oz, (e.g., cheddar, Swiss, provolone, Monterey jack, colby)					
Cheese food, 1 oz, (American, Velveeta)					
Cottage cheese, 1/2 cup					
Ice cream, frozen yogurt, 1/2 cup					
Other foods using dairy products					
Pizza, 1/8 of 15 inch pizza					
Lasagna, 1 cup or 8 oz					
Enchiladas, tacos, 1					
Macaroni & cheese, 1 cup					
Soups made with milk					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Fruits					
Orange juice with calcium, 1 cup					
Orange, whole					
Papaya, 1 cup					
Rhubarb, 1 cup					
Raisins, 1 cup					
Pear halves, dried, 10 each					

Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Vegetables, cooked					
Broccoli, 1/2 cup					
Bok choy, 1/2 cup					
Greens (collard, turnip, mustard, spinach), 1/2 cup					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Grains					
Total Cereal, 1 cup					
Special K Plus, 1 cup					
Other Fortified* cereal (e.g. Basic 4, Life Cinnamon), 1 cup					
Cereal, 1 cup					
Fortified* instant oatmeal, 1 cup					
Fortified* Graham crackers (e.g. Teddy Grahams), 24 pieces					
Fortified* cereal bars, 1 bar					
Fortified* bread, 1 slice					
Corn bread, 1					
Waffles (homemade or from mix), 1					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Meats & meat alternatives					
Sardines, 3.5 oz					
Oysters, clams, 20					
Crab legs, 1 cup					
Anchovies, 10					
Legumes/beans, 1/2 cup					
Almonds, 1/4 cup					
Mixed nuts, 1/4 cup					
Tofu set with calcium, 1/2 cup					
Food Group	**Per day**	**Per week**	**Per month**	**Per year**	**Don't eat**
Others					
Fortified* Crystal Light, 1 cup					
Fortified* Country Crock margarine, 1 tbsp					
Cheese cake, 1/8 of cake					
Cream pies (including pumpkin), 1/8 of pie					
Chocolate bar (1.5-2.15 oz)					
Slim Fast, can					
Slim Fast, powder mixed with water					
Slim Fast, powder mixed with milk					

* fortified = with added calcium

Code: ___________

What foods do you eat that you know are fortified with vitamin D?

____

Please take another minute and review you responses to the food frequency. Common errors are answering an amount for the food above or below the intended food, or skipping a line.

Have you re-checked your food frequency? ________ yes _______ no

HAPPY BONES EVALUATION

FACILITATOR:

	Unsatisfactory	Poor	Average	Good	Excellent
Knowledge of subject	1	2	3	4	5
Organization of training	1	2	3	4	5
Listening skills	1	2	3	4	5
Enthusiasm	1	2	3	4	5
Ability to answer questions	1	2	3	4	5
Presentation skills	1	2	3	4	5
Effectiveness in using equipment and materials	1	2	3	4	5

Additional comments about presenter(s): ____
____
____
____
____

CONTENT:

	Unsatisfactory	Poor	Average	Good	Excellent
Quality of content	1	2	3	4	5
Value	1	2	3	4	5
Relevance	1	2	3	4	5
Handouts	1	2	3	4	5
Amount of time spent on activities	1	2	3	4	5

Additional comments about the content: ____
____
____
____
____

ACTIVITIES:

Effectiveness (e.g., improvement in likelihood of engaging in specific bone healthy behavior and/or improving confidence) of the activities/give-a-ways:

	Not likely	Somewhat likely	Very Likely
Heel ultrasound	1	3	5
Body frame, Risk factor quiz	1	3	5
Serving size estimation	1	3	5
Food label critique/ calcium estimation	1	3	5
Taste tests of natural and fortified calcium sources	1	3	5
Pedometers	1	3	5
Heel drops	1	3	5
Balance, posture exercises	1	3	5
Stretch bands	1	3	5
Soy, Smoothie taste tasting	1	3	5
Bone Health Jeopardy	1	3	5
Bone healthy meal	1	3	5

Additional comments about the activities: ____
____
____
____
____

OVERALL EVALUATION:

	Unsatisfactory	Poor	Average	Good	Excellent
Overall rating	1	2	3	4	5

What did you like least or would change?: ____
____
____
____
____

What did you like most?: ____
____
____
____
____

AUTHOR'S BIOGRAPHY

Karen Plawecki was born in Hammond, Indiana. She grew up in South Bend, Indiana and attended Purdue University for her Bachelor's of Science degree. After completing her dietetic internship at Good Samaritan Hospital in Cincinnati, Ohio, Karen practiced as a clinical and outpatient dietitian at Baptist Hospital in Knoxville, Tennessee. She returned to Purdue to earn a MS in Nutritional Sciences. Her graduate work was part of ground breaking research in the area of calcium metabolism in adolescents. She helped to design and implement the first Camp Calcium. Following her MS degree, Karen worked in academics at Purdue and later became the Director of the Didactic Program in Dietetics at the University of Illinois at Urbana-Champaign and ultimately completed her doctorate training in Nutritional Sciences. Following her doctorate, Karen will continue to pursue options in food and nutrition behavior research.