EVALUATION OF OSTEOPOROSIS EDUCATIONAL INTERVENTIONS EFFECTS ON

KNOWLEDGE, HEALTH BELIEFS, SELF-EFFICACY, DIETARY CALCIUM AND

VITAMIN D INTAKES

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Title

Evaluation of Osteoporosis Educational Interventions Effects on Knowledge,
Health Beliefs, Self-Efficacy, Dietary Calcium and Vitamin D Intakes

By

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ABSTRACT

Osteoporosis is a serious public health issue, which is growing in significance because of our aging population. It is estimated that 34 million individuals in the United States are at risk for osteoporosis. Education may be key to increasing preventative behaviors in younger adults to help prevent osteoporosis in later life.

One purpose of this study was to determine the validity and reliability of three revised scales, which were revised to include vitamin D related items: Osteoporosis Knowledge Test –D, Osteoporosis Health Belief Scale-D, and the Osteoporosis Self-Efficacy Scale-D. These revised scales were then used to determine the effects of educational interventions (lecture versus hands-on activities) on osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and dietary vitamin D intake in a sample of college age adults.

A sample of 153 college age men and women completed online pre and post-questionnaires to assess osteoporosis knowledge, health beliefs, and self-efficacy using the validated revised Osteoporosis Knowledge Test (OKT-D), revised Osteoporosis Health Belief Scale (OHBS-D), and revised Osteoporosis Self-Efficacy Scale (OSES-D) respectively. Pre and post three-day food diaries were used to assess dietary calcium, vitamin D, and kcalorie intake.

In general, the college age adults in this sample were low in osteoporosis knowledge. Both intervention styles increased osteoporosis knowledge and health beliefs but not self-efficacy. Dietary calcium intakes at baseline met the recommendations while dietary vitamin D did not. No significant increases were found in dietary calcium or vitamin D intake after the educational interventions. Osteoporosis health beliefs were a significant predictor of dietary calcium intake ($p<.044$) and vitamin D intake ($p<.047$) accounting for

approximately 11.2% and 10.1% of the variance respectively. Self-efficacy was a significant predictor of vitamin D intake (p<.01) only, accounting for approximately 7.3% of the variance.

These findings suggest different types of osteoporosis educational interventions may increase knowledge and health beliefs in college-age adults but may not change behaviors. Perhaps tailored interventions towards specific health beliefs and self-efficacy are needed to warrant behavior change.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PBM…………………..Peak Bone Mass

BMD………………....Bone Mineral Density

OHBS………………..Osteoporosis Health Belief Scale

OKT…………………..Osteoporosis Knowledge Test

OSES…………………Osteoporosis Self-Efficacy Scale

OHBS-D......................Osteoporosis Health Belief Scale-revised with vitamin D items

OKT-D.........................Osteoporosis Knowledge Test-revised with vitamin D items

OSES-D.......................Osteoporosis Self-Efficacy Scale-revised with vitamin D items

CHAPTER ONE. INTRODUCTION

Osteoporosis is a disease characterized by low bone mass and deterioration of bone tissue which can lead to bones that are weaker and more susceptible to fractures (National Osteoporosis Foundation, [NOF], 2010). Common sites of osteoporosis-related fractures are the hip, spine, distal forearm, pelvis, ribs, and leg bones (NOF, 2010). Osteoporosis is primarily thought of as a disease that affects women, however, of those 34 million who are at risk for osteoporosis, 12 million are men (NOF, 2010). An additional health concern is that men also tend to fracture bones later in life, making it more difficult to recover compared to women (NOF, 2010). Peak bone mass (PBM) is generally attained by the age of 30. After reaching PBM, bone mass deteriorates at about 0.3% each year, which is related to aging changes to bone (Sedlak, Doheny, & Jones, 1998; World Health Organization [WHO], 2003). Additionally, in women, the rate of bone loss dramatically increases after menopause to approximately 3-7% each year (Heaney, 1992). High bone mineral density (BMD) can provide protective effects against osteoporosis in late adulthood (Lloyd, Petit, Lin, & Beck, 2004). Understanding variables that lead to increased PBM as well as variables that can lead to greater bone loss in later adulthood may help to contribute to preventative behaviors earlier in life.

Osteoporosis related fractures can cause severe pain and psychological symptoms associated with pain such as depression, anxiety, anger, and loss of self-esteem. Additionally, fractures can cause physical limitations and fear of having another fracture (Hallberg, Bachrach-Lindstrom, Hammerby, Toss, & Ek, 2009; Kannus, Parkkari, Niemi, & Palvanen, 2005). According to Yousri, Yichientsaia, Thyagarajen, Livingstone, and Bradley (2012) 20% of individuals who suffer a hip fracture will die within one year of the fracture occurrence.

The cost of treating osteoporosis is expected to be $200 billion by the year 2040 (Tussing & Chapman-Novakofski, 2005). Hip fractures alone accounted for 14% of fractures and 72% of fracture treatment costs in 2005 (Burge et al., 2007). The cost of prevention programs is far less than costs associated with the treatment of osteoporosis and related fractures (Tussing & Chapman-Novakofski, 2005).

Age, gender, low body weight, ethnicity, family history, smoking, excessive use of alcohol, limited physical activity, and decreased hormones such as estrogen and testosterone can predispose an individual to osteoporosis (United States Department of Health and Human Services [USDHHS], 2004). Two important dietary factors known to contribute to osteoporosis are low levels of dietary calcium and vitamin D.

Calcium plays a major role in bone formation. Bones and teeth make up more than 99% of the body's calcium (Boskey, 2007). Since calcium is important for bone structure, it is imperative that the diet be adequate in dietary calcium for adequate bone health. Recommendations are 1300 mg of calcium for youth ages 9-18 and 1000 mg for adults 19-50 (Ross, Manson et al., 2011). Approximately 78%-90% of women over age 20 are not meeting calcium recommendations (National Institutes of Health [NIH], 2005). Vitamin D also plays a role in ensuring adequate calcium absorption. Inadequate vitamin D intake can lead to poor absorption rates of calcium (Heaney, 1992). Research primarily focuses on calcium intake as an outcome measure of osteoporosis education interventions; few studies examine vitamin D in this context.

The relationship between vitamin D and osteoporosis related falls and fractures has been studied in detail. Adequate vitamin D intakes have been shown to decrease fall and fracture rates (Hosseini & Hossieini, 2008). Vitamin D recommendations have been updated to include

recommendations of 600 IU for individuals ages 1-70 (Ross, Manson et al., 2011). Individuals in northern latitudes in particular may be insufficient in vitamin D. Calcium absorption may be decreased without adequate vitamin D, leading to a deficiency of calcium and increasing the risk of osteoporosis (Heaney, 1992). These nutritional factors are important variables in the prevention of osteoporosis. Early education should be conducted to help prevent the pain and cost of osteoporosis related falls and fractures.

Knowledge and beliefs can play an important role in influencing dietary behavior. Knowledge alone does not always predict behavior (Wallace, 2002) due to the strong influence of internal health beliefs. The expanded health belief model (EHBM) has been used to identify factors related to promoting healthy behaviors (Rosenstock, 1960). The model indicates that health behavior depends on perception in four major areas: severity of a potential illness, susceptibility to that illness, benefits of taking preventive action, and the barriers to taking that action (Rosenstock, 1960). According to the EHBM, individuals who have certain beliefs will be more likely to achieve a behavior and self-efficacy is expected to increase with increasing knowledge (Rosenstock, Strecher, & Becker, 1988). Lifestyle behavior, cessation of smoking, adequate exercise, and adequate nutrition can influence bone health in later adulthood (Morgan, 2008; Sadler & Huff, 2007). Health beliefs often influence these lifestyle choices (Gammage & Klentrou, 2011; Sadler & Huff, 2007). Primary prevention strategies need to be increased and commenced as early as possible to promote a high PBM. Because osteoporosis is not a disease that one can cure, prevention is critically important (Tung & Lee, 2006). By assessing the knowledge of osteoporosis risk factors and the extent to which preventive behaviors, such as adequate calcium intake, vitamin D intake, and physical activity are practiced among college students, health care professionals will be better equipped to develop, implement, and evaluate

comprehensive osteoporosis educational interventions. Additionally, it is important to understand which type of educational intervention program best leads to behavior changes such as increasing dietary calcium and vitamin D intakes. Since osteoporosis affects more women compared to men, many educational and prevention programs have been tailored to and evaluated only in female samples (Sadler & Huff, 2007), and osteoporosis in men has not been as thoroughly researched.

There is limited research concerning osteoporosis knowledge and osteoporosis health beliefs among college age students of both genders. There is minimal research on these populations' current osteoporosis preventative behaviors (Gammage, Francoeur, Mack, & Klentrou, 2009). Results from previous osteoporosis education interventions have been varied. The use of information such as brochures, workshops or interventions that only delivered information did not increase dietary calcium intake (Sedlak, Dohney, & Jones, 2000). Additionally, in a study that did assess dietary vitamin D intake, a 45-minute lecture did not increase dietary calcium or vitamin D intakes (Bohaty, Rocole, Wehling, & Waltman, 2008). A hands-on approach to educating, which included tailored activities to improve self-efficacy as well as osteoporosis health beliefs was, however, found to increase calcium intake significantly (Tussing & Chapman-Novakofski, 2005). Prevention, including proper nutrition and physical activity, should begin as early as possible in order to prevent osteoporosis rather than treat its associated fractures, falls, and related effects on quality of life (Gronholz, 2008). Increased prevention practices may theoretically lead to lower risk of osteoporosis, related fractures and falls, and increased health care costs in later life.

The purpose of this study was three-fold. The first purpose was to determine if modifying the Osteoporosis Health Belief Scale and Osteoporosis Self-Efficacy Scale resulted in valid and

reliable scales that included vitamin D in the instruments. The second purpose was to determine the level of osteoporosis knowledge, beliefs, and behaviors among college age students. The third and final purpose was to determine which educational delivery method would increase osteoporosis knowledge, beliefs, and preventative behaviors, specifically dietary calcium and vitamin D intake. This study will use the Expanded Health Belief Model (EHBM) and examine the constructs that include perceived susceptibility, severity, benefits, barriers, health motivation, and self-efficacy and their relation to osteoporosis prevention. An in-depth review of the current literature will be included followed by two articles. The first article will correspond to the first purpose of the study. The second article will correspond to the second and third purposes of the study. Finally, conclusions related to the broader contributions of the study will be presented in the final chapter.

CHAPTER TWO. LITERATURE REVIEW - OSTEOPOROSIS

Osteoporosis is the most common preventable bone disease in humans, and represents a major public health problem (USDHHS, 2004). Osteoporosis is defined as a skeletal disorder characterized by diminished bone strength, which increases a person's risk of fracture (National Osteoporosis Foundation [NOF], 2010). Osteoporosis is a silent disease until complications such as falls and fractures are visible. The most common fractures associated with osteoporosis are those of the vertebrae (spine), proximal femur (hip) and distal forearm (wrist) (NOF, 2010). Most fractures in older adults are due to low bone mass, even when they result from considerable trauma (NOF, 2010). Fractures have the potential to result in chronic pain, disability, and death (Ioannidis et al., 2009; Kannus et al., 2005; Salkeld et al., 2000). Similarly, fractures can cause psychological symptoms, most notably depression and loss of self-esteem. Fractures are also associated with pain, physical limitations, lifestyle, and cosmetic changes (Kannus et al., 2005). Anxiety, fear, and anger from fractures may impede recovery. High morbidity and consequently, dependency on caregivers due to a fracture can strain interpersonal relationships and social roles between individuals and their families (Hallberg et al., 2009; National Osteoporosis Foundation [NOF], 2010).

Osteoporosis can also lead to falls. Falls are a major health concern and the fifth leading cause of death in the older population (Rubenstein, 2006). In 2000, the direct cost from fatal and non-fatal falls was approximately $19.5 billion (Finkelstein, Chen, Miller, Corso, & Stevens, 2005). Falls are a large cause of functional impairment, disability, pain, and death in the older adult population (Kannus et al., 2005). The incidence of fracture and other injuries related to osteoporosis is expected to increase as the older adult population increases (Hosseini & Hosseini, 2008).

Osteoporotic fractures in older adults (a high percentage of these fractures were hip fractures) led to almost 550,000 hospitalizations, 180,000 nursing home admissions, 2.6 million physician visits, and approximately 2.4 million medications used (USDHHS, 2004). Osteoporosis-related fractures have been estimated to cost the United States health care system $17 billion in 2005 and are projected to cost $200 billion annually by 2040 (Tussing & Chapman-Novakofski, 2005). Hip fractures alone accounted for 14% of all fractures and 72% of fracture costs (Burge et al., 2007). One in five older adults die during the first year after a hip fracture and almost one third will require nursing home admission (National Institute of Health [NIH], 2001).

While women suffer from the majority of osteoporosis related fractures and incur the majority of the costs associated with them, men also incur costs related to osteoporosis-related fractures. It is estimated that the costs for osteoporosis-related fracture care for men is $3.2 billion or 18% of the total expenses related to osteoporotic fractures (USDHHS, 2004). In a study that included both men and women, researchers examined longitudinal changes in BMD at different points of the body to determine the differences in BMD between genders. Average yearly bone loss for women over four years ranged from 0.86% to 1.12% compared to 0.04%- 0.90% for men. They also found that men had a higher baseline BMD than women and, despite this, women still had a greater average percent loss in BMD over the four years in all sites of the body tested. Older men continued to lose BMD, but their rates of bone loss continued to be lower compared to women (Hannan et al., 2000). Interestingly though, men typically experience fractures at higher BMD compared to women (van Helden et al., 2006).

Bone Health

Bone strength is the combination of both bone density and bone quality (NIH, 2010). Bone quality includes certain factors that are related to bone development, including bone construction, turnover, cumulative damage, and mineralization (NIH, 2010). In healthy bones, the activity of osteoclasts (cells responsible for bone resorption) is balanced by the activity of osteoblasts (cells responsible for bone formation). Osteoporosis consequently develops when bone resorption exceeds bone formation, resulting in a net loss of bone tissue and changes to bone structure (Heaney, 1992). In men and women, aging is associated with significant loss of bone mass. In women, menopause-related estrogen decreases lead to higher levels of bone resorption, which are not compensated by increases in bone formation (NIH, 2010). Most importantly, there is an increased loss of trabecular bone (spongy marrow substance found at the end of long bones). As one ages, trabecular bone changes to become more porous and structured similarly to a honeycomb arrangement. There is also a loss of cortical bone (dense, compact bone which makes up the outer shell of bones), though this loss is much less compared to loss of trabecular bone (NIH, 2010). Men do not exhibit the significant bone loss that women do, simply because they do not have the same estrogen content that women do nor do they experience menopause. However, men do show a similar pattern of age-related bone loss (Khosla & Riggs, 2005). In both men and women, the changes in bone mass related to osteoporosis can result in an increased risk of fracture.

During childhood, bone modeling occurs which synthesizes new bone and simultaneously removes old bone (Seeman, 2003). Generally, as breakdown occurs in the inside of the bone, bone synthesis is occurring on the outside of the bone, which exceeds breakdown. During puberty however, bone synthesis is occurring on the inside and the surface of the bone,

resulting in thicker, denser bones. Bone synthesis usually reaches its peak by age 30 in adults (Heaney, 2000). This remodeling process is important even though bone synthesis decreases after the approximate age of thirty. Bone remodeling repairs damage to the bones and removes old bone which can become brittle and less pliable. The remodeling process continually happens throughout the lifespan and, every ten years, the skeleton is basically replaced. Even with aging, new bone can be formed, especially on the outside of the bone despite this process being slower in old age (Seeman, 2003).

Osteoporosis affects a large number of people, including both genders and all races. Its prevalence is expected to increase as the population ages. The NOF has estimated that more than 10 million Americans have osteoporosis and an additional 33.6 million have low bone density. Approximately one out of every two women and one in five men will experience an osteoporosis-related fracture at some point in their lifetime (NOF, 2010).

Nutritional Risk Factors Affecting Osteoporosis

Vitamin D.

Osteoporosis is not a "normal" part of aging. It is a disease in bone mass related to calcium and vitamin D deficiencies over the lifespan (NIH, 2010). The Institute of Medicine (IOM) report on the development of the Daily Recommended Intakes (DRIs) recommends an additional increased need for vitamin D for older adults aged 51-70 and 71 and older. The amount of vitamin D recommended and outlined in the DRIs follows in Table 1. The recommendations for adults have recently been updated in 2010 to state that recommendations are 600 IUs per day vitamin D for adults 19-70 and 800 IUs per day for adults older than 70 years of age (Ross, Taylor, Yaktine, & Del Valle, 2011; Sheffer and Taylor, 2008).

Table 1

Dietary Reference Intakes for Vitamin D

Life stage	Recommended Daily Allowance Vitamin D IU/day	Upper Limit Vitamin D IU/day
Infants 0 to 6 months	400	1000
Infants 6 to 12 months	400	1500
1-3 years old	600	2500
4-8 years old	600	3000
9-13 years old	600	4000
14-18 years old	600	4000
19-30 years old	600	4000
31-50 years old	600	4000
51-70 years old men	600	4000
51-70 years old women	600	4000
>70 years old	800	4000

Note. Adapted from the Institute of Medicine's Report "Dietary Reference Intakes for Calcium and Vitamin D," by C.A. Ross, C.L. Taylor, A.L. Yaktine, and H.B. Del Valle, 2011, C.A., Taylor, C.L. Yaktine, A.L., Del Valle, H.B. (2011). Food and Nutrition Board. The National Academies Press, Washington, D.C.

Sources of vitamin D.

Vitamin D3 is naturally synthesized in the body via ultraviolet radiation. The human skin makes vitamin D3 when 7-dehydrocholesterol reacts with Ultraviolet B (UVB) light at wavelengths of 290-315 nanometers (nm) and can synthesize up to 25,000 International Units (IU) of vitamin D in the skin until the skin turns slightly red or pink, also known as a minimal erythemal dose (MED) of sun exposure (Holick, 1995). Ultraviolet exposure past the MED does not continue to increase vitamin D production. The ultraviolet production of vitamin D precursors (7-dehydrocholesterol) is balanced by degradation of vitamin D and its precursors. The concentration of vitamin D precursors in Caucasian individual's skin reaches equilibrium

within 20 minutes of ultraviolet exposure (Holick, 1995). The amount of sun exposure that is needed to generate a MED will vary depending on different factors such as latitude, season, time of day, ozone amount, and cloud cover (Webb, 2006). For example, in the United States, at approximately 40 degrees latitude, or similar latitude of Philadelphia, Pennsylvania, vitamin D production will not be sufficient for three to six months each year (Holick et al., 2011). Because of this, researchers estimate that 10-20% of the population becomes mildly deficient in 25(OH)D by the end of winter (Holick et al., 2011; Hollis, 2005). Vitamin D production will also depend on individual factors such as skin type and age, as sun exposure times can be three to four times longer in individuals with higher amounts of melanin (the pigment responsible for darker skin pigmentation, brown or black hair, or brown eyes) in their skin (Diamond et al., 2005).

Vitamin D is found naturally in only a limited amount of food products such as eggs, mushrooms, cod liver oil, and cold water, fatty fish. Eggs and mushrooms contain minimal vitamin D contents (Calvo, Whiting, & Barton, 2004). In the United States, milk and milk products (fortified with vitamin D), meat, fish, eggs, and ready to eat (RTE) cereals (fortified with vitamin D) make up the top five food products consumed that contain vitamin D (Hill, Jonnalagadda, Albertson, Joshi, & Weaver, 2012). Since only certain foods are fortified with vitamin D, and the naturally occurring food sources of vitamin D are not commonly consumed foods or contain small amounts of vitamin D (ie. 25 IUs), it may be difficult to obtain enough vitamin D via the diet to reach the recommended amount of 600 IU vitamin D per day. Supplementation may then be needed to achieve this recommended level.

There are two major forms that are commonly used to fortify foods, vitamin D_2 and vitamin D_3. Vitamin D_2 (ergocalciferol) is obtained from fungal or plant sources and not made by the human body. Vitamin D_3 (cholecaliferol) is made by the body and can also be obtained from

animal sources (Hollis, 2005). In DeLuca's (2004) overview of vitamin D metabolism, he

explains vitamin D's major role in calcium regulation in the body. A narrow range of serum

calcium regulates bone growth, maintenance of bone density, and normal functioning of the

nervous system. Vitamin D is essential for efficient utilization of this range of calcium in the

body as well as regulating parathyroid hormone (PTH) excretion. Elevation in PTH increases the

activity of 25(OH)D3 -1-hydroxylase in the kidney which in turn increases the production of 1-

25(OH)2D: when 1-25(OH)2D production is increased, 1-25(OH)2D increasing the intestinal

absorption of dietary calcium in order to normalize serum calcium. (DeLuca, 2004).
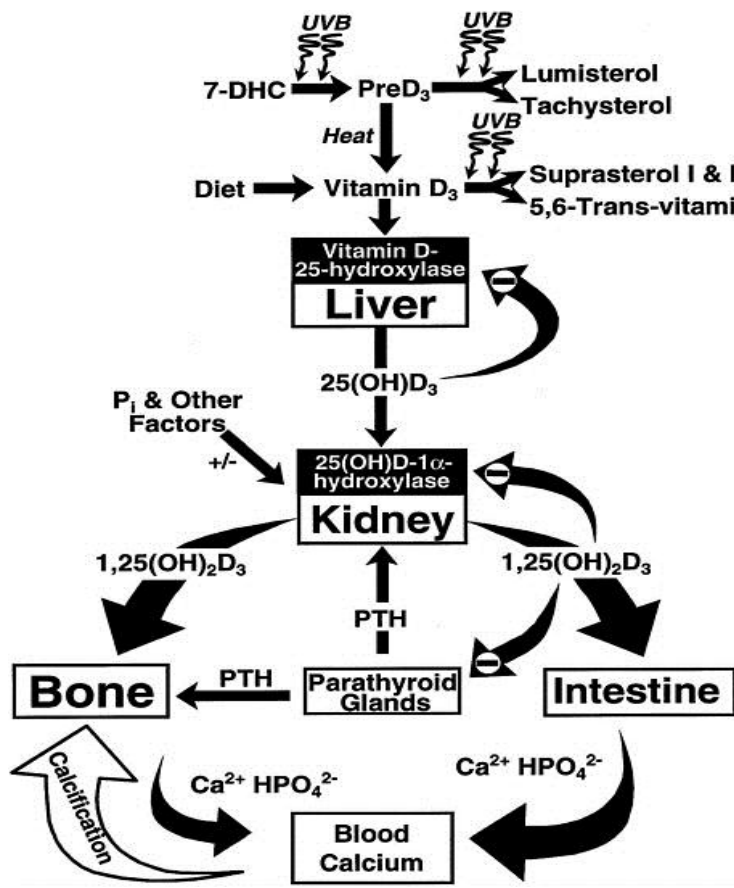
Figure 1. Photosynthesis of Vitamin D_3 and the Metabolism of Vitamin D_3 to 25(OH)D_3 and 1,25(OH)$_2$$D_3$. Parathyroid hormone (PTH) stimulates the synthesis of 1,25(OH)$_2$$D_3$, which, in turn, stimulates intestinal calcium transport and bone calcium mobilization, and regulates the synthesis of PTH by negative feedback. Adapted from "Environmental factors that influence the cutaneous production of vitamin D." by M.F. Holick, 1995, *The American Journal of Clinical Nutrition, 61*(3), 638S-645S.

Vitamin D toxicity.

Current dietary recommendations of vitamin D range from 200 IU to 800 IU (depending on age) per day with a safe upper limit of 4000 IU vitamin D per day for adults (Ross, Taylor et al., 2011). Potentially toxic side effects of vitamin D overdose include bone demineralization, hypercalciuria, hypercalcemia, and nephrocalcinosis with renal failure. These effects are found rarely and generally occur when a daily dose, generally due to supplement intake, exceeds 10,000 IU per day of vitamin D on a chronic basis (Veith, 1999).

Vitamin D deficiency.

Vitamin D deficiency has been historically defined and recently recommended by the Institute of Medicine (IOM) as a 25(OH)D level of less than 20 ng/ml (Ross, Manson et al., 2011). Vitamin D insufficiency has been defined as a 25(OH)D of 21–29 ng/ml (Ross, Manson et al., 2011). Previous research has not been consistent with using these cut off values for vitamin D deficiency and vitamin D insufficiency (Thacher & Clarke, 2011). Vitamin D deficiency is generally identified through the diagnosis of rickets, osteomalacia, or osteoporosis. However, vitamin D insufficiency has been used to describe 25(OH)D levels that are associated with diseases such as cancer, diabetes, multiple sclerosis, or other diseases (Thacher & Clarke, 2011). Specifically setting a definition for vitamin D deficiency and insufficiency based on 25(OH)D levels is still currently debated and is a limitation of the literature.

Consequences of vitamin D deficiency are abnormalities in calcium, phosphorus, and bone metabolism. A deficiency of vitamin D can cause a decrease in the effectiveness of absorption of intestinal calcium resulting in an increase in PTH levels (Holick, 2007). Secondary hyperparathyroidism maintains normal serum calcium by moving calcium out of bones by increasing osteoclast activity and therefore decreasing BMD (Holick, 2007). Children with

vitamin D deficiency can develop skeletal deformities, or rickets, due to mineralization of bone not being fully completed in childhood (Holick, 2006). Adults with vitamin D deficiency first develop osteomalacia (softening of the bone) which decreases bone mass and BMD. In addition, osteopenia, or bone pain often accompanies osteomalacia. In adults, there is enough mineralization bone so that skeletal deformities do not happen. Bone mass and BMD simply decreases in adults with vitamin D deficiency. When bone mass and BMD decrease by a standard deviation, osteoporosis develops (Holick, 2007). Table 2 shows Vitamin D deficiency stages along with clinical symptoms or signs.

Table 2

Vitamin D Deficiency Stages and Clinical Symptoms/Signs

Stages of vitamin D deficiency	What Happens	Clinical Symptoms/Signs	Age Group
Stage 1	25(OH)D levels decrease and result in hypocalcemia; 1-25(OH)2D may increase or remained unchanged	No visible signs or symptoms Dietary calcium absorption from the gut decreases from 30%–40% to 10%–15% when there is vitamin D deficiency	All age groups
Stage 2	25(OH)D levels continue to decrease; PTH works to maintain normal calcium range by breaking down bone	Low concentrations of 25-OH-D trigger the release of PTH. The increase in PTH facilitates the movement of calcium out of the bone, resulting in decreased bone mass in infants-adolescents; and bone mass and BMD in adults (after bone has mineralized). Fracture risk increases – due to decreased bone mass and BMD	Infants-Adolescents-<u>Rickets</u> Enlargement of the skull, joints of long bones, and rib cage; curvature of spine and femurs; generalized muscle weakness Adults (after bone mineralization) <u>Osteomalacia and osteopenia</u> Weakening and softening of bone with associated bone pain. BMD and Bone mass decrease Abnormal immune function with greater susceptibility to acute infections and other long-latency disease states such as cancers.
Stage 3	Severe 25-OH-D deficiency with hypocalcemia, bones have blatant signs of bone mass loss	Continued increase in PTH from Stage 2. Continued decrease of bone mass and BMD from Stage 2	Infants-Adolescents- Rickets continues to produce skeletal deformities Adults- Osteoporosis develops, bone mass and BMD decreases continue, microfractures develop in the bone, increased risk for fractures

Risk factors for developing vitamin D deficiency.

Factors that contribute to vitamin D deficiency include exclusively being breast fed, dark skin, aging, covering all exposed skin or using sunscreen whenever outside, fat malabsorption syndromes, inflammatory bowel disease, and obesity. Individuals with increased melanin or darker skin pigmentation synthesize less vitamin D from UVB radiation exposure than those with less melanin or lighter skin pigmentation (Matsuoka, Wortsman, Haddad, Kolm, & Hollis, 1991). Consequently, risk of vitamin D deficiency is increased in dark-skinned individuals, especially African American individuals who live in northern latitudes. Melanin in the skin blocks UVB radiation from penetrating the skin and therefore less vitamin D_3 is made (Matsuoka et al., 1991). African American individuals need at least five to ten times longer exposure to sun than Caucasian individuals to produce adequate vitamin D_3 (Nesby-O'Dell et al., 2002).

Age is also a risk factor for developing vitamin D deficiency. Individuals as they age, may have a decreased ability to synthesize vitamin D_3 in the skin when exposed to UVB radiation (Holick, 2007). As one ages, lifestyle factors such as increasing the amount of clothing worn and decreasing the amount of time spent on outdoor activities may decrease the amount of UVB radiation exposure. In older adults, the skin changes in regard to the amount of precursor it contains in order to synthesize vitamin D. The precursor decreases and the production of vitamin D in the skin after UVB exposure is decreased (Holick, Matsuoka, & Wortsman, 1989). Additionally, the renal production of 1-25(OH)2D decreases because of diminishing renal function with age (Lau & Baylink, 1999). These changes in vitamin D metabolism place the aging population at risk for vitamin D deficiency, especially in winter seasons and in individuals who live at higher latitudes. These potential deficiencies in vitamin D place older adults at increased risk for osteoporosis (Lips, 2001). A detailed review of 25(OH)D levels in various

populations in Europe, the United States, Australia, and other countries including 83 different studies was conducted by Lips (2001). He found that vitamin D insufficiency is common among community-dwelling older adults and almost universal among institutionalized older adults at multiple latitudes.

Chronic coverage of all exposed skin, either with clothing, shelter, or sunscreen significantly increases the chances of becoming vitamin D deficient. The use of sunscreen with a sun protection factor (SPF) of 8 and 15 reduce Vitamin D production by 95% and 98% respectively (Matsuoka, Wortsman, Hanifan, & Holick, 1988). Seasonal variation of UVB radiation can also increase the risk of becoming vitamin D deficient. Concentrations of 25(OH)D are generally highest in late summer and early autumn and lowest in late winter and early spring (Bolland et al., 2006). Three hundred, seventy-eight healthy, community dwelling living, men and 1,606 post-menopausal women were examined from January, 2004 until May, 2005. The researchers found that seasonal variation in 25(OH)D levels were prominent in both genders, however men were found to have lower rates of suboptimal vitamin D status, even in winter (Bolland et al., 2006). Such seasonal variations in 25(OH)D concentrations indicate that a person could have adequate 25(OH)D concentrations in the summer and autumn months but suboptimal concentrations in the winter and spring. Adult populations in latitudes far away from the equator such as the northern United States face a challenge of meeting adequate vitamin D status from UV exposure (Lips, 2001).

In the United States, obesity [defined as body mass index (BMI) $\geq$ 30] has been increasing, although at a slower rate than the past 10 years (Centers for Disease Control [CDC], 2010). Obesity may increase the risk of vitamin D deficiency since vitamin D synthesized in the skin or ingested can be deposited deep down in body fat stores, making 25(OH)D (the storage

form) of vitamin D possibly unavailable for vitamin D metabolism (Wortsman, Matsuoka, Chen, Lu, & Holick, 2000.) When dietary vitamin D or vitamin D from UV exposure is not available, this stored vitamin D [25(OH)D] in the fat tissue, is converted to 1-25(OH)$_2$D. However, in obese individuals, this vitamin D is thought to be stored deep in the fat tissue and thus, more difficult to utilize. Consequently, the amount of vitamin D available is reduced and increased dietary vitamin D intake or supplementation may be required to maintain a sufficient vitamin D status (Wortsman et al., 2000).

Vitamin D, bone mineral density, falls, and fractures.

Decreased BMD is a risk factor for osteoporosis. Lower BMD may predispose an individual to fractures and falls associated with osteoporosis (Bischoff-Ferrari, Zhang, Kiel, & Felson, 2005). Stone et al. (1998) found that older Caucasian women in the highest quartile of serum 25(OH)D (> 80 nmol/L) had a mean annual loss in total hip BMD of 0.1% compared to 0.7% in the lower quartile (< 52.5 nmol/L). Additionally, there has been a positive association reported between 25(OH)D and BMD of the femoral neck that was independent of age, gender, BMI, disease severity, and physical activity (Bischoff-Ferrari et al., 2005). Additionally, fifteen percent of the previous study's sample were classified as vitamin D deficient (<40 nmol/L), and 51% had 25(OH)D levels between 40-80 nmol/L. Individuals in the 40-80 nmol/L group and greater than 80 nmol/L group had a 7.3% and 8.5% higher BMD than those in the deficient group respectively (Bischoff-Ferrari et al., 2005).

Over 60% of community-dwelling older adults 50 years and older have reported falling at least one time in a 4-year period (Painter, Elliott, & Hudson, 2009). Falls signify the largest single cause of injury mortality in older individuals and are an independent factor of functional decline, (Kannus et al., 2005), leading to 40% of all nursing home admissions (Tinneti &

17

Williams, 1997) and considerable economic costs (Bishop et al., 2002). Annual costs from all fall related injuries in the United States in persons 65 years or older have been projected to increase from $20.3 billion in 1994 to $32.4 billion by 2020 (Bishop et al., 2002). Pooled results from a meta-analysis showed a statistically significant reduction (22%) in the risk of falling with vitamin D supplementation (>800 IU vitamin D per day) compared with calcium or placebo independent of vitamin D type, duration of therapy, calcium supplementation, and sex (Bishoff-Ferrari et al., 2004).

Not only may serum vitamin D status be a risk factor for decreasing BMD and falls, it may also play a role in fractures. A review of vitamin D supplementation with and without calcium supplementation on prevention of falls and fractures showed that doses of 700-800 IU vitamin D per day decreased hip fracture risk by 26% and non-vertebra fracture risk decreased by 23% compared to calcium supplementation with no combined vitamin D or placebo. No significant benefits for reducing fractures were found in studies using supplements of 400 IU vitamin D per day. Additionally, numerous studies contain methodological problems including using lower amounts (<600 IU per day) of vitamin D supplementation, while other studies included confounding factors, such as poor vision, that may have resulted in increased falls and fractures (Frances, Anderson, Petel, Sahota, & van Staa, 2006). Results from studies that included calcium plus vitamin D supplements or vitamin D alone on the risk of fractures have been conflicting. This could be due to differences in vitamin D doses used, gender, baseline vitamin D status, type of vitamin D used or the heterogeneity in the samples of populations studied (Frances et al., 2006).

Trivedi, Doll, and Khaw (2003) examined vitamin D supplementation of 100,000 IU to be taken orally every 4 months over 5 years. The dose of 100,000 IU every 4 months is

equivalent to a daily dose of 800 IU of vitamin D based on 25(OH)D levels. They found that the participants had a 22% lower rate for first time fractures at any site in the body and a 33% lower risk of fractures occurring at the hip, wrist/forearm or vertebrae, the most common sites for fractures. The study found a 40% higher average concentration of serum 25(OH)D decreased PTH levels, but not significantly. This suggests that an 800 IU/day supplement may not be enough to significantly lower PTH levels and could still lead to fractures. A larger or more frequent dose could lower PTH levels and lead to increased bone mass. This study supports the position that requirements for vitamin D should be increased (Trivedi et al., 2003).

Vitamin D may play a role in preventing fractures and falls in older adults. It is important to begin obtaining adequate vitamin D as early as possible in life in order to prevent osteoporosis related decreases in BMD, falls, and fractures in later life. The previous research has indicated that much of the United States population may be vitamin D insufficient or deficient. Estimates of vitamin D deficiency in the United States range from 20% to 100% of the population (Holick, 2006; Holick, 2007; Holick et al., 2011; Lips et al., 2006). Additionally, previously mentioned research indicates that 800 IU of vitamin D may be the minimal dose to see any positive effects in older adults on BMD, falls and fractures (Trivedi et al., 2003) and suggests that dietary intake may need to be increased from the current IOM recommendations of 600 IU per day.

Dietary calcium.

Dietary calcium intake is another nutritional factor that is related to osteoporosis and determines bone strength and maintenance of BMD throughout the lifespan. It is particularly important during the prepubescent and adolescent years when bone mass develops rapidly (Bonjour, Chevalley, Rizzoli, & Ferrari, 2007; Zhu et al., 2008). Additionally, in

19

postmenopausal women, a diet high in calcium has been shown to be beneficial in the prevention of osteoporosis (Daniele et al. 2004; Moschonis & Manios, 2006).

Calcium is a nutrient that is commonly associated with the formation and metabolism of bone. Approximately 99% of the body's calcium is stored as calcium hydroxyapatite in the bones and teeth (Boskey, 2007). Calcium is also found in the circulatory system, extracellular fluid, muscles, and other tissues that are essential for vascular contraction, muscle function, hormone secretions, intracellular signaling, and nerve impulses. Bone tissue is the main source of calcium for these metabolic pathways and is crucial for remodeling of bone which includes creating new bone and removing old bone (all within the same bone) (Seeman, 2003).

Calcium recommendations and sources.

The IOM has recently released recommendations for calcium as shown in Table 3. The current recommendations are 1000 mg for adults 19-50, 1200 mg for women 51-70 and 1200 mg for adults 70 years and older (Ross, Taylor et al., 2011).

Calcium is generally associated with dairy products such as milk, yogurt, and cheese. These food sources of calcium provide the major portion of calcium in the general diets of the United States. Milk, cheese, and yogurt, in addition to food items that these dairy products are added to (e.g. pizza) supply an estimated 72 % of calcium for diets in the United States. The following foods make up the remainder of the calcium supplied by food sources: vegetables (7%), grains (5%), legumes (4%), fruit (3%), meat, poultry, and fish (3%), eggs (2%), and miscellaneous foods (3%) (Wells & Buzby, 2009).

In the United States, fortification or the addition of nutrients that are not normally naturally found in those foods is becoming routine. Calcium and vitamin D fortification seem to be part of this trend. Food and beverage fortification with calcium and vitamin D of orange juice

and RTE cereals are just some these new foods inundating the market (Poliquin, Joseph, & Gray-Donald, 2009). The USDA database for nutrient composition is often out of date with regard to products that contain calcium and vitamin D since new products are constantly being introduced to the market. If the databases are not up-to-date, then intakes of dietary calcium and vitamin D may be underestimated by those using the database for dietary assessment. Furthermore, estimates of calcium and vitamin D intakes may be further underestimated because approximately 50% of the United States population reports that they use some type of dietary supplement (Poliquin et al., 2009).

Table 3

Dietary Reference Intakes for Calcium

Life stage	Recommended Daily Allowance	Upper Limit
	Calcium mg/day	Calcium mg/day
Infants 0 to 6 months	200	1000
Infants 6 to 12 months	260	1500
1-3 years old	700	2500
4-8 years old	1000	2500
9-13 years old	1300	3000
14-18 years old	1300	3000
19-30 years old	1000	2500
31-50 years old	1000	2500
51-70 years old men	1000	2000
51-70 years old women	1200	2000
>70 years old	1200	2000

Note. Adapted from the Institute of Medicine's Report "Dietary Reference Intakes for Calcium and Vitamin D," by C.A. Ross, C.L. Taylor, A.L. Yaktine, and H.B. Del Valle, 2011, C.A., Taylor, C.L. Yaktine, A.L., Del Valle, H.B. (2011). Food and Nutrition Board. The National Academies Press, Washington, D.C.

Dietary calcium absorption from animal products is thought to be superior to plant sources of calcium because animal sources may contain vitamin D and Vitamin K, which can enhance bioavailability (Kass-Wolf, 2004). Additionally, plant sources may contain phytates, oxalates, fiber, and phosphate that may decrease the bioavailability of calcium from such sources (Nordin, 1997).

The relationship between calcium bioavailability and caffeine has also been studied. Caffeine may increase urinary calcium excretion leading to a reduction in BMD and therefore increase the risk of osteoporosis. In a review by Heaney (2002), evidence was mixed when examining effects of caffeine on calcium balance. Although some studies found a small negative calcium balance with caffeine consumption, these results were typically found in individuals who were inadequate in dietary calcium intake (<600 mg/day calcium). Additionally, the effects were found to be negated by one to two tablespoons of milk per cup of coffee (Heaney, 2002). The majority of observational studies found no effect of caffeine on calcium and BMD. Adequate calcium intake may offset any effect that caffeine may have on calcium balance (Heaney, 2002).

Calcium intakes in the United States population.

The IOM has defined the Adequate Intake (AI) of calcium as 1,000 mg/day for individuals aged 19 to 50 years and 1,200 mg/day for persons older than age 51 years (Ross, Taylor et al., 2011). A study by Mangano, Walsh, Insogna, Kenny, and Kerstetter (2011) evaluated NHANES data from 2003-2006 and found that only 15% of men and 8% of women older than age 71 had dietary calcium intakes that met the 1,000 mg/day AI level. Additionally, it is of interest to note that median dietary calcium intakes decreased by 22.7% and 14% in men and women respectively, from the youngest to the oldest age group.

22

Approximately 51% of the total sample in Mangano et al. (2011) were taking a calcium supplement. Supplemental calcium may play a role in preventing bone loss due to dietary calcium intakes often being below the recommended intake levels. Supplemental calcium can include calcium added to foods, such as calcium fortified orange juice, as well as calcium contained in dietary supplements and antacids. Even though there has been an increase in dairy consumption in the United States in the past few years (Forshee, Anderson, & Storey, 2006), calcium supplementation may still be needed in order to meet the AI levels, especially for older adults. According to Mangano et al. (2011) percentages of those taking a calcium supplement increased in an older adult sample (aged 81 and older) compared to younger men. Men who used a calcium supplement in the 19-30, 31-40 and 41-50 year old age groups had an average intake of dietary calcium close to the recommended 1000 mg per day (973 ± 57.3 mg; 1030 ± 45.6 mg and 908 ± 40.4 mg respectively). Women who took a calcium supplement in all age groups did not meet the recommendations for dietary calcium by dietary intake alone but when a calcium supplement was factored in, the age groups of 19-30 and 31-40 years old were close to meeting the recommendations of 1000 mg calcium per day (Mangano et al., 2011).

Non-Nutritional Risk Factors Affecting Osteoporosis

Physical activity.

Physical activity is related to bone mass since the more stress that is placed on the skeleton, the greater bone mass that is synthesized (USDHHS, 2004). If physical activity is stopped, muscle mass is lost, which in turn signals the need for less bone. Consequently, bone is then removed from the body (USDHHS, 2004).

Rates of physical activity can vary depending on which part of the country is assessed. In the United States, approximately 25% of the population reported that they did not participate in

any type of physical activity other than what they experienced in their job. In Minnesota, less than 20% of the state's population reported being physically inactive while in North Dakota, approximately 25% reported they were physically inactive (CDC, 2008). Several different factors have been identified that increase physical activity adherence including increasing motivation and enjoyment that relates to the activity, making physical activity a priority, improving body image, and increasing access to support (Huberty et al., 2008).

Physical activity recommendations indicate that adults should engage in 150 minutes of moderate-intensity (5-6 on a scale of 0 to 10) activity or 75 minutes of vigorous intensity (7-8 on a scale of 0 to 10) activity per week for health and bone health. However, resistance exercises must be performed two to three times per week for optimal bone health. (American College of Sports Medicine [ACSM], 2007). Lower intensity exercise such as walking will only slightly improve bone health. Vigorous weight bearing activities such as jogging will more likely benefit bone to a greater extent (NOF, 2010). However Winters-Stone (2005) suggests that these activities should be performed for 30-60 minutes to see bone health benefits.

Exercise may provide additional benefits such as reducing falls and fractures, specifically in the older adult population. Weight-bearing physical activity, specifically resistance training, has been shown to improve muscle mass and muscle strength (Kukulja, Nowson, Sanders, & Daly, 2009). This increased muscle mass and muscle strength can improve balance and gait (Chodzko-Zajko et al., 2009). Studies have shown that resistance training alone can reduce the risk of falling as well as reducing the risk of fracture (Heesch, Byles, & Brown, 2008). In a review of physical activity and the risk of osteoporosis-related fractures by Moayyeri (2008), moderate to vigorous physical activity was associated with a reduction of hip fractures by 45% in men and 38% in women. Additionally, the risk of falling showed a U-shape where the risk

decreased in those except either the most active or the most inactive. This is presumably related to the more physical activity one partakes the greater the risk of falling due to requiring balance more often. A person is at greater risk simply because there are more chances to experience a fall by accident. The inactive group was at greater risk for falling due to also having a lower BMD (Moayyeri, 2008).

Genetic predisposition.

Numerous genetic factors may play a role in the development of osteoporosis (New & Bonjour, 2003). Twin studies have shown that 85% of the BMD variance is due to genetic factors (Geuguen et al., 1995; Krall & Dawson-Hughes, 1993). Deng et al., (2000) has shown that a family history of hip fracture is a risk factor for fracture incidence independent of BMD and was estimated that a fracture is heritable by 25-35%. Additionally, Andrew et al. (2005) found that wrist factures were 54% heritable.

Genetics may also play a role in body weight and body composition. It is hypothesized that a greater weight induces greater strain on the body, specifically muscle mass and bone, resulting in a protective effect against developing osteoporosis (Chumlea, Wisemandle, Guo, & Siervogel, 2002). Reid (2002) stated that body weight (which includes body fat and muscle mass) has a beneficial effect on BMD. Additional studies have found an increase in BMD related to increased body weight and body composition (Ilich, Borwnbill, & Tamborini, 2003; Laet et al., 2005).

Hormones.

Estrogen is a major player in building and maintaining bone mass. Age of menarche has been shown to affect PBM and therefore, BMD in later life. Chevalley, Rizzoli, Hans, Ferrari, and Bonjour (2005) found that calcium intake may impact timing of menarche, which impacts

PBM. A greater PBM could be due to earlier age at which menarche begins and estrogen increases. In older adults, estrogen deficiency may be seen after menopause and therefore has an impact on bone, as osteoclast activity is not inhibited due to lack of estrogen (Pietschmann et al., 2001). Additionally, in men, testosterone deficiency has been associated with bone loss; however, estrogen seem to play a more important role in bone mass of men compared to testosterone. In men with osteoporosis, estrogen is decreased and sex-hormone-binding globulin (SHBG) is elevated. These elevated SHBG levels can lead to osteoporosis because they decrease the bioavailability of estrogen and testosterone, which consequently allows osteoclast activity to surpass osteoblast activity leading to reduction in bone mass (Pietschmann et al., 2001).

Bone loss that occurs with estrogen deficiency is accelerated and bone mass decreases about 3-7% per year for the first five years after menopause (Heaney, 1992). Postmenopausal women are at greater risk for fractures due to this rapid decrease in estrogen. Nutrition also plays a role in the menopause and osteoporosis relationship. A high dietary calcium intake may help prevent against decreased BMD. Dietary calcium has been found to be associated with higher levels of estrogen metabolites and higher BMD when compared to those taking calcium supplements (Napoli, Thompson, Civitelli, & Armamento-Villareal, 2007).

Medication treatment.

Obtaining PBM and maintaining bone mass over the life span is the overall goal for prevention and treatment. Modifiable risk factors such as dietary calcium, vitamin D, and weight-bearing physical activity must be adequate to reduce osteoporosis risk. Prevention is the key to attempting to decrease costs and health issues associated with osteoporosis such as fractures and falls (USDHHS, 2004). However, if an individual is at a high risk of fracture, medication therapy may be justified. Antiresorptive medications can reduce bone loss, stabilize

26

the structure of the bone, and decrease bone turnover. Medications can include bisphosphonates, estrogen, selective estrogen receptor modulators, calcitonin, and parathyroid hormone (USDHHS, 2004).

Currently bisphosphonates that are FDA-approved include alendronate (Fosamax®), risedronate (Actonel®), and Ibandronate (Boniva®). These medications are thought to work by binding to the bone surface, osteoclasts then take up these medications, which in turn decrease osteoclast activity, and thus reduces bone loss (USDHHS, 2004). Alendronate (Fosamax®) has been shown to increase BMD by 6%-8% at the spine and by 3%-6% at the hip over a three-year period in postmenopausal women. Additionally, almost the entire sample was able to either maintain or increase their BMD (Black et al., 1996). This small increase in BMD may seem trivial, but according to the authors, it translates to a reduction in fracture risk by approximately 50% (Black et al., 1996; Cranney, et al., 2002). Alendronate has also been shown to be an effective treatment for both men and women (Fleisch, 2002; Orwoll et al., 2000). Risedronate (Actonel®), another bisphosphonate, has also been shown to increase BMD and reduce fracture risk. Risedronate decreased vertebral fractures by 68% that included a large sample size of women (n=7705) and additionally decreased vertebral fractures by 66% in women that had a hip fracture within one year of treatment (Maricic et al., 2002). Risedronate has also been effective in women with low bone mass or osteopenia (Reid et al., 2000). A third bisphosphate that is currently FDA-approved for treatment and prevention of osteoporosis is Ibandronate (Boniva®). There are two forms of this medication including a daily or once a month prescription. The daily prescription has been shown to significantly decrease vertebral fractures by 49%; increase lumbar spine BMD by 6.5%, and increase hip BMD by 3.4% (Bilezikian, 2009). The once a

month form of the medication has been shown to have a greater increase in both lumbar spine and total hip BMD compared to the daily form (Bilezikian, 2009).

Hormone replacement therapy is another form of prevention and treatment that may be used. Hormone therapy was first approved in the 1960s for postmenopausal osteoporosis (USDHHS, 2004). The approval of the therapy was based on the fact that bone is lost after menopause due to decreases in estrogen (Riggs, Khosla, & Melton, 2002) and replacing such estrogen with hormone therapy would therefore likely increase bone mass (USDHHS, 2004). However, estrogen only therapy has been found to be associated with an increased risk of uterine cancer. Therefore, estrogen only therapy is generally prescribed only to those individuals who have had their uterus removed. All other estrogen therapies are prescribed in combination with progesterone (USDHHS, 2004). Combined estrogen and progesterone hormone therapy has been found to increase spinal BMD by 3.5%-7%, hip BMD by 2%-4%, and forearm BMD by 3%-4.5% (Lindsay, Gallagher, Kleerekoper, & Pickar, 2002). However, many studies have found negative effects of hormone therapy including increased risk of stroke, cognitive impairment, and deep vein thrombosis (Anderson et al., 2004; Shumaker et al., 2003; Shumaker et al., 2004). Breast cancer risk was also found to increase in women who were taking the combined therapy (Lagro-Janssen, Rosser, & van Weel, 2003).

Additional osteoporosis therapies include the use of Calcitonin and parathyroid hormone (PTH). Calcitonin is a hormone secreted by cells in the thyroid gland (Silverman, 2003) and was one of the first drug therapies available for the treatment of osteoporosis. Calcitonin is offered as an injection and nasal spray, however it is not widely used due to newer therapies being available (USDHHS, 2004). The theory behind calcitonin use is that it may inhibit bone resorption by acting directly on the osteoclasts. Calcitonin has been proven to decrease spine fractures;

however, there were a number of biases to the study which led to questionable results (Chesnut et al., 2000). The use of PTH has been approved for the treatment of severe osteoporosis in both men and postmenopausal women. It has been shown to increase BMD and reduce fractures. Spine BMD increased by 9.7% and hip BMD increased by 2.6% (Neer et al., 2001) after a twenty-one month treatment using PTH. Spine fractures decreased by 65%, and non-spine fractures decreased by 53% (Neer et al., 2001).

Dietary Assessment of Calcium and Vitamin D

There are many different dietary assessment methods available. The most common methods include food diaries, 24-hour recalls, and the use of Food Frequency Questionnaires (FFQ). Dietary intake is difficult to assess due to variation in humans. There is no gold standard for measuring dietary intake, but there are methods that are more feasible than others. Different methods may be applied based on sample size, funding, and research questions.

A food diary involves participants writing down all food and beverages consumed during a period of time. The food diary method requires increased respondent burden because of the time and work in order to complete the diary. However, a major benefit includes not relying on memory to record food intakes compared to 24-hour recall and FFQs (Black et al., 1993). Food diaries are also relatively cost effective and require less researcher time to administer compared 24-hour recalls, however, data entry time is increased with food diaries compared to 24-hour recalls. Therefore, in a study with a large sample size, a food diary collection method would be practical and feasible when assessing dietary intake.

There are limitations for the different forms of dietary assessment. Since food diaries use the participant's reported foods and beverages, they are subject to reliability threats. Participants may not accurately provide serving sizes or descriptors of their food and beverage products.

Underreporting of food is often seen, especially in female samples. Possible reasons for under-reporting vary based on the person and are therefore difficult to control for (Marks, Hughes, & van der Pols, 2006; McNaughton, Mishra, Bramwell, Paul, & Wadsworth, 2004). Underreporting of food intakes may be related to individuals changing their normal eating patterns which can result in individuals under eating during the data collection period. For example, in a study by Chinnock (2006), 60 men and women completed a four-day food diary. Participants were instructed to eat normally during the recording of their food diaries. Participants were actually found to lose weight during the study. Chinnock proposed it could have been due to awareness to consume less food to encourage weight loss or due to amount of work to record each food and beverage item over a four-day span. Assessment of food intakes can therefore be affected by under-reporting. Johansson, Akesson, Berglund, Nermell, and Vahter (1998) showed that when collecting four-day food diaries, dietary calcium intake was under-reported due to individuals under-reporting total calorie intakes. This resulted in an underestimation of calcium by approximately 15%.

The 24-hour recall is a reflective dietary assessment method where the individual recalls food and beverage intake for the previous 24-hours. A 24-hour recall is not a reliable method for estimating individual total energy intake or dietary calcium intake (McNaughton et al., 2004). The large day-to-day variation of food intake cannot be captured with a single 24-hour dietary assessment (Kelemen, 2007; McNaughton et al., 2004). In addition, many people find it difficult to accurately describe and recall portion sizes (Margetts & Nelson, 1997). Therefore, the accuracy of total energy intake and dietary calcium intake is likely to be significantly over- or underestimated (McNaughton et al., 2005).

In addition to observation bias described above, interviewer bias is another source of error with the 24-hour recall. Even with a well-trained interviewer bias can occur. Slight modifications in the question's wording can alter participants' responses. The detail and quality of data collected can also be significantly affected by the interviewer and interviewee's mood (Black et al., 1993; Margetts & Nelson, 1997). In addition, in a study with a large sample size, interviews needed to assess dietary intake are time consuming and impractical.

FFQs are designed to assess eating patterns based on frequency of consumption of certain groups of food over a long period of time, usually over the last 3, 6, or 12 months. It is preferable to develop a FFQ for each study based on the population of interest to ensure it includes culturally appropriate foods and popular dishes (Kelemen, 2007; Margetts & Nelson, 1997). Additionally, portion sizes used in the questionnaire should reflect the average portion size consumed by the population of interest (Margetts & Nelson, 1997).

A number of studies have reported an over-estimation of dietary calcium intake with the FFQ. Riboli, Elmstahl, Saracci, Gullberg, and Lindgarde (1997) found a 250-item and a 130-item FFQ to significantly over-estimate total energy, protein, carbohydrate, and dietary calcium intakes compared to a three-day weighed food diary. Ambrosini, Mackerras, de Klerk, and Musk (2003) also found the FFQ to over-estimate dietary calcium intakes compared to a seven-day food diary. In Amrosini et al.'s study, 83 men and women completed a food record and 72 men and women completed a FFQ. Results showed significant differences in estimated dietary calcium intake between the two methods. Mean dietary calcium intakes according to the seven-day food diary and FFQ were 757±222mg/day and 888±331mg/day, respectively. The proportion of dietary calcium intake below the RDI was 58% from the FFQ, compared to 96%

when using the seven-day food diary. Therefore, these authors suggested that FFQs may over-estimate dietary calcium intake.

In summary, although food diaries are likely to give under-estimations of total energy and dietary calcium intake, the magnitude and direction of error is better understood compared to the 24-hour recall and FFQ. Food diaries have also been found to provide a better estimate of dietary calcium intake compared to the 24-hour recall and FFQ.

Osteoporosis Knowledge

For primary prevention, individuals have to be aware of osteoporosis before they are exposed to the disease and should take some preventive steps (Germalmaz & Oge, 2008). Even with knowledge, people may not change behavior, but without knowledge, behavior change may not be reasonable (Ailinger, Braun, Lasus, & Whitt, 2005).

Sedlak, Doheny, and Jones (2000) developed a study design specific to three different groups of women. Nearly all participants were Caucasian. In group one, (the educational program group), 31 college age women met for three educational sessions over a three-week period. The second group (intermediate program) consisted of a community sample of 35 women between 22 and 83 years of age. They participated in a three-hour program on osteoporosis. The last group, (short program group) consisted of 18 nurses who participated in a 45-minute continuing education program relating to osteoporosis. The majority of the nurses were between 35 and 45 years old. The Osteoporosis Knowledge Test, Osteoporosis Health Belief Scale, and Osteoporosis Preventing Behaviors Survey were used to assess knowledge and beliefs. Sedlak, Doheny, and Jones found that with all of the different programs used, participants' knowledge increased with regard to osteoporosis prevention. This also agrees with findings from Ailinger et al. (2005), where individuals who had received information about osteoporosis gained or

demonstrated more knowledge. However, although participants knew more, this knowledge increase did not always lead to a change in health beliefs or behavior (Sedlak Doheny, & Jones, 2000). Kasper, Peterson, and Allegrante (2001) found similar results regarding knowledge and preventative behaviors. In their study, college age women's knowledge about obtaining adequate calcium intake and physical activity for prevention of osteoporosis did not influence their exercise or calcium intake behaviors. There was no mention of vitamin D knowledge included (Kasper et al., 2001).

Researchers have determined osteoporosis knowledge through the use of questionnaires. Ribeiro, Blakeley, and Laryea (2000) questioned 185 women who were members of church groups in Canada and discovered that even in well-educated women, osteoporosis knowledge was poor. Being deficient in osteoporosis knowledge may lead to women being unable to perceive their actual risk of developing osteoporosis, schedule preventative tests, or take beneficial dietary and physical activity precautions to help prevent osteoporosis. Additionally, the participants did not know that osteoporosis is a life-long progression and not a disease that precipitates directly after menopause. Knowledge in the area of prevention and treatment can allow individuals to make informed choices (Ribeiro et al., 2000).

Osteoporosis knowledge was also studied by Ailinger et al. (2005). Participants included men and women with the majority of them being Caucasian. The women were all premenopausal. This sample also had limited knowledge about osteoporosis. Interestingly, educational level was not correlated with osteoporosis knowledge. This is in contrast with Gemalmaz & Oge's (2008) findings where younger and higher educated women knew more about osteoporosis. However, older age has been shown to be a predictor of osteoporosis knowledge. This may also be related to menopausal status as menopausal women had greater

osteoporosis knowledge compared to premenopausal women (Ailinger et al., 2005; Larkey, Hoelscher, Houtkooper, & Renger, 2003). However, Larkey et al. (2003) discovered that no matter which age, women seem to have misconceptions regarding which form of exercise is best for osteoporosis prevention.

Kasper et al. (2001) conducted research on 325 college age women and discovered that they were able to identify risk factors such as lack of physical activity and low calcium intake, but few were able to identify risk factors such as early menopause, postmenopausal status, or menstrual irregularities. Regarding learning styles to increasing knowledge related to osteoporosis, these women preferred handouts, brochures, magazine articles, and short five-minute counseling sessions during medical office visits, or 15-30 minute on-campus lectures. The women did not prefer methods that included a computer program or the internet. Additionally, there was no difference found in those at high risk versus low risk for osteoporosis on the preferred learning method to increase knowledge (Kasper et al., 2001).

Educational Intervention Limitations

Education is often conducted with older adult women to assess their osteoporosis knowledge and preventative behaviors (Wallace, 2002). Nonetheless, PBM is attained earlier in life, as previously discussed. It is imperative that osteoporosis education and preventative behaviors begin early in life and continue into adulthood in order to decrease the risk of developing osteoporosis. A study by Kasper et al. (2001) examined college aged women, in an undergraduate health class, in which 86% of participants had heard of osteoporosis, but only approximately 4% were partaking in adequate exercise and dietary calcium intake. The women preferred to receive education about osteoporosis via a brochure, magazine, or short educational sessions. Additionally, the researchers found that this sample of women was not concerned as

34

much about osteoporosis as they were about heart disease and breast cancer. Moreover, participants' beliefs about osteoporosis were not related to their exercise habits, calcium intake, or osteoporosis knowledge. Knowledge about acquiring adequate calcium and physical activity for prevention did not influence their behaviors (Kasper et al., 2001).

Few studies have examined the effects of osteoporosis educational interventions on men. Men are often not concerned with osteoporosis and may be unaware of their risk for developing osteoporosis (Phalen, 2002). Additionally, men often have osteoporosis knowledge deficiencies and may not engage in preventative behaviors due to their lack of knowledge (Tung & Lee, 2006). Researchers conducted an osteoporosis educational intervention program of a 45-minute lecture, followed by a 30-minute video demonstration of weight-bearing exercise, and 15-30 minutes of open discussion. Questionnaires (OKAT, OHBS, and OSES) assessed knowledge, health beliefs, and self-efficacy in relation to osteoporosis and preventative behaviors. Vitamin D information was not assessed. Calcium intake was assessed by questions stating do you drink milk (yes/no) and do you eat dairy products (yes/no). The men in this sample had limited knowledge regarding osteoporosis. Approximately only 30% performed weight-bearing physical activities, and less than 20% drank milk and consumed dairy products three or more times per week prior to the intervention. Post-intervention knowledge and health beliefs about osteoporosis increased as did preventative behaviors, such as weight bearing physical activity, compared to the control group. However, changes in self-efficacy were not found to be statistically significant (Tung & Lee, 2006).

Almost all osteoporosis education interventions examine dietary calcium as the main behavior change outcome measure and neglect vitamin D. There are some studies that provide support for osteoporosis education interventions increasing dietary calcium intake or changing

35

behaviors (Blalock et al., 2002; Tussing & Chapman-Novakofski, 2005). However, additional studies are not always in agreement and have found no effects of osteoporosis education interventions on increasing dietary calcium intake (Kasper et al., 2001; Ribeiro & Blakeley, 2001; Sedlak, Doheny, & Jones, 2000). Ribeiro and Blakeley (2001) found that although an osteoporosis workshop significantly increased osteoporosis knowledge, there was not a significant change in dietary calcium intake. However, participants reported a high mean baseline dietary calcium intake (1,179 mg/day), which may explain why there were no significant differences between baseline and follow-up dietary calcium intakes.

Educational Interventions to Increase Osteoporosis Protective Behaviors

Werner (2005) evaluated ten osteoporosis intervention studies and found positive change in health behavior in four. Three of these trials used interactive methods of teaching. The researchers proposed that in order to increase the chance of increasing dietary calcium intake, intervention trials may need to consist of workshops that actively involve the participants, such as group discussions and problem solving exercises. This interaction may help to overcome any barriers to calcium intake individuals may perceive, which has been found to predict dietary calcium intake (Schmiege, Aiken, Sander, & Gerend, 2007; Turner, Hunt, DiBrezzo, & Jones, 2004; Von Hurst & Wham 2007).

Different types of educational interventions have been used in research related to osteoporosis, and there is little consensus as to which is best in producing wanted outcomes. Bohaty et al. (2008) studied an education intervention and the effects on increasing calcium and vitamin D intakes in young adults. Dietary intakes were assessed via a three day food diary and analyzed by The Nutritionist Five software. A pre-posttest method was used to determine osteoporosis knowledge. Participants attended one 45-minute PowerPoint presentation on the

importance of calcium and vitamin D in regard to osteoporosis prevention, osteoporosis risk in young women, calcium rich foods choices as well as calcium food choices for those that were lactose intolerant or follow a vegetarian diet. Additionally, participants were given a brochure after the presentation. Two weeks after the presentation, a follow up call was placed to participants to reinforce calcium and vitamin D intakes as well as to answer any questions participants may have had. Eight weeks later, participants also filled out a second three-day food diary. Calcium and vitamin D supplements were given to each participant for completing the study. Dairy product consumption, calcium intake, and vitamin D intake did not significantly increase after the intervention; however, osteoporosis knowledge significantly increased after the intervention (Bohaty et al., 2008).

Ha, Caine-Bish, Holloman, and Lowry-Gordon (2009) examined the use of a 15-week class-based nutrition intervention on college students and assessed behaviors related to soft drink and milk consumption. Using a pre-posttest design, data was collected during the first two weeks and the last week of the class. Dietary intakes were assessed using a three-day food diary consisting of two weekdays and one weekend day. Dietary analysis was conducted by one individual using NutriBase IV clinical software. Lectures were 50 minutes and included hands-on activities. Additionally, students compared their dietary intakes with the current dietary recommendations in order to personally analyze their own diets. This type of intervention yielded results where regular soft drink consumption significantly decreased but diet soft-drink consumption did not. Additionally, milk intake increased significantly from baseline, but only in women. A nutrition class-based intervention of 15 weeks with hands on activities was shown to increase nutrition knowledge significantly; however behavior changes were only modest (Ha et al., 2009).

Educational interventions including multiple sessions of two hours, three-hour educational programs, a 45-minute presentation with brochure and semester long nutrition courses have all been shown to increase osteoporosis knowledge (Bohaty et al., 2008; Chan, Kwong, Zang & Wan, 2007; Ha et al., 2009; Ha & Cain-Bish, 2009; Piaseu, Belza, & Mitchell, 2001). The challenge then becomes to increase preventative osteoporosis behaviors as many interventions fail to do this. A semester long, class-based nutrition intervention has been shown to increase fruits and vegetable consumption, increase milk consumption in women, and to decrease soft drink consumption (Ha et al., 2009; Ha & Cain-Bish, 2009).

Perhaps the strongest study supporting dietary behavior change was a study by Tussing and Chapman-Novakofski (2005). They studied an educational intervention of eight short sessions, with the use of hands-on activities, and the impact on dietary calcium intake in relation to osteoporosis prevention. Calcium intake significantly increased after the intervention, and participants indicated that the hands-on activities influenced the change in behavior. Conceivably, a nutrition course designed to discuss osteoporosis, that includes hands on activities, could be used as an effective educational intervention in young adults. This type of course could build on other nutrition topics, such as increased physical activity, nutritional adequacy, and an overall healthy lifestyle which could complement prevention of osteoporosis.

Ammerman, Lindquist, Lohr, and Hersey, (2002) found that interventions that included small group activities and goal setting were associated with changes in dietary behaviors including consuming less total fat, less saturated fat, and increased fruit and vegetable intakes. Food related activities were found to decrease total fat and increase fruit and vegetable intakes but did not affect saturated fat intake behaviors.

Health Belief Models

The Health Belief Model (HBM) has been used to identify factors related to promoting healthy behaviors (Rosenstock, 1960). The model states that a person's healthy behavior depends on his or her perception of four major areas: severity of a potential illness or disease, susceptibility to that illness, benefits of taking preventive action, and the barriers or costs to taking that action (Rosenstock, 1960). According to the HBM, individuals who have certain beliefs will be more likely to achieve a preventative behavior (Rosenstock, 1960).

The Expanded Health Belief Model (EHBM) is a four-stage theoretical model reflects the foundation that preventive behaviors (i.e. adequate dietary vitamin D intake) result from the direct and indirect influences of knowledge, attitudes, and self-efficacy (Rosenstock, Strecher, & Becker, 1988). Bandura (1977) has defined self-efficacy as an individual's belief of his or her capability to implement an action in order to achieve a specified goal. Self-efficacy is expected to increase with increasing knowledge (Rosenstock et al., 1988). For instance, the EHBM suggests that an individual is more likely to carry out an action (e.g., consume adequate vitamin D) if he or she believes they are vulnerable to osteoporosis and if they develop osteoporosis, they could lose independence. Next, the individual might perceive the benefits of taking action as outweighing the barriers or costs. Finally, overall health motivation and self-efficacy may contribute to an individual taking action.

There are conflicting studies on the topic of HBM and how it relates to nutrient intake (Chang, 2006; Tussing & Chapman-Novakofski, 2005; Wallace, 2002). Studies using the HBM generally focus on calcium intake if a nutrient intake is used as an outcome measure (Chang, 2006; Tussing & Chapman-Novakofski, 2005; Wallace, 2002) and rarely includes vitamin D. Therefore, studies involving calcium will be reviewed.

A study on calcium intake and osteoporosis examined the influence of personal constructs and the HBM on predicting osteoporosis preventive behaviors (i.e., calcium intake) among college women. A mailed questionnaire assessed demographic information, osteoporosis knowledge, osteoporosis health beliefs, and osteoporosis self-efficacy. No association between osteoporosis knowledge and dietary calcium intake were found. The authors concluded that women differ considerably in both their osteoporosis-protective behaviors and beliefs regarding osteoporosis as defined by the HBM and those educational messages should be customized to each individual's current behaviors and beliefs (Wallace, 2002).

In contrast, Chang (2006) found that young adult women had a greater amount of osteoporosis knowledge compared to men, but also had a lower dietary calcium intake (454 mg per day). The women in the study believed that they were at risk of osteoporosis but felt that prevention was difficult. Additionally, they perceived that osteoporosis is not serious and that taking preventative measures would not be worthwhile. The factors that most strongly affected the intake of calcium by women were, in order, knowledge, number of children, self-rated health score, BMI, graduation from high school, having gone through a bone density examination, and family history which in total accounted for 31.8% of the variation in dietary calcium intake (Chang, 2006).

Additional studies have examined the HBM and calcium intake. Tussing and Chapman-Novakofski (2005) determined if an osteoporosis prevention program would have a considerable impact on calcium intake. A convenience sample of women participated in an eight-week intervention class that included a short lecture and a hands-on activity to increase self-efficacy and handouts to reinforce the learned behaviors. Dietary calcium was assessed using an eight question Food Frequency Questionnaire (FFQ) and concepts of the HBM were assessed by a

modified 52 question Osteoporosis Health Belief Scale questionnaire, both at baseline and post-study. Post-study dietary calcium intake significantly increased compared to baseline calcium intakes. After using regression analysis, it was indicated that 14% of the variance in calcium intake was explained by self-efficacy (e.g. "I can use food labels to make shopping decisions") (Tussing & Chapman-Novakofski, 2005).

An additional study that used the Osteoporosis Health Belief Scale questionnaire was conducted by Cline and Worley (2006). In the study, questionnaires were mailed to 1,700 community-dwelling women, aged 45 years and older. Three groups were identified from cluster analysis. Group one subjects believed they were susceptible to osteoporosis and identified supplements (i.e. calcium and/or vitamin D supplements) as providing benefits with few barriers to using them. Group two subjects believed they were susceptible to osteoporosis and that the disease has serious consequences but identified that there are many barriers and few benefits to using supplements. The third group did not think they were susceptible to osteoporosis and had few opinions about calcium or soy supplements. Group one's subjects were more likely to use calcium and/or vitamin D supplements. The authors concluded that women may be able to be divided into groups based on the osteoporosis beliefs and interventions or education could be tailored to these different groups (Cline & Worley, 2006). Studies including men are lacking and future research should include men and women because barriers to prevention or perceived susceptibility to osteoporosis may differ by gender.

Concluding Remarks

The research reviewed summarizes that research is limited to calcium education interventions and rarely includes vitamin D education as part of osteoporosis prevention education. It may be beneficial to include vitamin D intake as this can impact calcium

absorption. Additionally, interventions often do not include men as participants. Educational programs mainly target women. Although osteoporosis effects more women, it is still of great importance to prevent osteoporosis in men.

Additionally, dietary behaviors are often not assessed with detailed methods such as a three-day food diary but generally consist of two to three questions relating to milk intake and/or dairy product intakes or dietary behaviors are not assessed at all. The need for osteoporosis prevention programs that increase knowledge and also increase osteoporosis preventative behaviors is crucial, specifically in earlier stages of life when prevention may have a greater impact.

Research examining the most effective delivery methods in young adults to induce behavior change appears to be lacking and especially with regard to osteoporosis education and related dietary behavior changes that include vitamin D. Additionally, it would be beneficial to create education programs such as nutrition courses that use hands on activities, small group interactions, and goal setting for the young adult population. This type of intervention may help to begin educational campaigns earlier in life in order to prevent osteoporosis rather than attempting to treat it. Although many interventions have shown to increase knowledge, they do not always increase preventative behaviors. The earlier education is presented, it can be hypothesized that increased protective behaviors such as obtaining adequate dietary vitamin D and calcium, may result in higher PBM and may lower the risk of developing osteoporosis and subsequent fracture and falls. This reduction in risk may lead to a reduction in health care cost spending later in life and lead to greater quality of life as one ages.

CHAPTER THREE. DETERMINATION OF THE VALDITY AND RELIABILITY OF A MODIFIED OSTEOPOROSIS HEALTH BELIEF SCALE AND OSTEOPOROSIS SELF-EFFICACY SCALE TO INCLUDE VITAMIN D ITEMS

Abstract

The objective of this study was to determine the validity and reliability of a modified Osteoporosis Health Belief Scale and modified Osteoporosis Self-Efficacy Scale. A convenience sample of 153 college-age adults at a Midwestern college and university was used.

Cronbach α was used to test internal consistency for both the OHBS and OSES with vitamin D revisions. Intra-class correlation coefficients were used to assess test-retest reliability. Factor analysis was used to determine validity of the original structures with modified vitamin D items.

Results show that the OHBS Cronbach α was .82 while subscales Cronbach α coefficients ranged from .75-.87.The OSES Cronbach α was .98 while subscales Cronbach α coefficients ranged from 0.96-0.98. Total ICC for OHBS and OSES was .79 and .97 respectively. Factor analysis extracted eight factors for the OHBS-D and three factors for the OSES-D which explained 52.2% and 82.2% of the total variance respectively.

In conclusion, modifications to the OHBS and OSES to include vitamin D items had strong internal consistency and test-retest reliability, and were determined to be valid. Key Words: osteoporosis, health beliefs, self-efficacy, vitamin D, reliability.

Introduction

Osteoporosis, a public health risk for approximately 34 million Americans (National Osteoporosis Foundation [NOF], 2010), is a preventable disease where bones lose mass and can deteriorate over time, causing them to weaken and become more susceptible to fractures (NOF,

2010). Several risk factors may increase the possibility of an individual developing osteoporosis. Non-modifiable risk factors include advanced age, female gender, non-Hispanic Caucasian race, and family history of osteoporosis or fracture (Robitaille et al., 2008). Modifiable risk factors include insufficient dietary intake of calcium and vitamin D, an inactive lifestyle, low body weight, alcohol use, and smoking (Dell, Green, Anderson, & Williams, 2009; Robitaille et al., 2008). Osteoporosis preventative actions can be implemented throughout the lifespan in order to decrease the risk of developing low bone density. These preventative actions should begin as early in life as possible to reduce the risk of developing osteoporosis since peak bone mass (PBM) is attained around age 30 (Heaney, 2000).

Vitamin D plays a role in helping the body absorb and regulate calcium (DeLuca, 2004). Dietary sources of vitamin D are limited to only a few foods. Milk and milk products, meat, fish, eggs, and ready to eat (RTE) cereals were the top five food products consumed that contain vitamin D in the United States (Hill, Jonnalagadda, Albertson, Joshi, & Weaver, 2012). Additionally, vitamin D may be synthesized by ultraviolet radiation (UV) (Holick, 1995). The Institute of Medicine (IOM) recommends 600 IU of vitamin D for adults aged 19-70 and 800 IU for adults older than 70 years of age for optimal bone health (Ross, Taylor, Yaktine, & Del Valle, 2011). The estimates of vitamin D deficiency in the United States range from 20% to 100% of the population (Holick, 2006; Holick, 2007; Holick et al., 2011; Lips et al., 2006).

Calcium is commonly associated with the formation and metabolism of bone. Approximately 99% of the body's calcium is stored as calcium hydroxyapatite in the bones and teeth (Boskey, 2007). Dietary calcium intake is particularly important during the prepubescent and adolescent years when bone mass develops rapidly (Bonjour, Chevalley, Riszzoli, & Ferrari, 2007; Zhu et al., 2008). Dietary calcium intake generally comes from food and dietary

supplements. Calcium is generally associated with dairy products such as milk, yogurt, and cheese. These foods provide the major portion of calcium in U.S. diets. The recommendations for calcium are currently 1000 mg for adults 19-50. The recommendation for females aged 51-70 is 1200 mg of calcium per day and for males 51-70 is 1000 mg per day (Ross et al., 2011). Adults aged 70 and older are recommended to take 1200 mg per day (Ross et al., 2011).

Theoretical Background

There are many theoretical explanations available to help determine behaviors that could affect health outcomes, such as increasing calcium and vitamin D to prevent osteoporosis. The Health Belief Model (HBM) has been used to identify factors related to promoting healthy behaviors (Rosenstock, 1960). The model states that a person's healthy behavior depends on his or her perception of four major areas: severity of a potential illness or disease, susceptibility to that illness, benefits of taking preventive action, and the barriers or costs to taking that action (Rosenstock, 1960). According to the HBM, individuals who have certain beliefs will be more likely to achieve a preventative behavior (Rosenstock, 1960).

The more recent Expanded Health Belief Model (EHBM) is a four-stage theoretical model reflects the foundation that preventive behaviors (i.e. adequate dietary vitamin D intake) result from the direct and indirect influences of knowledge, attitudes, and self-efficacy (Rosenstock, Strecher, & Becker, 1988). Bandura (1977) has defined self-efficacy as an individual's belief of his or her capability to implement an action in order to achieve a specified goal. Self-efficacy is expected to increase with increasing knowledge (Rosenstock et al., 1988). For instance, the EHBM suggests that an individual is more likely to carry out an action (e.g., consume adequate vitamin D) if he or she believes they are vulnerable to osteoporosis and if they develop osteoporosis, they could lose independence. Next, the individual might perceive the

benefits of taking action as outweighing the barriers or costs. Finally, overall health motivation and self-efficacy may contribute to an individual taking action. The EHBM is the model that was used to develop the Osteoporosis Health Belief Scale (OHBS) and the Osteoporosis Self-Efficacy Scale (OSES). This model reflects the content of the scales as health beliefs such as susceptibility and health motivation are subscales of the OHBS and self-efficacy is measured in the OSES.

Health Beliefs and Self-Efficacy Scales

Health beliefs are often related to osteoporosis preventative behaviors, such as obtaining adequate dietary calcium (Chang, 2006; Cline & Worley, 2006). Additionally, osteoporosis self-efficacy may play a role in behavior change such as increasing dietary calcium and vitamin D intakes (Tussing & Chapman-Novakofski, 2005; Wallace, 2002). Osteoporosis health beliefs that also include self-efficacy and their association with vitamin D have not been studied in detail. Beliefs about osteoporosis are often measured using Kim, Horan, Gendler, and Patel's (1991) Osteoporosis Health Belief Scale (OHBS) (Appendix A5). The OHSB is a 42-item instrument that includes seven subscales: Susceptibility Seriousness, Benefits-Exercise, Benefits-Calcium, Barriers-Exercise, Barriers-Calcium, and Health Motivation. The original scale does not include questions pertaining to vitamin D.

Osteoporosis self-efficacy is often assessed using Horan, Kim, Gendler, Froman, and Patel's (1998) Osteoporosis Self-Efficacy Scale (OSES). Similarly to the OHBS, the OSES does not include osteoporosis self-efficacy related vitamin D items and could be revised in order to determine self-efficacy of vitamin D intake, as this is an integral role in preventing osteoporosis. The current OSES is a 21-item instrument (Appendix A6). The original scale includes two subscales-calcium and exercise.

46

The original OHBS and OSES have previously been used with samples of college age women (Ziccardi, Sedlak, & Doheny, 2004); men age 65 and older (Sedlak, Doheny, & Estok, 2000), postmenopausal Caucasian women (Sedlak, Doheny, Estok, Zeller, & Winchell, 2007) and college age men and women (Gammage, Francoeur, Mack, & Klentrou, 2009). Additionally, the original OHBS and OSES have been used to assess health beliefs including self-efficacy among different age groups cohorts and both genders (Johnson, McLeod, Kennedy, & McLeod, 2008).

The OHBS and OSES are generally used in conjunction and have been used to assess osteoporosis health beliefs and self-efficacy to perform osteoporosis preventative behaviors (Ziccardi et al., 2004). Additional studies using the OHBS and OSES have examined impact of length of osteoporosis prevention programs in women (Sedlak, Doheny, & Jones, 2000), educational interventions influence on calcium intake related to health beliefs and self-efficacy in women (Tussing & Chapman-Novakofski, 2005), and post-menopausal women's osteoporosis preventative behaviors after having a DXA scan (Sedlak, Doheny, & Jones, 2000). Furthermore, the OHBS and OSES have been used to describe older men's osteoporosis health beliefs and confidence or self-efficacy in performing osteoporosis preventative behaviors (Sedlak, Doheny, & Estok, 2000).

Because of the lack of measures including vitamin D beliefs and self-efficacy, the aim of the current study was to determine the reliability and construct validity of an Osteoporosis Health Belief Scale and an Osteoporosis Self-Efficacy Scale modified to include vitamin D related items. The OHBS-D scale is designed to measure health beliefs related to osteoporosis and includes vitamin D related items. Additionally, the OSES-D scale is designed to measure self-efficacy related to osteoporosis and includes vitamin D related items. Again, no other scales have

been developed to measure vitamin D related self-efficacy associated with osteoporosis to be used with an adult population.

Methods

This study is part of a larger study on the influence of educational interventions on osteoporosis preventative behaviors. The study was reviewed and approved by both North Dakota State University and The College of St. Benedict/St. John's University institutional review boards.

Participants and recruitment.

Participants were recruited through an introductory nutrition course that included six sections of approximately thirty students for each section. Recruitment was conducted through an in-class announcement invitation to partake in an extra credit research opportunity. Men and women (18 years of age and older) were both invited to participate in the study. A consent form was provided in an on-line format before completing the questionnaires. Additionally, demographic questions were included at the end of the questionnaire. Recruitment began March 1st, 2012 and ended March 31st, 2012.

One hundred fifty-three young adults ages 18-23 participated in the study. There were 41 males (27%) and 112 females (73%). The overall percentages of students at the sample university were 47% male and 53% female. The overall respondent rate from the sample was 85%. Participants data in the control group (n=51) was used to determine reliability of the scales while pooled data from all participants (n=153) was used to assess validity of the scales. All participants were currently enrolled undergraduate students. The majority of the participants were Caucasian (80.5%) followed by Asian or Pacific Islander (9%), Hispanic/Latino (5%), African American (4%) and American Indian or Alaska Native (1%) Almost all participants

48

were single (98%). Participants mainly lived on campus (59%) and purchased the majority of their food at the campus cafeterias. The remaining participants (41%) lived in campus apartments and purchased the majority of their food from local grocery stores.

A majority of the participants exercised (88%) and 31% took some type of dietary supplement. The majority of the sample did not know anyone with osteoporosis (79%), and did not have a relative with osteoporosis (86%). Of those who did have a relative with osteoporosis (14%), 47% said that it was a blood relative. A chi-square test showed that there were no statistically significant differences between the control group and the overall pooled group for all demographic and lifestyle variables.

Measures.

Osteoporosis health belief scale validity and reliability.

Permission to use and modify the Osteoporosis Health Belief Scale (OHBS) and the Osteoporosis Self-Efficacy Scales (OSES) was granted by Dr. Phyllis Gendler at Grand Valley State University. The original OHBS and OSES have previously been validated among Caucasian samples. Beliefs about osteoporosis were measured using the OHBS. The original OHSB is a 42-item instrument. The original scale includes seven subscales: Susceptibility (items 1-6), Seriousness (items 7-12), Benefits-Exercise (items 13-18), Benefits-Calcium (items 19-24), Barriers-Exercise (items 25-30), Barriers-Calcium (items 31-36) and Health Motivation (items 37-42). The original OHBS was modified to include Benefits-Vitamin D (items 43-48) and Barriers-Vitamin D (items 49-54) that are modeled after the calcium items and was labeled as OHBS-D.

The OHBS uses a 5-point Likert scale from 'strongly agree' to 'strongly disagree.' Answers were coded and scored by assigning a '1' for 'strongly disagree' answers and '5' for

'strongly agree' answers. Possible scores for each subscale ranged from 6 to 30 with a low score indicating a low perception and a high score indicating a high perception. Possible total scores ranged from 54-270.

The original OHBS and OSES have been found to be valid and reliable (Horan et al., 1998; Kim et al., 1991). Concurrent validity for the original OHBS was established by the original researchers (Kim et al., 1991), through measurement of calcium intake and exercise behaviors in conjunction with a HBM instrument. Dietary calcium intake was measured by assessing the amount and frequency of calcium rich foods and supplements that were consumed. The HBM instrument used to determine concurrent validity was a self-breast exam instrument developed by Champion (1984) that consisted of 50 items representing the five theoretical dimension of the HBM. Construct validity of the OHBS was established using factor analysis (Kim et al., 1991) which extracted five factors that accounted for 49.3% of the total. The original factors included susceptibility, barriers, benefits, seriousness, and health motivation. Benefits to calcium and exercise loaded on one factor, as did barriers to calcium and exercise. However, while the authors identified five original factors, they discussed that the factors of benefits and barriers could be split for both calcium and exercise resulting in seven different subscales rather than the original five. Additionally, most people using the OHBS use seven subscales including susceptibility, seriousness, health motivation, benefits of calcium, benefits of exercise, barriers of calcium, and barriers of exercise (Chan, Kwong, Zang, & Wan, 2007; Cline & Worley, 2006; Tussing & Chapman-Novakofski, 2005).

The original OHBS Cronbach alphas for susceptibility, seriousness, and health motivation subscales were .82, .71, and .73 respectively. Cronbach alpha coefficients for subscales of benefits of calcium, barriers of calcium, benefits of exercise, and barriers of

exercise were .80, .74, .81 and .82 respectively. Test– retest reliability for the total instrument was .90. Additional studies have found slightly lower test-retest reliability for the total instrument to be .77-.84 (Sedlak, Doheny, & Estok, 2000; Sedlak, Doheny, & Jones, 2000). Subscale reliabilities from additional studies have ranged from .76-.92 and .80-.84 (Sedlak, Doheny, & Estok, 2000; Sedlak, Doheny, & Jones, 2000). Therefore, based on Cronbach alpha coefficients of the total scale and the subscales, it was indicated that the original OHBS has adequate test-retest reliability.

Osteoporosis self-efficacy scale validity and reliability.

The OSES-D was used to determine self-efficacy related to exercise, dietary calcium, and vitamin D intakes. The original OSES uses a 21-item survey with two subscales, an osteoporosis self-efficacy scale and an osteoporosis self-efficacy calcium scale. Self-efficacy for exercise was evaluated using 10 items. The self-efficacy for calcium intake was determined using 11 items. Horan et al. (1998) originally developed the self-efficacy scale as a line scale from "not at all confident" to "very confident". The subjects were to mark on the line closer to "not at all confident" (0) to "very confident" (100). In this current study, the scale was adapted to an online format where participants were asked to mark a spot on the line. A computer-generated scale was used to score the mark on the 10 cm line. Additional self-efficacy vitamin D related items were added to increase the scale to a 32-item scale. The self-efficacy vitamin D items were modeled after the calcium items. A total maximum score for the OSES with additional vitamin D items was 3200.

The original OSES was developed by Horan et al. (1998). Construct validity was established by factor analysis that extracted two factors: calcium and exercise. Criterion related validity was established by examining calcium intake and exercise. Calcium intake was

measured by 24-hour recall. Exercise was measured by the Atherosclerosis Risk in Communities (ARIC)/Baecke Habitual Physical Activity Questionnaire (ABHPAQ) which was used to evaluate long-term patterns of exercise. The original authors have deemed the original OSES valid based on criterion related validity and factor analysis.

The OSES has also previously been evaluated and found to have a test-retest reliability of .90 overall (Horan et al., 1998). Additional studies have agreed with these results, finding the total test-retest reliability for the OSES to be .95 and .96 (Sedlak, Doheyn, & Estok, 2000; Sedlak, Doheny, & Jones, 2000). Subscale reliability was found to be .76-.92 (Sedlak, Doheny, & Jones, 2000) and .96-.96 (Sedlak, Doheny, & Estok, 2000) indicating that the OSES is test-retest reliable. Additionally, internal consistency estimates were .93 for the calcium subscale and .94 for the exercise subscale. As a result, the original authors concluded the original OSES is internally consistent.

Data collection.

In the current study, the OHBS-D, and OSES-D, pre and post-tests were administered on-line. Participants (n=153) were asked to provide their names and course section to receive extra credit (15 points or approximately 2% of total points for the class). Additionally, names were provided so treatment groups could be identified. Treatment groups were identified by lecture day and times. Only the research assistant had access to the questionnaires to ensure confidentiality. Participants were encouraged to complete the questionnaire and a reminder email was sent after one week. The entire questionnaire (OHBS-D, OSES-D, and demographic questions) had a total of 106 items.

Statistical analysis.

Statistical analyses were conducted using SPSS (version 19.0, SPSS, Inc., Chicago, IL, 2010. Participant demographics were summarized using frequencies and percentages. Chi-square analysis was used to determine whether the participants were equally distributed in regard to demographic characteristics in the pooled sample (n=153). This study's purpose was to determine the validity and reliability of two modified scales, the OHBS-D and the OSES-D.

Validity.

To determine the validity of the OHBS-D, two steps were taken. Step one consisted of determining content validity of vitamin D related items for the OHBS-D scale. This was established by identifying the domain of content through a comprehensive review of the literature. Step two was to conduct a factor analysis of the OHBS-D using all of the participants (n=153) in order to validate the original structure with the added vitamin D items. The scree plot and magnitude of the eigenvalues were used to determine the number of factors that could be extracted.

To determine the validity of the OSES-D, the same two steps for determining the validity of the OHBS-D were used. Step one consisted of determining content validity of the modified vitamin D items through a comprehensive review of the literature. Step two included running a factor analysis of the OSES-D (again including all participants, n=153) in order to validate the original scale and the OSES-D with added vitamin D related items.

Reliability.

To determine the reliability of the OHBS-D two measures were conducted using the control group. Step one consisted of determining Cronbach α in order to test for internal consistency for the OHBS-D scale. A Cronbach α coefficient of $\geq .70$ was used as the cutoff

point to evaluate internal consistency (Nunnally & Bernstein, 1994). Step two consisted of using item-total statistics that were calculated using data from T1 to evaluate the contribution of each item to the total score. The criterion of $\geq .30$ was used for item-total correlations (Nunnally & Bernstein, 1994). Step three consisted of determining the intra-class correlation coefficients (ICC) to assess test-retest reliability of the OHBS-D. The criterion of ICC > .70 was preset to evaluate adequate test-retest reliability (Weir, 2005). Additionally, an ICC of .60-.79 was considered stable with and ICC > .80 being considered exceptional (March & Sullivan, 1999).

The OSES-D followed the same three steps to determine internal consistency and test-retest reliability as was undertaken with the OHBS-D using the control group participants (n=51). Step one determined Cronbach α to test for internal consistency; step two determined item-total correlations to assess if any items should be eliminated; and step three determined test-retest reliability by determining ICC.

Results

Validity.

Osteoporosis health belief scale.

At baseline, no significant differences were found in OHBS-D or OSES-D between participants. The OHBS-D included vitamin D items that were added to the original scale which were modeled after the current calcium items. Content validity for the additional modified vitamin D items were determined by a review of the literature and input from nutrition, nursing, and human development faculty. Factor analysis was used to evaluate the validity of the original OHBS structure as well as the additional vitamin D items. For the factor analysis, the first 13 eigenvalues exceeded 1.0; however, the scree plot showed eight sharp bends and thus eight

factors were identified which explained 58.2% of the total variance. Eigenvalues of greater than

1.0 may overestimate factors; therefore the scree plot was used for a more accurate factor

extraction (Costello & Osborne, 2005). Factors extracted included susceptibility, seriousness,

health motivation, benefits to exercise, benefits to calcium and vitamin D, barriers to exercise,

barriers to calcium, and barriers to vitamin D. Factor loadings ranged from .38-.85. (See Table

4). This signifies that the original OHBS and the OHBS-D demonstrate construct validity based

on factor analysis.

Table 4

Factor Loadings for the OHBS-D Including Vitamin D Related Items

Item	Loading
Factor 1 Susceptibility	
1. Your chances of getting osteoporosis are high.	.83
2. Because of your body build, you are more likely to develop osteoporosis.	.64
3. It is extremely likely that you will get osteoporosis.	.75
4. There is a good chance that you will get osteoporosis.	.85
5. You are more likely than the average person to get osteoporosis.	.81
6. Your family history makes it more likely that you will get osteoporosis.	.65
Factor 2 Seriousness	
7. The thought of having osteoporosis scares you.	.64
8. If you had osteoporosis you would be crippled.	.71
9. Your feelings about yourself would change if you got osteoporosis.	.69
10. It would be very costly if you got osteoporosis.	.76
11. When you think about osteoporosis you get depressed.	.67
12. It would be very serious if you got osteoporosis.	.76
Factor 3 Benefits of Exercise	
13. Regular exercise prevents problems that would happen from osteoporosis.	.66

(Continued)

Table 4

Factor Loadings for the OHBS-D Including Vitamin D Related Items (continued)

Item	Loading
14. You feel better when you exercise to prevent osteoporosis.	.75
15. Regular exercise helps you build strong bones.	.85
16. Exercising to prevent osteoporosis also improves the way your body looks.	.77
17. Regular exercise cuts down on the chances of broken bones.	.57
18. You feel good about yourself when you exercise to prevent osteoporosis.	.75
Factor 4 Benefits of Calcium and Vitamin D	
19. Taking ENOUGH CALCIUM prevents problems from osteoporosis.	.42
20. You have lots to gain from taking in ENOUGH CALCIUM to prevent osteoporosis.	.40
21. Taking in ENOUGH CALCIUM prevents painful osteoporosis.	.69
22. You would not worry as much about osteoporosis if you took in ENOUGH CALCIUM	.57
23. Taking in ENOUGH CALCIUM cuts down on your chances of broken bones.	.38
24. You feel good about yourself when you take in ENOUGH CALCIUM to prevent osteoporosis.	.66
25. Taking ENOUGH VITAMIN D prevents problems from osteoporosis.	.61
26. You have lots to gain from taking in ENOUGH VITAMIN D to prevent osteoporosis.	.59
27. Taking in ENOUGH VITAMIN D prevents painful osteoporosis.	.73
28. You would not worry as much about osteoporosis if you took in ENOUGH VITAMIN D	.79
29. Taking in ENOUGH VITAMIN D cuts down on your chances of broken bones.	.81
30. You feel good about yourself when you get ENOUGH VITAMIN D to prevent osteoporosis.	.74
Factor 5 Barriers to Exercise	
31. You feel like you are not strong enough to exercise regularly.	.62
32. You have no place where you can exercise.	.67
33. Your significant other or family discourages you from exercising.	.57
34. Exercising regularly would mean starting a new habit which is hard for you to do.	.71
35. Exercising regularly makes you uncomfortable.	.83
36. Exercising regularly upsets your everyday routine.	.72

(Continued)

Table 4

Factor Loadings for the OHBS-D Including Vitamin D Related Items (continued)

Item	Loading
Factor 6 Barriers to Calcium	
37. Calcium rich foods cost too much.	.70
38. Calcium rich foods do not agree with you.	.73
39. You do not like calcium rich foods.	.74
40. Eating calcium rich foods means changing your diet which is hard to do.	.66
41. In order to eat more calcium rich foods, you have to give up other foods that you like.	.57
42. Calcium rich foods have too much cholesterol.	.64
Factor 7 Health Motivation	
43. You eat a well-balanced diet.	.50
44. You look for new information related to health.	.79
45. Keeping healthy is very important to you.	.73
46. You try to discover health problems early.	.81
47. You have a regular health check-up even when you are not sick.	.50
48. You follow recommendations to keep you healthy.	.74

Osteoporosis self-efficacy scale.

In the OSES-D, vitamin D items that were added were modeled after the current calcium items. Content validity of the OSES-D was determined similarly to the OHBS-D. Factor analysis was used to evaluate the validity of the original OSES structure as well as the additional vitamin D items. For the factor analysis, the first three eigenvalues exceeded 1.0 and these results agreed with the scree plot. Therefore, three factors (Calcium, Exercise, and Vitamin D) for the OSES-D were extracted that explained 82.2% of the total variance. Factor loadings ranged from .59-.89 (See Table 5). This signifies that the original OSES and the OSES-D demonstrate construct validity based on factor analysis.

Table 5

Factor Loadings for the OSES-D Including Vitamin D Related Items

Item	Loading
Self-Efficacy- Exercise	
1. Begin a new or different exercise program	.62
2. Change your exercise habits	.63
3. Put forth the effort required to exercise	.89
4. Do exercises even if they are difficult	.87
5. Maintain a regular exercise program	.89
6. Exercise for the appropriate length of time	.79
7. Do exercises even if they are tiring	.88
8. Stick to your exercise program	.88
9. Exercise at least three times a week	.85
10. Do the type of exercises that you are supposed to do	.84
Self-Efficacy – Calcium	
11. Begin to eat more calcium rich foods	.81
12. Increase your calcium intake	.65
13. Consume adequate amounts of calcium rich foods	.83
14. Eat calcium rich foods on a regular basis	.89
15. Change your diet to include more calcium rich foods	.81
16. Eat calcium rich foods as often as you are supposed to	.84
17. Select appropriate foods to increase your calcium intake	.74
18. Stick to a diet which gives an adequate amount of calcium	.77
19. Obtain foods that give an adequate amount of calcium	.77
20. Remember to eat calcium rich foods	.70
21. Take calcium supplements if you don't get enough calcium from diet	.84
Self-Efficacy – Vitamin D	
22. Begin to eat more Vitamin D rich foods	.71
23. Increase your Vitamin D intake	.76
24. Consume adequate amounts of Vitamin D rich foods	.76
25. Eat Vitamin D rich foods on a regular basis	.62
26. Change your diet to include more Vitamin D rich foods	.69
27. Eat Vitamin D rich foods as often as you are supposed to	.72
28. Select appropriate foods to increase your Vitamin D intake	.77
29. Stick to a diet which gives an adequate amount of Vitamin D	.70
30. Obtain foods that give an adequate amount of Vitamin D	.80
31. Remember to eat Vitamin D rich foods	.74
32. Take Vitamin D supplements if you don't get enough Vitamin D from diet	.55

Reliability.

Osteoporosis health belief scale.

When assessing the internal consistency of the OHBS-D, a Cronbach α of .82 exceeded the preset α criterion of $\geq$ .70. The potential decrease of α coefficients associated with deletion of any individual item (SPSS "α if deleted") ranged from .81 to .82. Cronbach α coefficients ranged from .75-.87 for the subscales of the OHBS-D, which also exceeded the preset α criterion of $\geq$ .70. All item-total correlations for each subscale including the revised vitamin D subscales items (benefits and barriers) met the criterion of $\geq$ .30, ranging from .36-.78. Each of the subscales and subsequent items for such subscales contributed to increasing the overall scale internal consistency and therefore were retained (Table 6). This indicates that the OHBS-D demonstrates internal consistency. Test-retest reliability was determined by assessing ICC. The overall ICC for the OHBS-D was .79, which exceeded the preset criteria of .70. Additionally, subscales ICCs ranged from .73-.87 indicating that the OHBS-D was test-retest reliable (Table 6).

Osteoporosis self-efficacy scale.

When assessing the internal consistency of the OSES-D, a Cronbach α of .98 exceeded the preset α criterion of $\geq$ .70. Potential lowering of α coefficients associated with deletion of any individual item (SPSS "α if deleted") ranged from .97 to .98. Cronbach α coefficients ranged from .96-.98 for the subscales of the OSES-D, which also exceeded the preset α criterion of $\geq$ .70. This indicates that the OSES-D demonstrated internal consistency. All item-total correlations for each subscale including the revised vitamin D subscale items met the criterion of $\geq$ .30 ranging from .36-.96. Each of the subscales and subsequent items for such subscales contributed to increasing the overall scale internal consistency and therefore were retained (Table 6). The

overall ICC for the OSES-D was .97. The subscales ICCs ranged from .93-.94 and thus reveal

that the OSES-D is test-retest reliable (Table 6).

Table 6

Internal Consistency and Test-Retest Reliability for the OHBS-D and OSES-D Scales.

Subscale	Cronbach alpha	Cronbach alpha if item deleted range	Item-Total Correlation Ranges	ICC	ICC 95% CI
OHBS-D					
Total	.82	.81-.82	-	.79	.70-.86
Susceptibility	.87	.82-.87	.54-.78	.82	.74-..89
Seriousness	.75	.69-.75	.36-.58	.76	.65-.84
Benefits to Exercise	.86	.83-.86	.55-.71	.83	.75-.89
Benefits to Calcium	.81	.76-.79	.49-.63	.87	.81-.92
Barriers to Exercise	.84	.79-.84	.51-.76	.82	.74-.88
Barriers to Calcium	.82	.76-.82	.47-.72	.77	.67-.85
Health Motivation	.81	.75-.83	.48-.67	.85	.79-.91
Benefits to Vitamin D	.85	.81-.83	.58-.70	.83	.75-.88
Barriers to Vitamin D	.84	.85-.87	.67-.77	.73	.61-.83
OSES-D					
Total	.98	.97-.98	.44-.88	.97	.95-.98
Exercise	.96	.96-.96	.70-.89	.93	.90-.95
Calcium	.96	.95-.97	.36-.91	.93	.89-.95
Vitamin D	.98	.97-.98	.68-.96	.94	.92-.96

Note: CI indicates confidence interval; ICC, intra-class correlation coefficient; OHBS-D, Osteoporosis Health Belief Scale with modified vitamin D items; OSES-D, Osteoporosis Self-Efficacy Scale with modified vitamin D items.

Discussion

Validity.

Factor analysis results extracted an 8-factor model related to health beliefs and

osteoporosis when examining the OHBS-D. All items loaded .38 or higher on the extracted

factors. If assessing the modified portion only of the OHBS-D scale, the additional vitamin D

items had loadings of .59 and higher. The addition of benefits of vitamin D subscale loaded on

the same factor as benefits of calcium. These factor loadings are logical considering dietary

calcium and dietary vitamin D are found in similar foods as well as being related in their

mechanisms for bone health. However, barriers to vitamin D loaded on a separate factor. Barriers

to obtaining adequate vitamin D may be different compared to barriers to obtaining calcium as

vitamin D can be produced by UV light and therefore the latitude at which someone lives may

determine vitamin D status (Holick et al., 2011). Additionally, it may be difficult to attain

adequate dietary vitamin D as natural foods sources of vitamin D are limited (Calvo, Whiting, &

Barton, 2004). These differences would support the separate factor loading of barriers to vitamin

D. The addition of the vitamin D related items also show factor loadings consistent with the

original scale. The factor analysis also indicates that the original scale exhibits construct validity

as indicated by the original authors (Kim et al., 1991). The original scale was found to have

content validity via measuring calcium intake from food diaries and exercise from an existing

questionnaire. Additionally, the original OHBS was said to have construct validity from the

original factor analysis that identified seven potential subscales (Kim et al., 1991). Additionally,

another study has found the original OHBS valid via confirmatory factor analysis yielding the

same factors or subscales (Chan et al., 2007). This current study replicates the findings by the

original authors as well as indicating that the modified vitamin D items added to the scale also

demonstrate construct validity in the OHBS-D. The OHBS-D is thus considered a valid measure

of osteoporosis related health beliefs that include vitamin D related items.

In the OSES-D, factor analysis results extracted as 3-factor model related to self-efficacy

and osteoporosis when examining the OSES-D. All items loaded .55 or higher including the

additional vitamin D items. The addition of the vitamin D subscale loading onto a separate factor suggests that vitamin D related items could be successfully added to the original OSES. Factor analysis also indicates that the original scale demonstrates construct validity as indicated by the OSES original authors (Horan et al., 1998). The original OSES factor analysis yielded to factors which demonstrated construct validity. Additionally, Horan et al. (1998) determined the original OSES had criterion validity by examining calcium intake via a 24-hour recall and exercise from evaluated an exercise questionnaire. This current study again replicates the findings by the original authors as well as indicating that modified vitamin D items also demonstrate construct validity in the OSES-D. The OSES-D is therefore considered a valid measure of osteoporosis related health beliefs that include vitamin D related items.

Reliability.

The OHBS has previously been studied and test-retest reliability for the overall scale was found to be .90, while the overall Cronbach α was .82, indicating strong reliability (Kim et al., 1991). Furthermore, the findings from this study agree with previous research of a strong reliability, both internally consistent and test-retest reliable for the OHBS (Chang, 2006; Piaseu, Belza, & Mitchell, 2001; Johnson et al., 2008). The addition of vitamin D related items to the OHBS did not change the overall reliability. Moreover, the subscales of benefits to vitamin D and barriers to vitamin D were found to have strong internal consistency as well as contribute to strong test-retest reliability. Previous research has recognized that ICC values that range from .60-.79 show good test-retest reliability and an ICC of greater than .80 is thought to show strong test-retest reliability (March & Sullivan, 1999). The OHBS-D subscales had ICC ranging .73-.87 and Cronbach α ranging from .75-.87 that indicates strong reliability. Thus, the OHBS-D

could be used as a reliable measure to assess osteoporosis-related health beliefs that include items regarding vitamin D.

The original OSES has also been previously studied and found to have a strong internal consistency and test-rest reliability for each of the original subscales (exercise and calcium) (Horan et al., 1998). Findings from this research agree with the original authors as well as others (Ali & Twibell, 1995; Horan et al., 1998; Piaseu et al., 2001). The addition of vitamin D related items to the OSES did not change the overall reliability. Additionally, the subscale of vitamin D was found to have strong internal consistency (Cronbach $\alpha = .98$) and contribute to strong test-retest reliability (ICC=.97). Therefore, the OSES-D can be a reliable measure to evaluate self-efficacy and osteoporosis related behaviors that include obtaining vitamin D.

Limitations and implications.

Limitations of the current study are the small sample size (n=153) and use of a convenience sample. The control group sample size was rather small (n=51). Our sample was homogenous with respect to population demographics that limit the generalization to white young adults, ages 18-25. Additionally, the sample comes from mostly middle-upper class families. This does not allow for psychometric analysis of different ethnicities, age groups, education groups,' or other confounding demographic characteristics. In the original development of the OHBS, sample size was 150, and in the development of the OSES, sample size was 201. Our sample size of 153, although considered a small sample size, was larger than previous scale development studies (Latimer, Walker, Kim, Pasch, & Sterling, 2011; Ogedegbe, Mancuso, Allegrante, & Charlson, 2003). Additionally, other studies have used similar sample sizes for scale development (Badia, Prieto, Roset, Diez-Perez, & Herdman, 2002; Marquis, Cialdella, & De la Loge, 2001).

The purpose of this study was to determine the reliability and validity of revised osteoporosis health belief and osteoporosis self-efficacy scales. These study findings are important because valid and reliable scales that assess health beliefs and self-efficacy that include vitamin D related items are lacking. The OHBS-D and OSES-D are consistent measurement tools suitable for young adults. The revised items do not add much time to completing the scales and the findings support their validity, internal consistency, and test-retest reliability. Further testing of the OHBS-D and OSES-D with larger sample sizes, over longer periods of time, with diverse populations is needed to support these findings. Study findings support the use of both scales in educational programs as instruments to assess and consistently evaluate health beliefs and self-efficacy related to osteoporosis.

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CHAPTER FOUR. OSTEOPOROSIS EDUCATIONAL INTERVENTIONS TO INCREASE OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEFS, SELF-EFFICACY, DIETARY CALCIUM AND VITAMIN D INTAKES IN YOUNG ADULTS

Abstract

The objective of this study was to assess osteoporosis education interventions and their impact on osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium and vitamin D intake. This study was a quasi-experimental pre-post-test design that included a convenience sample of 153 college-age adults at a Midwestern college and university.

Variables that were measured in this study included osteoporosis knowledge, osteoporosis health beliefs, osteoporosis self-efficacy, dietary calcium intake and dietary vitamin D intake. A 3 X 2 repeated measures analysis of variance (ANOVA) was used to assess differences in educational intervention treatments. Regression analysis was used to determine OHB and OSE predictors of dietary calcium and vitamin D intake.

Results indicated that increases in osteoporosis knowledge, $F(1, 149) = 110.05$, p<.001, and health beliefs $F(1, 149) = 11.71$, p<.001, were significant. Self-efficacy was not significantly different $F(1, 149) = 1.47$, p<.227; $F(2, 149) = 2.87$, p>.06. Osteoporosis health beliefs were a significant predictor of dietary calcium intake (p<.044) and vitamin D intake (p<.047) accounting for approximately 11.2% and 10.1% of the variance respectively. Self-efficacy was a significant predictor of vitamin D intake (p<.01) which accounted for the approximately 7.3% of the variance.

In conclusion, both interventions increased osteoporosis knowledge and health beliefs but not self-efficacy. Current or future health related classes that focus on osteoporosis prevention

could incorporate either educational method to increase knowledge and health beliefs. Both interventions did not alter dietary behavior significantly.

Scope of the Problem

Osteoporosis is a chronic disease defined by decreased bone mass and increased fracture risk (NOF, 2010). It is estimated that 10 million people in the United States have osteoporosis and an additional 34 million have osteopenia or are at risk for developing osteoporosis (NOF, 2010). Women are much more likely than men to be diagnosed with osteoporosis and low bone mass (Dawson-Hughes et al., 2010). Additionally, rate of bone loss in women increases dramatically after menopause with bone loss accelerating to 3-7% compared to just 0.3% after the age of 30 (Heaney, 1992). Men are also at risk of developing osteoporosis or low bone mass as they age. About 1-2 million men have osteoporosis and 8-13 million have osteopenia (NOF, 2010). The prevalence of osteoporosis is expected to increase in both genders due to increased life expectancy rates and an increasing older adult population (Kannus, Parkkari, Niemi, & Palvanen, 2005).

Risk Factors

Several risk factors may increase the possibility of an individual developing osteoporosis. Risk factors one cannot change include increased age, female gender, Caucasian race, and family history of osteoporosis, or fracture (Robitaille et al., 2008). Risk factors that could be altered include dietary intake of calcium and vitamin D, physical activity included in one's lifestyle, low BMI, excessive alcohol use, and smoking (Robitaille et al., 2008).

There are preventative actions that individuals can practice throughout life that will put them at a decreased risk of developing low bone density. Peak bone mass (PBM) is developed by age 30 and therefore preventative actions of maximizing bone mass in order to reduce the risk of

osteoporosis-related fractures in later life should begin as early as possible (Heaney, 2000). These preventative efforts include consuming a diet adequate in calcium and vitamin D, not smoking, and participating in weight-bearing exercise (Dell, Green, Anderson, & Williams, 2009).

Adequate dietary vitamin D is a modifiable risk factor that could potentially help reduce the risk of developing osteoporosis. Vitamin D aids the body in regulating calcium absorption (DeLuca, 2004). Dietary vitamin D is found in only a select number of foods. The top five food products consumed in the United States that contain vitamin D are milk and milk products, meat, fish, eggs, and ready to eat (RTE) cereals (Hill, Jonnalagadda, Albertson, Joshi, & Weaver, 2012).   Non-dietary vitamin D may be synthesized by ultraviolet radiation (UV) (Holick, 1995).

The Institute of Medicine (IOM) report on the daily recommended intakes (DRIs), recommends 600 IUs of vitamin D for adults aged 19-70 and 800 IUs for adults older than 70 years of age (Ross, Taylor, Yaktine, & Del Valle, 2011). For optimal bone health, the recommendations have increased from 400 IU per day to 600 IU per day for most adults (Ross et al., 2011). Previous vitamin D deficiency estimates in the United States have ranged from 20% to 100% of the population (Holick, 2006; Holick, 2007; Holick et al., 2011; Lips et al., 2006) prompting the new IOM report on vitamin D.

Calcium is a nutrient commonly related to development and maintenance of bone. Almost all (99%) of the body's calcium is stored as calcium hydroxyapatite in the bones and teeth (Boskey, 2007). Calcium is also found in the circulatory system, extracellular fluid, muscles, and other tissues that are essential for vascular contraction, muscle function, hormone secretions, intracellular signaling, and nerve impulses (Boskey, 2007).

Dietary calcium intake is a nutritional factor related to bone health and is particularly important during the prepubescent and adolescent years when bone mass is being acquired (Bonjour, Chevalley, Rizzoli, & Ferrari, 2007; Zhu et al., 2008). Calcium containing foods and dietary supplements make up dietary calcium intake. Calcium containing foods such as milk, yogurt, and cheese provide the major portion of calcium in the general diets of the United States. Milk, cheese, yogurt, and food items these dairy products are added to (e.g. pizza) supply an estimated 72 % of calcium for diets in the United States (Wells & Buzby, 2008).

The recommendations stated by the IOM for calcium are 1000 mg for adults aged 19-50. The recommendations are increased to 1200 mg for females aged 51-70 per day and 1000 mg for males aged 51-70. Adults aged 70 and older are recommended to intake 1200 mg per day (Ross et al., 2011). Even though there has been an increase in dairy consumption in the United States in the past few years (Forshee, Anderson, & Storey, 2006), calcium supplementation may still be needed in order to meet the recommended levels, especially for older adults.

Education and Prevention

For the process of prevention, individuals should be aware of osteoporosis before they are exposed to the disease in order to take some preventive measures (Gemalmaz & Oge, 2008). Even with knowledge, people may not change behavior, but without knowledge, behavior change may not be reasonable (Ailinger, Braun, Lasus, & Whitt, 2005). Osteoporosis knowledge has been shown to increase with different types of education such as a three-hour program on osteoporosis, three educational sessions over the course of three weeks or even a 45-minute continuing educational program (Sedlak, Doheny, & Jones, 2000). However, increased osteoporosis knowledge did not always lead to changes in behavior such as increased calcium intakes (Kasper, Peterson, & Allegrante, 2001). Some studies have found no association with

73

osteoporosis knowledge and dietary calcium intake (Hernandez-Rauda, & Martinez-Garcia, 2004; Wallace, 2002) while others have found increased dietary calcium (Babatunde, Himburg, Newman, Campa, & Dixon, 2011; Tussing & Chapman-Novakofski, 2005). Vitamin D knowledge relating to osteoporosis is generally not included in previous studies. To this author's knowledge, only Bohaty, Rocole, Wehling, and Walman (2008) have examined actual dietary vitamin D intake and its relation to osteoporosis knowledge.

Knowledge is a necessary component related to health behavior; however, it may not be sufficient by itself to facilitate behavioral change, possibly due to internal beliefs. The health belief model (HBM) and the expanded health belief model (EHBM) have been used to identify factors associated with the practice of disease detection and health promotion behaviors (Glanz, Lewis, & Rimer, 1997). The HBM states that a person's healthy behavior depends on his or her perception of four major areas: severity of a potential illness, susceptibility to that illness, benefits of taking preventive action, and the barriers to taking that action (Rosenstock, 1960). According to the HBM, individuals are more likely to achieve a behavior if they have certain beliefs pertaining to that behavior (Rosenstock, 1960). The EHBM suggests the foundation of preventive behaviors is obtained from direct and indirect influences of knowledge, attitudes, and self-efficacy. Self-efficacy has been defined as an individual's belief of his or her ability to conduct an action in order to achieve a specified goal (Bandura, 1977). Self-efficacy is also expected to increase with increased knowledge (Rosenstock, Strecher, & Becker, 1988).

There are conflicting studies on the topic of HBM and EHBM and how they relate to nutrient intakes. Studies using these models generally focus only on dietary calcium intake and rarely include dietary vitamin D intake as behavioral assessments. EHBM constructs have been associated with nutrient intakes (Ievers-Landis, Burant, & Drotar, 2003). For example, calcium

74

intake (14%) was related to self-efficacy in one study (Tussing & Chapman-Novakofski, 2005). However, some studies have not found any HBM constructs that predict calcium intake (Anderson, Chad, & Spink, 2005; Wallace, 2002).

The length, type of intervention, and findings of educational interventions for preventing osteoporosis differ and there appears to be no consensus on what style and length of intervention is best for behavior change. Interventions that primarily deliver only information, such as a brochure or a lecture, have been found to increase knowledge but not preventative behaviors (Sedla, Doheny, & Jones, 2000). Several studies have examined osteoporosis knowledge, health beliefs, and self-efficacy in combination but failed to include preventative behavior assessments such as dietary calcium or dietary vitamin D intakes (Berarducci, 2004; Chan, Kwong, Zang, & Wan, 2007; Curry, Hogstel, Davis, & Frable, 2002).

Educational intervention lengths and content of programming differ greatly in the literature. Educational interventions range from 45-minute lectures (Bohaty et al., 2008; Sedlak, Doheny, & Jones, 2000) to a semester long educational courses (Kasper et al., 2001). Educational interventions of a 45-minute lecture, a three-hour one-time session, and three educational one-hour sessions over a three-week period were found to increase osteoporosis knowledge, but not health beliefs or calcium intakes (Sedlak, Doheny, & Jones, 2000). An educational intervention that included three two-hour sessions showed significant improvements in osteoporosis knowledge, health beliefs, and self-efficacy, but failed to include assessment of any preventative behavior changes such as dietary calcium and vitamin D intakes (Chan et al., 2007). Only a few studies have included information in educational interventions regarding adequate dietary vitamin D intake (Bohaty et al., 2008; Curry et al., 2002; Soloman et al., 2006). Additionally, only one study has included assessment of dietary vitamin D intake after an

educational intervention (Bohaty et al., 2008). However, this study only examined osteoporosis knowledge and did not include health beliefs or self-efficacy in their measurements.

A further concern with osteoporosis educational interventions is that many of the studies primarily focus on women (Gammage & Klentrou, 2011). There are a few studies that have looked specifically at osteoporosis education for men (Doheny, Sedlak, Estok, & Zeller, 2007; Lee & Lai, 2006; Sedlak, Doheny, & Estok, 2000; Tung & Lee, 2006), and some studies have examined educational interventions for both men and women (Ailinger et al., 2005; Chan et al., 2007; Gammage, Francoeur, Mack, & Klentrou, 2009). Ailinger et al.(2005) found no difference in osteoporosis knowledge between men and women. Similarly, in additional studies, there were no baseline differences in osteoporosis knowledge, health beliefs, or self-efficacy between genders (Chan et al., 2007; Gammage et al., 2009). After three 2-hour education sessions osteoporosis knowledge, health beliefs, self-efficacy increased in both men and women (Chan et al., 2007).

There are four gaps in the literature that the current study attempted to fill. First, this study attempted to add to the existing knowledge base of educational interventions that are applied to both men and women as much of the literature focuses solely on women. Second, this study attempted to fill the gap of which type of educational intervention influences osteoporosis knowledge, health beliefs, and self-efficacy. Third, vitamin D information was included in the education intervention content and this study attempted to assess vitamin D content which is often lacking in the literature. Finally, this study attempted to fill the gap of assessing preventative vitamin D behaviors by assessing dietary vitamin D. The findings relevant to the following research questions will help address these gaps.

RQ1) How do education intervention outcomes differ based on gender in a college age adult population?

RQ2) How does education intervention style (lecture versus hands-on activities) influence the level of osteoporosis knowledge, osteoporosis health beliefs, and osteoporosis self-efficacy?

RQ3) What are the scores for: osteoporosis knowledge that includes vitamin D related knowledge; osteoporosis health beliefs that include vitamin D related health beliefs; and osteoporosis self-efficacy that includes vitamin D related self-efficacy using newly revised scales that include vitamin D related items?

RQ4) How does education intervention type influence dietary calcium and vitamin D intake?

RQ5) How are dietary calcium and vitamin D intakes affected by osteoporosis health beliefs and osteoporosis related self-efficacy?

Methods

Participants and recruitment.

Participants were recruited through six sections (approximately 30 students each) of an introductory nutrition course. Recruitment was conducted through an in-class announcement invitation to partake in an extra credit research opportunity. Both men and women (18 years of age and older) were invited to participate. A consent form was provided in an on-line format before completing the questionnaires. Additionally, demographic questions were included at the end of the questionnaire.

Institutional review board.

The study was reviewed and approved by both North Dakota State University and The College of St. Benedict/St. John's University institutional review boards. A research assistant accessed the online questionnaire responses and collected the three-day food diaries to ensure confidentiality of participants. The research assistant provided all three of the course instructors the names of students who have completed the extra credit after the final exam was scored so that extra credit points could be factored into the student's final grades. All research participants read and signed an online consent form prior to completing any portion of the research project. See Appendix A9 for an example of the consent form.

Instruments.

Osteoporosis knowledge test including vitamin D related items.

Permission to use and modify the Osteoporosis Knowledge Test (OKT) revised in 2011, the Osteoporosis Health Belief Scale (OHBS) and the Osteoporosis Self-Efficacy Scales (OSES) was granted by Dr. Phyllis Gendler at Grand Valley State University. See Appendix A4 for a copy of the OKT (revised 2011), OHBS and OSES. The OKT, OHBS, and OSES have previously been validated among a Caucasian sample. The OKT was revised in 2011 by Gendler, Coviak, Martin, Kim, and Von Hurst (2011). The OKT was revised to include questions regarding vitamin D but has not been studied in detail. The OKT (revised 2011) has six subscales: OKT (revised 2011) Risk Factors (items 1-11), Exercise (items 12-17), Calcium (items 18-25), Vitamin D (items 26-29), General (items 30-32) and Medication (items 33-34). The subscale of medication was added by this author and the complete OKT (revised 2011) with medication questions will be referred to as OKT-D. Validity of the OKT (revised 2011) has been evaluated by content validity, and questions were examined for difficulty,

effectiveness of distracters, and discrimination according to Gendler et al. (2011). The possible answers for participants will be a combination of True/False/Don't Know and multiple-choice. Answers were coded by assigning '1' for correct and '0' for incorrect. The total maximum score for the OKT-D was 34.

Osteoporosis health belief scale including vitamin D related items.

Beliefs about osteoporosis were measured using the Osteoporosis Health Belief Scale (OHBS) (Appendix A5). The original OHSB is a 42-item instrument with seven subscales: Susceptibility (items 1-6), Seriousness (items 7-12), Benefits-Exercise (items 13-18), Benefits-Calcium (items 19-24), Barriers-Exercise (items 25-30), Barriers-Calcium (items 31-36) and Health Motivation (items 37-42). The original OHBS uses a 5-point Likert scale from 'strongly agree' (5) to 'strongly disagree.' (1). Possible scores for each subscale ranged from 6 to 30 with a low score indicating a low perception and a high score indicating a high perception. Possible total scores ranged from 54-270. The original OHBS was modified to include Benefits-Vitamin D (items 43-48) and Barriers-Vitamin D (items 49-54) using similar wording to the calcium questions in order to create the OHBS-D. Concurrent validity of the original OHBS was established through assessment of calcium and exercise behaviors along with the HBM instrument. Construct validity was established using factor analysis (Kim et al., 1991). The original OHBS Cronbach alpha coefficients for susceptibility, seriousness and health motivation subscales were .82, .71, and .73 respectively. Cronbach alpha coefficients for subscales of benefits of calcium, barriers of calcium, benefits of exercise, and barriers of exercise were .80, .74, .81 and .82 respectively. Test– retest reliability for the total instrument was .90.

In Chapter three, the OHBS-D was examined for validity by a review of the literature and factor analysis. Additionally, internal consistency and test-retest reliability were assessed.

The previous article found that the OHBS-D was valid and factor analysis extracted eight factors which accounted for 58.2% of the variance. Internal consistency estimates were .82 for the total instrument and subscale Cronbach alpha coefficients ranged from .75-.87 indicating the OHBS-D was internally consistent. Test-retest ICC was .79 for the total instrument with subscales ranging from .73-.87 indicating that the OHBS-D was test-test reliable.

Osteoporosis self-efficacy scale including vitamin D related items.

The OSES-D was used to determine self-efficacy related to exercise, calcium and vitamin D intakes. The original OSES was developed by Horan, Kim, Gendler, Froman, and Patel (1998) and uses a 21-item survey consisting of two subscales, an osteoporosis self-efficacy exercise scale and an osteoporosis self-efficacy calcium scale. The self-efficacy for exercise was evaluated using 10 items. A question related to the self-efficacy of exercise is the respondent's confidence in changing exercise habits. The self-efficacy for calcium intake was determined using 11 items. A question related to self-efficacy of calcium is their confidence in increasing their calcium intake. Horan et al. (1998) originally developed the self-efficacy scale as a line scale from "not at all confident" to "very confident". The subjects were to mark on the line closer to "not at all confident" if they did not feel confident up to "very confident" as their confidence rose. The possible scores of the scale range from 0 for "not at all confident" to 100 for "very confident." When using the OSES-D, participants were asked to mark a spot on the line and a computer-generated scale was used to score the mark on the 10 cm line.

Previous research on the original OSES demonstrated test-retest reliability coefficients of both subscales at .90 (Horan et al., 1998). Additional questions on self-efficacy related to vitamin D were added to create the OSES-D. The self-efficacy vitamin D questions were modeled after the calcium questions. A total maximum score for the OSES-D items added was 3200. In

Chapter three, the OSES-D was examined for validity by a review of the literature and factor analysis. Additionally, internal consistency and test-retest reliability were assessed. The previous article found that the OSES-D was valid and factor analysis extracted three subscales that accounted for 82.2% of the variance. Internal consistency estimates were .98 for the total instrument, with subscales Cronbach alpha coefficients ranging from .97-.98 indicating the OSES-D was internally consistent. Test-retest ICC was .97 for the total instrument with subscales ranging from .93-.94 indicating that the OSES-D was test-test reliable.

Dietary assessment information was collected using three-day food diaries, which included one weekend day and two weekdays (See Appendix A3). Average dietary calcium and vitamin D intakes were assessed over the three reported days using Diet Analysis Plus Software, USA (10th edition). Separately, two researchers analyzed 10 of the same food diary records. Total kcalories, calcium (mg) and vitamin D (IU) were determined and compared for individual days and as three-day averages. Inter-rater correlation coefficients ranged from .90-.94. Any discrepancies found were discussed until an agreement was made. The remaining food dairies were analyzed by one of the two researchers. Average dietary calcium intakes and average vitamin D intakes were reported in mg/day and IUs/day as well as in relation to total energy (kcalories).

Data collection.

A convenience sample (n=153) of students from six sections that consisted of 180 students in an introductory nutrition course participated in this study (84.4% response rate). Students were given a verbal description of the project. The OKT-D, OHBS-D, and OSES-D, pre and post-tests were administered on-line. Only the research assistant had access to the pre and post-test data to ensure confidentiality. Participants were encouraged to complete the

questionnaire and a reminder email was sent after one week. Participants were asked to provide their names and course section to receive extra credit (15 points or approximately 2% of the total points for the class) and so the treatment groups could be identified. Treatment groups were identified by lecture day and times. The sections of the nutrition course were randomly assigned into three groups with two sections in each group: Control, treatment one (lecture) and treatment two (Hands-on activities). Random assignment occurred by drawing the course section numbers out of a hat. The control group sections (n=51) met at 9:40 a.m. and 1:00 p.m. Treatment one sections (n=53) met at 11:20 a.m. and 2:40 p.m. Treatment two sections (n=49) met 9:40 a.m. and 2:40 p.m.

The pre-test OKT-D, OHBS-D, and OSES-D were completed during the beginning of the semester. The vitamin D and calcium lectures were scheduled for the last third of the introductory class. The control group received the pre-test one week before the treatment groups. One week prior to the scheduled calcium and vitamin D lecture or hands-on activities, the control group was asked to complete the post-test. The control group received the calcium and vitamin D lecture after they had completed the post-test. The treatment groups were asked to complete the post-test directly after receiving the corresponding calcium and vitamin D information for their treatment. Both the control group and the treatment groups had a five week time period between completing the pre-test and post-test.

A lecture-based educational intervention on preventing osteoporosis by obtaining adequate dietary vitamin D, calcium, and exercise was developed and implemented in two introductory nutrition course sections. The same presenter provided the education intervention to ensure all of the same content was delivered to each class. Vitamin D, calcium, exercise, and

osteoporosis are part of the introductory nutrition course content. The lecture treatment was 70 minutes in length. See Appendix A1 for further details regarding lecture content.

A second treatment group of two different introductory nutrition course sections included a hands-on/small group educational intervention (n=48). This educational intervention specifically targeted the OKT-D, the subscales of the OHBS-D (i.e. barriers to vitamin D intake), and the OSES-D. Class activities included:

1-*Determining risk and protective effects on bone mass (15 minutes)* – Jenga (Hasbro Inc. Pawtucket, RI) game to represent bone instability and identify risk factors for osteoporosis.

2- Determining Susceptibility (15 minutes) - Measuring height and weight; risk factor quiz Additional questions asking about risk factors such as using alcohol, being menopausal, being female, family history, previous falls, etc. (See Appendix A2 for an example of the risk factor quiz).

3- Overcoming barriers (10 minutes) – Serving size and portion size games: Identify correct portion sizes of calcium-rich and vitamin D rich foods.

4-Facts and myths-practice of behaviors (12 minutes) - supplements, lactose intolerance, calcium and vitamin D sources, tasting vitamin D fortified lactose-free milks; tasting soy milk; practice reading supplement labels.

5- Practice Bone Health- High-calcium and high-vitamin D recipe sharing (10 minutes)- snacks of high-calcium and high-vitamin D foods; recipe contest.

6-Goal Setting and sharing (5 minutes) – Participants were asked to create a goal for themselves regarding protective factors relating to osteoporosis and how they will meet their goal: such as "I will obtain adequate vitamin D intake by taking a 1000 IU vitamin D supplement daily." Participants then selected two people to share this goal with in the class.

7-Formative assessment (3 minutes) – participants completed a formative assessment of what they liked most about the class, what they liked least and any improvements to the activities that they would have liked to see.

After the education interventions, participants from the three groups (control, treatment one, and treatment two) were asked to complete an additional three-day food diary (FD2) following the same format as the first three-day food diary (FD1). Participants submitted their food diaries to the research assistant. All pre-food diaries (FD1) for all three treatment groups were collected during February 3rd-6th 2012 in accordance to when the food diary analysis assignment was due in class. The control group post-food diaries were collected prior to the vitamin D and calcium lectures in those sections as to collect the information prior to the control group classes receiving any information. Both treatment one and treatment two group's food diaries were collected immediately after receiving their respective treatment (either lecture or hands-on activities). All post questionnaires were collected five weeks after the pre-questionnaires were collected. All groups had the same amount of time elapse between questionnaires.

Results

Demographic variables.

One hundred fifty-three young adults ages 18-23 participated in the study including 41 males (27%) and 112 females (73%).The representativeness of the sample was skewed towards females as the sample university consisted of 47% males and 53% females. Most participants had completed some undergraduate coursework (57%) or had graduated from high school (43%). The participants were Caucasian (80.5%), Asian or Pacific Islander (9%), Hispanic/Latino (5%), African American (4%), and American Indian or Alaska Native (1%). Almost all participants

84

were single (98%). Participants mainly lived on campus (59%) and purchased the majority of their food at the campus cafeterias. The remaining participants (41%) lived in campus apartments and purchased the majority of their food from local grocery stores. A majority of the participants exercised (88%) and 31% took some type of dietary supplement. The majority of the sample did not know anyone with osteoporosis (79%) and did not have a relative with osteoporosis (86%). Of those who did have a relative with osteoporosis (14%), 47% said that it was a blood relative. A chi-square test showed that there were no statistically significant differences between the three groups for all demographic and lifestyle variables. Demographic and lifestyle information including totals and percentages is found in Table 7.

Outcome variables.

Effects of educational interventions on osteoporosis knowledge, health beliefs, and self-efficacy.

A 3 X 2 repeated measures analysis of variance (ANOVA) was used to determine significant differences in osteoporosis knowledge (OKT-D), osteoporosis health beliefs (OHB-D), osteoporosis related self-efficacy (OSE-D), dietary calcium (CA) and dietary vitamin D (VD) intakes among the three intervention groups. If statistically significant differences were found, Tukey's HSD post-hoc analysis was conducted to determine significance between groups. In order to fill the gap of adding to the literature where males and females are included in osteoporosis education and to test the influence of gender on osteoporosis education interventions (RQ1), a 3 X 2 repeated measures ANOVA was conducted with gender as a covariate. There were no significant differences found by gender for any total scale score or subscale of the OKT-D, OHBS-D, OSES-D, dietary calcium, and dietary vitamin D intakes between educational intervention styles.

85

Table 7

Demographic and Lifestyle Characteristics of All Participants in the Osteoporosis Educational Intervention Groups

Characteristics	Total	Percentage (%)
Gender		
Male	41	26.8
Female	112	73.2
Education Level		
High school (college Freshman)	60	39.2
Some college (soph-senior)	87	56.9
Completion of undergrad degree	6	3.9
Some Grad school	0	0
Age (years)		
Mean (SD)	19.92 (1.39)	
Median (Range)	19 (18-23)	
Weight (lbs)		
Mean (SD)	149.29 (29.25)	
Median (Range)	142 (98-270)	
Height (inches)		
Mean	66.58 (3.79)	
Median	66 (599-77)	
Race/Ethnicity		
Caucasian	124	81.0
Asian/Pacific Islander	14	9.2
Hispanic/Latino	8	5.2
Black	6	3.9
American Indian/Alaskan Native	1	.7
Marital Status		
Single	150	98
Married	3	2
Living arrangement		
On campus apartments-has a kitchen	71	46.4
On campus dorms-no kitchens	82	53.6
Main source of food Purchases		
Campus cafeterias	82	53.6
Local grocery stores	71	46.4
Know someone with osteoporosis		
Yes	33	21.6
No	120	78.4
Have a relative with osteoporosis		
Yes	132	86.3
No	21	13.7
Exercise regularly (mod-vig) 150 min per week		
Yes	135	88.2
No	18	11.8
Take a dietary supplement		
Yes	48	31.4
No	105	68.6
Calcium supplement	9	5.9
Vitamin D supplement	8	5.2

To determine which education intervention style may impact changes in osteoporosis knowledge, health beliefs, and self-efficacy, several steps were taken to test the influence of osteoporosis education intervention type on OKT-D, OHB-D, and OSE-D (RQ2) as well as determine OKT-D, OHB-D, and OSE-D (RQ3) scores. At baseline, a chi-square test indicated no differences in demographic characteristics between the three groups at baseline. Additionally, no significant differences at baseline were found in total scores or subscale scores for the OKT-D, OHBS-D, OSES-D, CA, or VD between the three groups. The means and SDs are shown in Table 8 for each subscale of OKT-D, OHBS-D, and OSES-D. Additionally, baseline means and SDs for CA and VD intakes are included in Table 8.

With regard to the influence of intervention on osteoporosis knowledge, the next step in the analysis indicated that OKT-D total scores were considered low at baseline (57%). The further step of using the repeated measures ANOVA indicated that OKT-D total scores increased significantly over time, $F(1, 149) = 134.25$, p<.001, for all three groups. After running the 3X 2 ANOVA and significant differences were found between groups, Tukey's HSD post-hoc analysis was conducted. OKT-D total score differences between groups were significant between the control group and treatment one group only, $F(2, 149) = 3.80$, p<.02. All subscales of OKT-D, which included risk factors, exercise, calcium, vitamin D, general, and medications increased significantly over time (p<.05) in all three groups. For the knowledge measure (OKT-D), there were significant differences between groups only in the exercise subscale, $F(2, 149) = 3.20$, p<.04. After using Tukey's HSD post-hoc analysis, differences were found between the control group and treatment one group (p<.003) and the control group and treatment two group (p<.001). Overall, the OKT-D scores for the total group from pre to post-test increased from approximately

57% to 72%. Additionally, if looking at the three groups individually, although not statistically significant, it appears that OKT-D increased to a greater extent in the treatment groups.

Regarding osteoporosis health beliefs, after conducting a repeated measures ANOVA it was found that OHB-D totals were significantly different over time within groups, $F(1, 149) = 10.422$, p<.002, but not between groups. The OHBS-D subscales that were significantly different over time within groups were benefits of exercise, $F(2, 149) = 17.62$, p<.001, benefits of calcium, $F(1, 149) = 19.90$, p<.001, and benefits of vitamin D, $F(1, 149 = 37.16$, p<.001. No significant differences were found in the OHBS-D subscales between treatment groups. Although there were not significant differences found between groups, it does appear that OHBS-D subscale scores for benefits and barriers to vitamin D were trending in the correct direction, and to a greater extent in the treatment groups compared to the control group.

With regard to the influence of intervention on osteoporosis knowledge, after conducting the repeated measures ANOVA, the analysis established that there were no significant differences over time or between groups found for OSES-D total or subscales of the OSES-D including calcium, exercise, or vitamin D (p>.05). Although it was not statistically significant, total OSE-D increased to a greater extent in treatment two (hands-on activity) group compared to the control or treatment one (lecture) groups. The treatment two (hands-on activity) group was the only group to increase in OSE-D total score while the other two groups actually decreased. Additionally, self-efficacy for calcium and vitamin D intakes only increased in the treatment two (hands-on activity group).

Effects of educational interventions on dietary calcium and vitamin D intakes.

In order to fill the gap of adding to the literature where vitamin D information is included in osteoporosis education and to test the influence osteoporosis education interventions on

vitamin D and calcium intake (RQ4), a 3 X 2 repeated measures ANOVA was conducted. Dietary calcium and vitamin D intakes were not significantly different over time or between groups. Additionally, there were no significant differences if dietary calcium and vitamin D were analyzed in proportion with total kcalories for the day ($p > .05$). Although there were no significant differences found, both treatment groups showed an increase in dietary vitamin D intake while the control group decreased. The average dietary calcium intake was approximately 1078 mg per day. This level met the recommendations set forth by the IOM. Average dietary vitamin D intakes were approximately 224 IU per day, which was well below the recommendation of 600 IU per day. Nine participants were taking a calcium supplement ranging from 200-500 mg per day. Only eight participants were taking a vitamin D supplement and intakes ranged from 800-2000 IU per day. Supplements were not factored into dietary intakes as calcium recommendations were currently met and large doses of vitamin D supplements would skew the mean intake.

Nutrient intakes related to osteoporosis health beliefs and self-efficacy.

In order to answer which osteoporosis health beliefs and self-efficacy areas affect dietary calcium and vitamin D intakes (RQ5), two separate simultaneous regressions were conducted to predict dietary calcium intake and dietary vitamin D intake. The predictor variables for both dietary calcium and vitamin D intakes were the OHBS-D and OSES-D subscales. The OHBS-D overall regression was significant, $F(9, 151) = 2.26$, $p < .02$, accounting for approximately 11.2% of the variance in dietary calcium intake. The only significant predictor of dietary calcium intake was the subscale of barriers to calcium (Table 9). When perceived barriers to calcium increased, dietary calcium intake was found to decrease. The OHBS-D overall regression was not significant for dietary vitamin D intake ($p > .07$). The OSES-D overall regression was significant

for dietary vitamin D intake, $F(3, 152) = 1.80$, p< .01, and accounted for approximately 7.3% of the variability in dietary vitamin D intake.

Significant predictors included the OSES-D subscales of calcium and vitamin D (Table 9). As perceived self-efficacy of obtaining adequate calcium increased, so did dietary vitamin D intake. However, as perceived self-efficacy of obtaining adequate vitamin D increased, dietary vitamin D intake decreased. The OSES-D overall regression was not significant for dietary calcium intake (p>.19).

Table 8

Pre and Post Treatment Means and Standards Deviations for the OKT-D, OHBS-D, OSES-D, and Nutrient Intakes Across Conditions

	Control		Intervention Group 1		Intervention Group 2	
OKT-D (knowledge)	**Pretest**	**Posttest**	**Pretest**	**Posttest**	**Pretest**	**Posttest**
Total Score (34)	19.3±4.4	23.2±3.1*	19.7±4.0	25.3±3.2*	18.7±4.4	24.6±2.9*
Risk factors (11)	6.5 ± 2.2	8.0 ± 1.8*	6.8 ± 1.8	8.6 ± 1.6*	6.4 ± 1.7	8.3 ± 1.9*
Exercise (6)	3.1 ± 1.3	3.6 ± 1.1*	3.3 ± 1.2	4.4 ± 1.0*	3.4 ± 1.3	4.6 ± .94*
Calcium (8)	5.5 ± 1.2	5.8 ± 1.2*	5.3 ± 1.2	6.0 ± 1.2*	5.3 ± 1.5	6.0 ± 1.1*
Vitamin D (4)	1.6 ± 1.9	2.0 ± 1.2*	1.6 ± 1.0	2.6 ± .89*	1.4 ± 1.1	2.4 ± 1.1*
General (3)	1.7 ± .89	1.7 ± .93*	1.6 ± .84	1.8 ± .87*	1.1 ± .91	1.9 ± .76*
Medication (2)	.98 ± .76	1.9 ± .35*	1.1 ± .72	1.8 ± .44*	1.0 ± .71	1.7 ± .48*
OHBS-D (attitude)						
Total Score (270)	157.3±15.0	163.7±15.3*	158.4±18.0	162.4±13.5*	156.1±10.6	162.2±16.1*
Susceptibility (30)	13.7±4.5	13.4 ± 4.5	14.2 ± 4.6	13.3±4.5	14.8±4.3	13.2 ± 5.1
Seriousness (30)	17.6±4.5	18.8±4.4	18.6±4.1	18.9±3.9	18.7±3.4	18.80±3.4
Benefit exercise (30)	23.7±3.8	24.9±4.2*	24.3±3.9	25.7±3.3*	22.9±4.0	25.6±3.7*
Benefit calcium (30)	23.2±4.5	24.6±3.5*	22.9±3.7	24.6±3.2*	21.9±3.2	23.8±3.6*
Barrier exercise (30)	10.3±4.1	10.3±3.8	10.1±4.1	10.6±4.3	10.7±4.0	10.7±5.2
Barrier calcium (30)	11.1±4.0	11.9±3.9	11.2±3.9	11.1±3.7	12.1±3.3	11.3±3.6
Health Motivation(30)	22.5±4.8	22.7±3.9	22.8±3.5	22.2±3.5	21.8±3.5	22.9±3.8
Benefit Vit D (30)	22.0±4.8	23.8±3.8*	21.8±3.5	24.4±3.1*	20.3±3.3	23.7±3.8*
Barrier Vit D (30)	13.4±3.8	13.3±4.2	12.4±4.0	11.7±3.5	13.0±2.8	12.1±3.6
OSES-D (self-efficacy)						
Total (3200)	2376.4±605.7	2331.4±579.1	2323.3±620.6	2304.9±584.7	2275.5±557.9	2569.3±515.1
Exercise (1000)	763.2±217.0	754.8±197.5	755.5±212.9	702.1±201.7	723.3±201.1	786.7±198.4
Calcium (1100)	819.1±231.3	807.6±217.9	795.5±244.4	817.8±208.6	781.6±211.6	905.7±179.4
Vitamin D (1100)	794.1±247.8	769.1±236.9	772.3±249.8	785.0±242.2	770.6±237.7	876.9±188.4
Nutrient Intakes						
Calcium (mg)	1109.6±605.9	1115.3±680.1	1074.1±665.2	1085.2±551.9	1049.6±521.7	985.7±555.9
Vitamin D (IU)	249.2±205.3	218.2±187.2	224.4 ± 251.4	258.2 ± 410.7	196.6 ± 141.8	204.2 ± 180.4
Calories (kcals)	2143.9±947.6	2133.3 ±897.0	2075.9± 904.9	2557.8± 3436.1	2157.4±1011	2009.3 ± 959.3

Note: * statistically significant (p<.05).

Table 9

Summary of Simultaneous Regression Predicting Dietary Calcium and Vitamin D Intakes

Variable	B	SE	B	p-value
Calcium Intake				
Osteoporosis Health Belief Subscales				.021*
Susceptibility	-23.77	21.23	-.19	.27
Seriousness	-38.40	22.86	-.25	.10
Benefits Exercise	-5.51	23.95	-.03	.82
Benefits Calcium	-23.36	21.22	-.15	.27
Benefits Vitamin D	-36.50	24.56	-.22	.14
Barriers Exercise	6.31	23.20	.05	.79
Barriers Calcium	-77.49	31.64	-.48	.016*
Barriers Vitamin D	-	-	-	-
Health Motivation	4.48	21.02	.03	.83
OHBS-D Total	21.89	17.42	.55	.21
Osteoporosis Self-Efficacy Subscales				.19
Exercise	-.15	.32	-.05	.63
Calcium	.81	.47	.28	.09
Vitamin D	-.25	.44	-.10	.56
OSES-D Total	-	-	-	-
Vitamin D intake				
Osteoporosis Health Belief Subscales				.047*
Susceptibility	-1.01	7.84	-.02	.90
Seriousness	13.65	7.50	.27	.07
Benefits Exercise	5.13	7.88	.01	.56
Benefits Calcium	1.97	8.42	.04	.82
Benefits Vitamin D	13.06	8.87	.25	.14
Barriers Exercise	2.98	9.00	.06	.74
Barriers Calcium	-	-	-	-
Barriers Vitamin D	6.63	11.05	.12	.55
Health Motivation	13.32	7.28	.26	.07
OHBS-D Total	-5.36	6.32	-.40	.40
Osteoporosis Self-Efficacy subscales				.01*
Exercise	-.13	.15	-.09	.21
Calcium	.74	.22	.54	.001*
Vitamin D	-.52	.20	-.42	.01*
OSES-D Total	-	-	-	-

Note: - Excluded from the model, * significant at p<.05.

Discussion

Educational interventions and gender.

This study attempted to fill the gap of including both men and women in osteoporosis

education interventions to increase osteoporosis knowledge, health beliefs, self-efficacy, dietary

calcium, and vitamin D. There were no differences found in outcome measures between genders. This study also helps to determine that osteoporosis education in this group of college-age adults does not differ by gender. However, there may be differences in older adult age groups compared to younger adult age groups (Sedlak, Doheny, & Jones, 2000) and age group differences should be studied in relation to outcomes due to educational interventions.

Educational interventions effects on osteoporosis knowledge, health beliefs, and self-efficacy.

This study evaluated the effectiveness of osteoporosis educational interventions for young adults by measuring changes in osteoporosis knowledge, health beliefs, self-efficacy, dietary calcium, and vitamin D intakes. The OKT-D was revised to include vitamin D and medication questions and was used to determine total osteoporosis knowledge. The OHBS-D and OSES-D were used to assess osteoporosis health beliefs and osteoporosis self-efficacy and were both amended to include vitamin D items.

This study helped to fill the gap of determining which education intervention style increases osteoporosis knowledge, health beliefs, and self-efficacy. Furthermore, past research had lacked vitamin D-related information in the educational interventions and assessments. The findings indicated average total osteoporosis knowledge was low at baseline (57%), which is consistent with previous findings (Anderson et al., 2005; Gammage & Klentrou, 2011; Wallace, 2002). Previous research refers to approximately 50% on the osteoporosis knowledge test as being a low score (Chan et al., 2007; Piaseu, Belza, & Mitchell, 2001; Tung & Lee, 2006). Both osteoporosis educational interventions (lecture and hands-on activities) were successful at increasing osteoporosis knowledge, similar to previous research (Babatunde et al., 2011; Bohaty et al., 2008; Sedlak, Doheny, & Estok, 2000; Tussing & Chapman-Novakofski, 2005;).

Interestingly, the control group also increased in osteoporosis knowledge, and health beliefs over time, despite not receiving the osteoporosis education until after the post-test was completed. The increase may simply be due to participating in a nutrition course. The participants have access to a textbook to determine answers to the pre and post-tests. Perhaps participants were interested in knowing the correct answers after taking the pre-test and thus led to higher knowledge scores for the post-test. It is also possible that by taking a nutrition course, participants could increase general knowledge about certain nutrients and diseases prior to actually learning the osteoporosis material. It could have been beneficial to have a control group that was not participating in a nutrition related course in order to control for possible knowledge increases related to take the nutrition course itself.

Both types of osteoporosis educational interventions increased total osteoporosis health beliefs, also in agreement with previous research (Gammage et al., 2009; Gammage & Klentrou, 2011). OHB-D scores on subscales that included benefits of exercise, benefits of calcium, benefits of vitamin D, and barriers to vitamin D also significantly increased regardless of osteoporosis educational intervention. Self-efficacy did not change based on osteoporosis educational intervention, which agrees with previous research (Gammage et al., 2009). Health beliefs could have increased similarly to knowledge simply by participating in the nutrition course over the semester. The course discusses prevention of diseases such as heart disease, cancer, and diabetes mellitus before discussing osteoporosis. Additionally, the majority of the participants were either nutrition or nursing majors. These participants could have been enrolled in other classes that discuss osteoporosis and bone health. This could have led to increased health beliefs in general.

Significant change was identified in OHBS-D subscales of benefits of exercise, benefits of calcium, and benefits of vitamin D for all three groups. The change may be due to osteoporosis information exposure. The benefits of exercise may also be due to discussing metabolism during physical activity in the nutrition course. There were no significant differences in barriers to exercise, barriers to calcium, or barriers to vitamin D. Scores were generally very low in these areas indicating the participants in general did not perceive these items on the scale to be difficult barriers to overcome. These subscales accompany the health beliefs of benefits of exercise, benefits of calcium, and benefits of vitamin D which, in general, participants scored high. Health motivation subscale scores overall were fairly high in all three treatment groups. The health motivation subscale of the OHBS has been related to the eagerness to participate in health-related behaviors (Kim et al., 1991). Although health motivation did not significantly increase, the fact that it was high at baseline indicates that the sample may have been more passionate about health behaviors in general. The nutrition course is a natural science elective for the student body. Students may select to enroll in this course because they have a high interest in nutrition and health.

Educational interventions effects on dietary calcium and vitamin D intakes.

Unlike previous research, this study assessed not only dietary calcium intake but also dietary vitamin D intake both at baseline and after educational interventions. Baseline average dietary calcium intake met recommendations which is consistent with previous research (Anderson et al., 2005; Sharma, Hoelscher, Kelder, Day, & Hergenroeder, 2009;). Meanwhile, average dietary vitamin D intakes were well below the recommendations which are also consistent with previous research that examined dietary vitamin D intakes (Bohaty et al., 2008). The educational interventions did not produce preventative behavior changes, such as increasing

dietary calcium and vitamin D intakes. This could be due to the average baseline dietary calcium intakes already meeting recommendations. Dietary vitamin D intakes may be difficult to change, as few foods naturally contain vitamin D. Additionally, foods fortified with vitamin D are fortified at generally low levels (<100 IU per serving) (Hill et al., 2012). Additional fortification of products with vitamin D or higher fortification levels may make it more feasible for individuals to meet the vitamin D requirements. Since vitamin D is not naturally occurring in many foods, vitamin D supplementation may be needed in order to reach the recommendation of 600 IU per day, especially in northern latitudes (Holick et al., 2011). Vitamin D supplement use was measured and no significant change was found in vitamin D supplement users or the amount of vitamin D supplements used by participants. Vitamin D supplementation was discussed during the educational interventions (lecture and hands-on activity groups) as to which type of vitamin D and what amount of supplementation may be needed to meet recommendations. However, dietary vitamin D intake was encouraged more so than supplement usage.

   Nutrient intakes related to osteoporosis health beliefs and self-efficacy.

Regression analysis showed that OHBS-D subscales as variables were able to account for significant variance in dietary calcium intake (p<.044) and vitamin D intake (p<.047). Approximately 11.2% and 10.1% of the variance was accounted for in dietary calcium and vitamin D intakes respectively. Consistent with previous research (Gammage & Klentrou, 2011; Piaseu et al., 2002), the subscale, barriers to calcium, was the only significant predictor of dietary calcium intake in the model. The variance explained by the overall OHBS-D model was fairly low but also fairly consistent with previous research. Gammage and Klentrou (2011) found that health beliefs explained 16% of the variance in dietary calcium intake. Ascertaining potential barriers for calcium intake and helping individuals overcome those barriers may help them to

consume more dietary calcium. In this study, participants on average were meeting the recommendations for calcium and this finding may help to explain why other subscales did not predict dietary calcium intake and why the approximate variance predicted in this model was slightly lower than previous studies.

The self-efficacy overall model was a predictor of vitamin D intake ($p<.01$) and accounted for the approximately 7.3% of the variance. Subscales of calcium and vitamin D were significant predictors in the model. The amount of variance in dietary vitamin D intake explained was fairly low. Previous research did not include vitamin D in predictor models or study the effects of self-efficacy on vitamin D intake. However, previous research indicated that when individuals have higher self-efficacy, this can lead to consuming more nutrients such as calcium (Larson, Story, Wall, & Newmark-Sztainer, 2006). This study supports self-efficacy as an important aspect of predicting dietary vitamin D intake. Becoming proficient at a skill has been shown positively related to changing a behavior and maintaining that behavior (Bandura, 1977). Perhaps increasing the time of the educational intervention in order to master skills such as reading labels and choosing vitamin D-rich foods could increase self-efficacy and therefore related dietary vitamin D intake.

Limitations.

This study was conducted at one Midwestern site and consisted of a mostly Caucasian sample. Convenience sampling was used and therefore, results cannot be generalized to the general public. The nutrition course included six different sections taught by three different instructors throughout the semester. Although it was discussed with the other instructors to not use examples of calcium, vitamin D, and bone health in discussions in class, osteoporosis information may have been presented in discussion within the course sections prior to the actual

96

osteoporosis, calcium, and vitamin D sections of class. The control group, which completed the post-test prior to receiving the osteoporosis lecture, increased in osteoporosis knowledge and health beliefs. It would have been beneficial to use a control group that has not or was not currently enrolled in a nutrition course. We also did not control for concurrent enrollment in additional nutrition or nursing classes. More than half of the participants lived on campus and subsequently chose foods that were available on campus. Although the campus offers many different food options, it may be difficult to change behavior when only so many food choices are available each day. Additionally, it may not be feasible to increase the amount of vitamin D foods in the cafeteria setting due to availability or cost and vitamin D supplementation may be warranted in this case.

Not only was the sample primarily Caucasian, the sample consisted of mostly upper middle class students who either purchased food on campus or at local grocery stores. Additionally, limitations to the activities may have been included in the hands-on activity intervention group. Only a few dairy products for portioning out were used due to time constraints and included cheese, regular white milk, and vanilla ice cream. Additional dairy products that are commonly consumed could have been used if more time allowed. Perhaps participants did not get to portion foods they commonly eat in order to overcome barriers and thus lead to changes in self-efficacy. According to the formative assessment, participants felt they did not have enough time to play the Jenga™ game that focused on risk factors of osteoporosis. Possibly learning about risk factors more in depth could increase knowledge further and lead to changes in goals set by participants in relation to self-efficacy.

Knowledge alone does not seem to increase self-efficacy. Conceivably, the young adult sample may not perceive osteoporosis as a direct threat to them at their current age. It may be

97

difficult for this age group to understand how their present lifestyle will impact their future older adult health status. Previous research agrees with this as Kasper et al., (2001) found that college age women believed that they were unlikely to develop osteoporosis, and that they were more concerned about developing other diseases such as heart disease and breast cancer. Perhaps simulating activities such as osteoporosis bone loss with accompanying muscle strength loss or how individuals would go about activities of daily living as part of class activities would impact participants' health beliefs including self-efficacy and possibly lead to behavior change. This could be a change to the hands-on activity educational intervention that may lead to increases in knowledge, health beliefs, self-efficacy, and dietary lifestyle changes.

Implications for research and practice.

The findings of this study indicate the need for further research on osteoporosis educational programs that will lead to behavior change such as increasing dietary calcium and vitamin D intakes. Promoting osteoporosis preventative behaviors that include obtaining adequate calcium, vitamin D, and exercise throughout the lifespan remains a good strategy for osteoporosis prevention despite this research showing that educational intervention did not change behaviors. Physical activity along with adequate calcium and vitamin D intakes play considerable roles in developing PBM during adolescence and young adulthood (Kanis et al., 2008). Therefore educational interventions should be designed to improve inadequate or to maintain adequate physical activity, dietary calcium, and dietary vitamin D intake levels. Moreover, additional educational interventions should be evaluated for effectiveness in changing behaviors.

Young men and women both should be encouraged to begin osteoporosis preventative behaviors as early as possible in order to build PMB and decrease their risk of osteoporosis-

related fractures in later life (Kanis et al., 2008). Future studies could follow long-term effects of osteoporosis educational interventions in order to determine changes in preventative behaviors. This study was the first of our knowledge to include vitamin D information on the OHBS-D and OSES-D. Future studies should include vitamin D questions to assess vitamin D knowledge, health beliefs, and self-efficacy as well as assessing dietary vitamin D intake in relation to osteoporosis. Adequate vitamin D intake is important for osteoporosis prevention (Kanis et al., 2008). Therefore, this study provides much needed direction on strategies for the design of future osteoporosis educational interventions in college-age adults.

This study also suggests that both types of educational intervention (lecture-based and hands-on activities) increase knowledge and health beliefs, but not self-efficacy related to osteoporosis. Current or future nutrition, nursing, or health related classes, along with nutrition extension services could use either educational intervention styles of lecture or hands-on activities to increase knowledge and health beliefs related to osteoporosis. Care should be taken to identify areas of osteoporosis health beliefs that could be improved, such as overcoming barriers. Perhaps certain areas of health beliefs could use more emphasis so that educators could tailor programs to improve outcomes. Additionally, the information from this study could be used by different health care providers to provide education for prevention such as nurses and physicians. Dietitians may use this information to educate patients in an outpatient setting as well. The sample in this study was meeting calcium recommendations and perhaps the educational interventions could be tailored more towards vitamin D intake for prevention. Educational programs could go one step further and teach people how to apply their gained knowledge to making improved lifestyle behaviors choices.

The EHBM variables (ie. health motivation, susceptibility, self-efficacy, etc) are generally the most significant predictors of osteoporosis preventative behaviors (Gammage & Klentrou, 2011). Other models such as the Trans-Theoretical Model could be applied if using different scales or assessing readiness to change. However, this study used the EHBM as a model due to the scales that were selected for this study. Perhaps in the young adult population the severity and susceptibility to osteoporosis is low compared to other diseases. This agrees with previous research (Kasper et al., 2001). Future research should evaluate the effectiveness of educational interventions and determine relevant beliefs to the young adult population. This study did not assess which health belief is the most important in the young adult population. Perhaps, young adults would be more likely to change behavior if they had access to practicing types of behavior change more in depth, such purchasing products at a grocery store or cafeteria that have contain higher amounts of calcium and vitamin D. Additionally, since the sample in the study was far below the recommendations for dietary vitamin D intake, supplement use may be warranted. Conceivably, providing supplements or allowing the sample to purchase supplements as an activity would change vitamin D intake behaviors. Supplement usage however, may not be recommended for the entire population due to differences in vitamin D status. Perhaps, 25(OH)D levels should be assessed before promoting high dosages of vitamin D supplements. Fortified foods with vitamin D may be the first step to increasing vitamin D consumption before the use of supplements due to added benefits foods such as containing antioxidants or other nutrients that vitamin D supplements do not include such as protein or calcium. The use of vitamin D fortified foods could be lengthened in the educational activities or lecture portion of education to increase knowledge and be beneficial for possibly overcoming barriers to vitamin D intake. Additional activities that could be beneficial for overcoming barriers could be lengthened in time so that

hands-on cooking activities could be accomplished. Such activities could include other types of calcium and vitamin D foods such as leafy green vegetables, which may be useful in overcoming barriers to change dietary calcium behaviors. These types of activities were not explored due to time constraints as well as keeping the time for both interventions similar.

It is also important to assess behavior change over a longer period of time, rather than directly after the intervention. It is uncertain if the sample participated in any behavior change after the post-test measurement of dietary calcium and vitamin D intakes. Previous research recommends that at least 50 hours of education is needed to create long-term changes in dietary behaviors (Hoelscher, Evans, Parcel, & Kelder, 2002). Additionally, Hoelsher et al. (2002) suggests that educational programs should be tailored to the correct developmental level. Perhaps the sample in this study was not at a developmental stage that was ready to make behavior changes based on susceptibility and seriousness of osteoporosis. Rather, they would be more likely to make behaviors changes based on certain health beliefs or developmental aspects that may influence certain health beliefs such as critical thinking skills or mastering a certain skill. These types of developmental aspects could lead to changes in beliefs of overcoming barriers or increased self-efficacy, which could possibly lead to behavior change. Additionally, a multi-factorial approach may be beneficial for overall health. Osteoporosis is just one disease that affects individuals as they age. Obtaining adequate physical activity and nutrition throughout the lifespan may be beneficial in leading to an overall healthy quality of life as one ages. Not only is it important to obtain adequate calcium and vitamin D, it is important to obtain overall adequate nutrition to prevent other deficiencies that may be related to other diseases.

Although this study focused on young adults, further research may be needed in other samples such as children, adolescents, young adults, middle age adults, and older adults.

Developmental differences may influence health beliefs. Moreover, it would be important to know how these beliefs change over the lifespan, and how they relate to changes in behavior.

Concluding remarks.

Although this study showed that participants experienced increases in knowledge and health beliefs, it also adds to the growing literature that increases in knowledge and health beliefs do not assure a change in behavior. The findings from this study also indicate that osteoporosis educational intervention methods may not differ in the amount osteoporosis knowledge learned. Therefore, in this college-age sample, it seems as though participants obtained equal amounts of OKT-D and OHB-D from either osteoporosis educational intervention method, which included lecture or hands-on activities.

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CHAPTER FIVE. DISCUSSION AND SUMMARY OF OSTEOPOROSIS EDUCATIONAL INTERVENTIONS AND VALIDITY AND RELIABILITY ASSESSMENT OF THE OHBS-D AND OSES-D

Instruments

In the previous chapters, two original scales were modified to include vitamin D related items, which have generally been excluded from previous research. Since vitamin D plays a role in osteoporosis prevention and the original OHBS and OSES scales are used to assess health beliefs and self-efficacy related to osteoporosis, it seems only relevant to include vitamin D related items. When modifying these two scales, the vitamin D related items were modeled after existing calcium items. A factor analysis demonstrated that that the original structure of the OHBS was valid. In addition, the OHBS-D items (barriers to vitamin D items and benefits to vitamin D items) loaded similarly to the original development of the scale (Kim, Horan, Gendler, & Patel, 1991). The addition of vitamin D related items resulted in a new factor of barriers to vitamin D. This factor is logical as vitamin D barriers are different than barriers to obtaining dietary calcium. Vitamin D is synthesized in the skin from UVB exposure and calcium is not (Holick, 1995). Additionally, vitamin D is not naturally present in many foods making it more difficult to obtain dietary vitamin D compared to dietary calcium (Hill et al., 2012). Benefits to vitamin D intake loaded on the benefits to calcium factor that is also logical as adequate calcium and vitamin D are both needed for bone health. Previous studies have examined the original scales and found them to be reliable in different populations such as older adult women, young men and women, and older men (Gammage, Francoeur, Mack, & Klentrou, 2009; Sedlak, Doheny, & Estok, 2000; Sedlak, Doheny, Estok, Zeller, & Winchell, 2007). Additional studies should be conducted in order to assess the validity and reliability in larger sample sizes as well as different populations. The OHBS-D and OSES-D were only used in a college age adult sample.

Additional testing of different age groups should be done to assure validity and reliability across all age groups. Larger sample sizes should also be studied as our study only included 153 participants. It is possible that we did not find significant results due to the instruments not being sensitive enough. Additional studies should be conducted to determine if the new scales are valid and reliable across different ethnicities, economic status, education levels, and other demographic characteristics, since our sample was relatively homogenous.

After factor analysis of the OSES-D, it was determined that the original OSES structure (Horan, Kim, Gendler, Froman, & Patel, 1998) was valid. Additionally, the OSES-D vitamin D items loaded on their own factor. This is logical as self-efficacy to obtaining enough dietary vitamin D may be different compared to obtaining adequate dietary calcium due to the limited availability of vitamin D products as well as vitamin D being synthesized by UVB exposure as previously stated (Hill et al., 2012; Holick, 1995).

Reliability assessment of the OHBS-D and OSES-D yielded results that indicated both scales are internally consistent and shown to have test-retest reliability. The two scales (OHBS-D and OSES-D) that include vitamin D items can now be used in research to assess osteoporosis health beliefs and self-efficacy in a more detailed manner without adding much time to the assessment instruments. Furthermore, the original authors of the OHBS and OSES have revised an osteoporosis knowledge test (OKT-revised) that has also been shown to be valid and reliable. The original OKT, OHBS, and OSES are often used to assess osteoporosis knowledge, health beliefs, and self-efficacy. The newly revised osteoporosis instruments can now be used to assess different sample's osteoporosis knowledge, health beliefs, and self-efficacy, and include a more up-to-date assessment of osteoporosis behaviors including not just dietary calcium, but dietary vitamin D intake as well.

This study helped to fill the gap in research that studies osteoporosis knowledge, health beliefs, and self-efficacy with regard to nutrient intakes, specifically related to vitamin D. This study attempted to produce revised osteoporosis health beliefs and self-efficacy scales that include vitamin D items and determine validity and reliability of such scales. These newly revised scales can be used in future research to determine health beliefs and self-efficacy with regard to both calcium and vitamin D intakes as these nutrients are important in tandem for osteoporosis prevention.

Future research may use the revised scales to determine health beliefs and self-efficacy in a larger sample size. Additionally, future research should include men and women of all ages and ethnicities. Additional research is needed to examine samples of different income levels, education levels, individual's access to food, health status, family history, and other confounding factors that may play a role in osteoporosis behaviors and prevention. Future research using the OHBS-D and OSES-D should examine the validity and reliability of these scales in the context of a more diverse sample rather than the currently tested homogenous sample of middle to upper class income students at a private college/university, ages 18-25. The current study examined both young men and women which is a strength compared to the majority of osteoporosis research which mainly studies women. Additionally, osteoporosis education interventions that use these common scales now can assess not only calcium but vitamin D as well.

Educational Interventions

After revising the OHBS and OSES scales, these two new scales (OHBS-D and OSES-D) were used in conjunction with the previously mentioned OKT-D to examine osteoporosis educational intervention effects on osteoporosis knowledge, health beliefs, and self-efficacy in a young adult population. The original OKT was previously revised by Gendler, Coviak, Martin,

Kim, & Von Hurst (2011), and additional medication items were added to create the OKT-D for this study. In a Midwestern sample of college age young adults, osteoporosis knowledge, health beliefs, and self-efficacy were assessed at baseline using these three revised instruments. Following this, participants were separated into a control group, lecture group, or a hands-on activity group. The lecture and hands-on activity groups were given the same information regarding osteoporosis risk factors, protective behaviors such as obtaining adequate dietary calcium, vitamin D, and physical activity. The hands-on activity group received this information via classroom activities that focused on the Expanded Health Belief Model. Dietary calcium and dietary vitamin D intakes were assessed in all three groups via pre and post-three-day food diary collections and subsequent analysis using DietAnalysisPro version 10 software. After examining dietary calcium and vitamin D intakes, average dietary calcium intakes met the current recommendations, while average dietary vitamin D intakes did not. This finding agrees with previous research that dietary vitamin D intakes are generally lacking worldwide (Calvo et al., 2004).

After assessing educational intervention effects, results indicated that both lecture and hands-on activities increased osteoporosis knowledge and health beliefs, but not self-efficacy. Despite the hands-on activities being specifically targeted towards increasing subscales of health beliefs and self-efficacy, which included goal setting and overcoming barriers, this type of activity related education did not provide an increase in self-efficacy. The results contradict Tussing and Chapman-Novakofski (2005) and Wallace (2002) but agree with other previous research (Sedlak, Doheny, & Jones, 2000). Self-efficacy has been associated with an increase in behavior change such as increasing dietary calcium intake (Tussing & Chapman-Novakofski, 2005) but has rarely been studied in association with dietary vitamin D intakes. It is possible that

educational interventions may be more effective with different age groups. Previous research has found that older adults are more interested in osteoporosis prevention compared to a younger adult population (Sedlak, Doheny, & Jones, 2000). Interventions could differ for non-college age participants and it may be beneficial to determine readiness to change. This may help promote behavior change rather than developing an educational intervention and assuming people will take action based on the information presented. Educational interventions may promote behavior change if baseline knowledge, health beliefs, and self-efficacy are determined and then the educational interventions are tailored to those baseline results. The literature is lacking in educational interventions based on participant's needs at the time of education. Rather, most educational interventions are developed before determining baseline knowledge, health beliefs, and self-efficacy of the participants.

Nutrient Intakes

This study also looked at a sample of college age men and women and not only examined osteoporosis knowledge, health beliefs, and self-efficacy, but also collected and analyzed dietary intakes. Previous research lacks analysis of dietary intakes in detail. Other studies have simply asked about servings of dairy products (Gammage & Klentrou, 2011; Kasper, Peterson, & Allegrante, 2001;) but few go as far as to collect and analyze actual dietary intakes including vitamin D. To this author's knowledge, only Bohaty et al. (2008) and Chan et al. (2007) have examined vitamin D intakes to some degree. Previous studies focus mainly on calcium intake (Gammage & Klentrou, 2011; Kasper et al., 2001; Tussing & Chapman-Novakofski, 2005). The current study adds to the literature regarding dietary vitamin D intake behaviors related to osteoporosis knowledge, health beliefs, and self-efficacy as vitamin D is often excluded. Similarly, this current study looks at educational interventions and their effects on both men and

women. Previous research has included college age men and dietary calcium intake (Gammage et al., 2009), however, most research focuses primarily on women.

Future Studies

Future research may use all of the revised scales (OKT-D, OHBS-D, and OSES-D) to determine osteoporosis knowledge, health beliefs, and self-efficacy in a larger sample size. It would be beneficial to include longitudinal studies as well to assess changes in knowledge, health beliefs, and self-efficacy and how they related to preventative behaviors over the lifespan. Additionally, cross-sectional studies of different age cohorts could be beneficial to determine validity and reliability of the revised scales in different age groups. Perhaps even additional studies that determine knowledge, health beliefs, and self-efficacy with an emphasis on vitamin D related items could be conducted in different regions of the United States, since obtaining adequate vitamin D may be more difficult in the northern latitudes. Additionally, future research should include men and women of all ages, ethnicities, economic status, and other demographic characteristics. Again, additional research is needed to examine more diverse samples.

This current research that includes osteoporosis knowledge, health beliefs, and self-efficacy with vitamin D items can be used to develop new course work in undergraduate, college-level courses for nutrition, nursing, or other health related fields that focus on osteoporosis. Similarly, educational interventions in the community can be developed to include vitamin D related items and focus on increasing vitamin D intakes in populations that are at risk for developing osteoporosis. Assessment can be completed in these educational interventions to determine the method that increases not only dietary calcium intake but also dietary vitamin D intakes as well.

Further research is needed to identify the educational method that is best at increasing osteoporosis knowledge, health beliefs, and self-efficacy, and which is also the educational method that best increases preventative behaviors. Future research could include interventions that contain aging simulations to help younger adults experience what it is like to have osteoporosis or what it may physically be like to age. Educational interventions could include a trip to observe physical therapy or rehabilitation after a fall or fracture to increase awareness of how fractures and falls may affect physical and mental wellbeing in older adulthood. Educational interventions could also include grocery shopping trips that focus on determining which foods are high in calcium and vitamin D that individuals would be willing to purchase on a regular basis. This could aid in overcoming barriers of obtaining adequate dietary calcium and vitamin D. After purchasing products, these products could then be incorporated into a laboratory experiment where calcium and vitamin D foods are made in a kitchen setting to further aid in overcoming barriers to obtaining adequate nutrient intakes. This may also lead to an increase in self-efficacy. Additionally, education interventions in northern latitudes could include a shopping trip for vitamin D supplements as well as purchasing them for participants. This type of intervention may help to increase vitamin D intakes due to dietary vitamin D lacking in many foods as well as UV exposure, as supplementation may be warranted to meet the minimum recommendations for vitamin D. Future research may also want to determine if actual serum vitamin D status is deficient in accordance with dietary vitamin D intake. Clearly, interventions are needed to increase dietary vitamin D intakes as research indicates that much of the world population is deficient in vitamin D status (Mithal et al., 2009). The current research findings indicated a similar deficit in dietary vitamin D intake, as participant intake levels did not meet the current recommendations.

Different age group cohorts may learn differently based on different levels of knowledge, health beliefs, and self-efficacy. A multi-factorial approach may be beneficial to promote overall adequate physical activity and nutrition. Osteoporosis is not the only disease that aging individuals may experience. Perhaps promoting overall health and wellness such as obtaining adequate dairy products, as well as other aspects of a healthy diet (ie. fruits and vegetables) may contribute to preventing of not only osteoporosis, but additional diseases associated with poor nutrition status and a sedentary lifestyle such as obesity, certain cancers, diabetes, etc.

Different educational interventions may need to be developed according to age, readiness to change, and possibly other demographic characteristics, as discussed previously. Despite this current study indicating that lecture or hands-on activities increased knowledge and health beliefs, it still remains unclear which educational approach is best for increasing preventative behaviors of obtaining adequate calcium and vitamin D intakes in young adults and further research is needed.

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130

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APPENDIX A. OUTLINE OF LECTURE

Vitamin D: (25 minutes)

- Vitamin chemical structure-prehormone
- Sources-Foods and UV rays
- Functions in the body – made in the skin, hydroxylated in the liver and kidneys, how it keeps calcium regulated (and PTH).
- Vitamin D recommendations: old and newly updated regulations
- Deficiency-rickets, osteomalacia and osteoporosis – differences between them and populations they affect. Symptoms of deficiency
- Risk Factors for developing Vitamin D deficiency- Latitude, infants, obesity, diseases, sunscreen, etc.
- Vitamin D and calcium absorption-Fractures and falls
- Summary –recommendations, foods to increase and supplement usage

Calcium : 25 minutes

- Where calcium is found in the body and why it is important
- Maintaining calcium balance
- Review of calcium, vitamin D, PTH, Calcitonin functions in the intestine, and how calcium absorption is enhanced or calcium is taken from the bones
- Calcium sources
- Absorption and which sources are most bioavailable
- Calcium recommendations
- Supplement use
- Caffeine and calcium intake
- Calcium deficiency – osteoporosis

Osteoporosis: (20 minutes)

- Prevalence
- Importance of vitamin D and calcium adequacy in early life
- Risk factors – smoking, alcohol, mediations, females versus males, age, race/ethnicity, menopause, low BMI, low vitamin D, low calcium, eating disorders, family history, previous falls/fractures etc.
- Bone health and how to maximize bone mass – exercise (weight bearing) and adequate nutrition
- Osteoporosis mediations – uses.

APPENDIX B. OSTEOPOROSIS RISK FACTOR SCREENING

What you cannot change – your family history

1. Have either of your parents been diagnosed with osteoporosis or broken a bone after a minor fall (a fall from standing height or less)?
    a. Yes
    b. No
2. Did either of your parents have a "dowager's hump"?
    a. Yes
    b. No

Your personal clinical factors

These are fixed risk factors that one is born with or cannot alter. But that is not to say that they should be ignored. It is important to be aware of fixed risks so that steps can be taken to reduce loss of bone mineral.

3. Are you 40 years old or older?
    a. Yes
    b. No
    c.
4. Do you classify your race/ethnicity as Caucasian or Asian?
    a. Yes
    b. No

5. Have you ever broken a bone after a minor fall, as an adult?
    a. Yes
    b. No

6. Are you underweight (is your Body Mass Index less than 18.5)?
    a. Yes
    b. No

7. Have you ever taken corticosteroid tablets (cortisone, prednisone, etc.) for more than 3 consecutive months (corticosteroids are often prescribed for conditions like asthma, rheumatoid arthritis, and some inflammatory diseases)?
    a. Yes
    b. No

8. Have you ever been diagnosed with rheumatoid arthritis?
    a. Yes
    b. No

9. Have you been diagnosed with an over-reactive thyroid or over-reactive parathyroid glands?
    a. Yes
    b. No

FOR WOMEN

10. Have your periods ever stopped for 12 consecutive months or more (other than because of pregnancy, menopause or hysterectomy)?
- a. Yes
- b. No

11. Were your ovaries removed before age 50, without you taking Hormone Replacement Therapy?
- a. Yes
- b. No

What you can change – your lifestyle factors

Modifiable risk factors which primarily arise because of diet or lifestyle choices.

12. Do you regularly drink alcohol in excess of safe drinking limits (more than 2 units a day)?
- a. Yes
- b. No

13. Have you ever had an eating disorder such as Anorexia Nervosa or Bulimia Nervosa?
- a. Yes
- b. No

14. Do you currently, or have you ever, smoked cigarettes?
- a. Yes
- b. No

15. Is your daily level of physical activity less than 30 minutes per day (housework, gardening, walking, running, resistance training etc.)?
- a. Yes
- b. No

16. Do you avoid, or are you allergic to milk or dairy products, without taking any calcium supplements?
- a. Yes
- b. No

17. Do you spend less than 10 minutes per day outdoors (with part of your body exposed to sunlight), without taking vitamin D supplements?
- a. Yes
- b. No

If you answered "yes" to any of these questions, it does not mean that you have osteoporosis. Diagnosis of osteoporosis can only be made by a physician through a bone density test. We recommend that you show this test to your doctor, who will advise whether further tests are necessary. The good news is that osteoporosis can be diagnosed easily and treated.

APPENDIX C. DIRECTIONS FOR KEEPING A FOOD RECORD

1) List everything you eat or drink (including water) for three consecutive days. Record all your food and beverages consumed in one day (24 hours) on one page. The day should begin with the first food or beverage consumed. Use a separate sheet for each day. Include all snacks, candy, gum, alcoholic beverages, soft drinks, ice cream . . . everything.

2) Record foods as soon after eating as possible. Do not trust your memory.

3) Provide additional information for each food as appropriate; for example, list what was in a tossed salad, casserole or hot dish, what kind of pizza, how the meat item was prepared (e.g. baked, fried, trimmed or untrimmed, poultry skin removed or left on). Include all extras: butter for bread, butter or sauce on vegetables, dressings on the salads, gravy, jelly, jam, cream and sugar.

4) Record the amount of each item. Please measure (measuring cups, spoons) if possible. Most individuals cannot accurately estimate how much they eat, and if incorrect portion sizes are used, this will obviously affect the accuracy of the nutrient analysis.

5) Try to eat what you usually eat. This is difficult when faced with the assignment of writing down each item, but it is important to achieve an accurate reflection of your diet. Your extra credit points are not based on the quality of your diet, but rather on your evaluation of your diet.

Food Record Form

Name _____

Height in inches _____   Weight in pounds _____

Date _____

Time	Food and Method of Preparation	Amount eaten (cups or ounces)

Food Record Form

Name _____

Date _____

Time	Food and Method of Preparation	Amount eaten (cups or ounces)

Food Record Form

Name _____

Date _____

Time	Food and Method of Preparation	Amount eaten (cups or ounces)

APPENDIX D. THE OSTEOPOROSIS KNOWLEDGE ASSESSMENT TOOL (OKAT)

REVISED 2011

Osteoporosis (os-te-o-po-ro-sis) is a condition in which the bones become very brittle and weak so that they break easily. Below is a list of things which may or may not affect a person's chance of getting osteoporosis. As you read each statement, think about if the person is: MORE LIKELY to get osteoporosis, or LESS LIKELY to get osteoporosis, or NEUTRAL, it has nothing to do with osteoporosis, or DON'T KNOW.

	more likely	less likely	neutral	don't know
1. Eating a diet LOW in dairy products	○	○	○	○
2. Being menopausal; "change of life"	○	○	○	○
3. Having a parent or grandparent who has osteoporosis	○	○	○	○
4. Being a white or Asian woman	○	○	○	○
5. Being an elderly man	○	○	○	○
6. Having ovaries surgically removed	○	○	○	○
7. Taking cortisone (steroids e.g. Prednisone) for a long time	○	○	○	○
8. Being overweight	○	○	○	○
9. Having an eating disorder	○	○	○	○
10. Consuming more than 2 alcoholic drinks per day	○	○	○	○
11. Smoking on a daily basis	○	○	○	○

For the next group of questions, select one answer from the 4 choices. If you think there is more than one correct answer, choose the BEST answer. If you are not sure, select DON'T KNOW
12. To strengthen bones, it is recommended that a person exercise at a moderately intense level for 30 minutes a day at least

○ 3 days a week

○ 4 days a week

○ 5 days a week

○ Don't know

13. Exercise makes bones strong, but it must be hard enough to make breathing

○   Just a little faster

○   Much faster, but talking is possible

○   So fast that talking is not possible

○   Don't Know

14. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis

○   Swimming

○   Walking briskly

○   Stretching

○   Don't know

15. Which of following activities is the best way to reduce a person's chance of getting osteoporosis

○   Bicycling

○   Yoga

○   Lifting weights

○   Don't know

16. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

○   Jogging or Running

○   Golfing using a golf cart

○   Gardening

○   Don't Know

17. Which of the following activities is the best way to reduce a person's chance of getting osteoporosis?

○   Bowling

○   Doing laundry

○   Aerobic dancing

○   Don't know

18. Which of these is the best source of calcium?

○   Apple

○   Cheese

○   Cucumber

○   Don't know

19. Which of these is the best source of calcium?

○   Peanut Butter

○   Turkey

○   Canned Sardines

○   Don't know

20. Which of these is the best source of calcium?

○   Chicken

○   Broccoli

○   Grapes

○   Don't know

21. Which of these is the best source of calcium?

○   Yogurt

○   Strawberries

○   Cabbage

○   Don't know

22. Which of these is the best source of calcium?

○   Ice cream

○   Grapefruit

○   Radishes

○   Don't know

23. Which of the following is the recommended amount of calcium intake for an adult?

○   600 mg - 800 mg daily

○   1000 mg - 1200 mg daily

○   1400 mg - 1600 mg daily

○   Don't know

24. How much milk must an adult drink to meet the recommended amount of calcium?

○   1 glass daily

○   2 glasses daily

○   3 or more glasses daily

○   Don't know

25. Which of the following is the BEST REASON for taking a calcium supplement?

○   If a person skips breakfast

○   If a person does not get enough calcium from their diet

○   If a person is over 45 years old

○   Don't know.

26. Which vitamin is required for absorption of calcium?

○   Vitamin A

○   Vitamin C

○   Vitamin D

○   Don't know

27. Which is the best source of the vitamin required for the absorption of calcium?

○   Carrots

○   Oranges

○   Sunlight

○   Don't know

28. Which is the best food source of the vitamin required for the absorption of calcium?

○   Spinach

○   Cheese

○   Salmon

○   Don't know

29. Which of the following is the recommended amount of the vitamin required for the absorption of calcium for an adult, 50 years old and older?

- ○ 800-1000 IU daily
- ○ 1200-1400 IU daily
- ○ 1600-1800 IU daily
- ○ Don't know

30. When is the best time to build strong bones?

- ○ Childhood
- ○ Adolescence
- ○ Young adulthood
- ○ Don't know

31. Osteoporosis can be diagnosed by

- ○ Blood test
- ○ DXA scan
- ○ Symptoms
- ○ Don't know

32. Once you have osteoporosis

- ○ There is nothing you can do about it
- ○ You can take medication to treat it
- ○ You must be careful lifting objects
- ○ Don't know

33. If you take medication to treat osteoporosis, do you still need to have adequate calcium intake?

- ○ Yes
- ○ No
- ○ Don't know

34. If you take medication to treat osteoporosis, do you still need to have adequate vitamin D intake?

- ○ Yes
- ○ No
- ○ Don't know

APPENDIX E. THE OSTEOPOROSIS HEALTH BELIEF SCALE WITH VITAMIN D

ITEMS (OHBS-D)

Below are questions about your beliefs about osteoporosis. There are no right or wrong answers. We all have different experiences which will influence how we feel. After reading each statement, select if you STRONGLY DISAGREE, DISAGREE, are NEUTRAL, AGREE, or STRONGLY AGREE with the statement. It is important that you answer according to your actual beliefs and not according to how you feel you should believe or how you think we want you to believe. We need the answers that best explain how YOU feel. Read each statement. Select ONE best option that explains what you believe.
Osteoporosis Health Belief Scale

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1. Your chances of getting osteoporosis are high.	○	○	○	○	○
2. Because of your body build, you are more likely to develop osteoporosis.	○	○	○	○	○
3. It is extremely likely that you will get osteoporosis.	○	○	○	○	○
4. There is a good chance that you will get osteoporosis.	○	○	○	○	○
5. You are more likely than the average person to get osteoporosis.	○	○	○	○	○
6. Your family history makes it more likely that you will get osteoporosis.	○	○	○	○	○
7. The thought of having osteoporosis scares you.	○	○	○	○	○
8. If you had osteoporosis you would be crippled.	○	○	○	○	○
9. Your feelings about yourself would change if you got osteoporosis.	○	○	○	○	○

(Continued)

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
10. It would be very costly if you got osteoporosis.	○	○	○	○	○
11. When you think about osteoporosis you get depressed.	○	○	○	○	○
12. It would be very serious if you got osteoporosis.	○	○	○	○	○
13. Regular exercise prevents problems that would happen from osteoporosis.	○	○	○	○	○
14. You feel better when you exercise to prevent osteoporosis.	○	○	○	○	○
15. Regular exercise helps you build strong bones.	○	○	○	○	○
16. Exercising to prevent osteoporosis also improves the way your body looks.	○	○	○	○	○
17. Regular exercise cuts down on the chances of broken bones.	○	○	○	○	○
18. You feel good about yourself when you exercise to prevent osteoporosis.	○	○	○	○	○

(Continued)

For the following questions, "taking in enough calcium" means taking enough calcium by eating calcium rich foods and/or taking calcium supplements. Additionally "taking in enough Vitamin D" means taking enough vitamin D by eating vitamin D rich foods, obtaining vitamin D from sunlight and/or taking vitamin D supplements.

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
19. Taking ENOUGH CALCIUM prevents problems from osteoporosis.	○	○	○	○	○
20. You have lots to gain from taking in ENOUGH CALCIUM to prevent osteoporosis.	○	○	○	○	○
21. Taking in ENOUGH CALCIUM prevents painful osteoporosis.	○	○	○	○	○
22. You would not worry as much about osteoporosis if you took in ENOUGH CALCIUM	○	○	○	○	○
23. Taking in ENOUGH CALCIUM cuts down on your chances of broken bones.	○	○	○	○	○
24. You feel good about yourself when you take in ENOUGH CALCIUM to prevent osteoporosis.	○	○	○	○	○
25. Taking ENOUGH VITAMIN D prevents problems from osteoporosis.	○	○	○	○	○
26. You have lots to gain from taking in ENOUGH VITAMIN D to prevent osteoporosis. (Continued)	○	○	○	○	○

150

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
27. Taking in ENOUGH VITAMIN D prevents painful osteoporosis.	○	○	○	○	○
28. You would not worry as much about osteoporosis if you took in ENOUGH VITAMIN D	○	○	○	○	○
29. Taking in ENOUGH VITAMIN D cuts down on your chances of broken bones.	○	○	○	○	○
30. You feel good about yourself when you take in ENOUGH VITAMIN D to prevent osteoporosis.	○	○	○	○	○

The following questions are about exercise, calcium and vitamin D.

	STRONGLY DISAGREE	DISAGREE	NEURAL	AGREE	STRONGLY AGREE
31. You feel like you are not strong enough to exercise regularly.	○	○	○	○	○
32. You have no place where you can exercise.	○	○	○	○	○
33. Your significant other or family discourages you from exercising.	○	○	○	○	○
34. Exercising regularly would mean starting a new habit which is hard for you to do.	○	○	○	○	○
35. Exercising regularly makes you uncomfortable.	○	○	○	○	○
36. Exercising regularly upsets your routine. (Continued)	○	○	○	○	○

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
37. Calcium rich foods cost too much.	○	○	○	○	○
38. Calcium rich foods do not agree with you.	○	○	○	○	○
39. You do not like calcium rich foods.	○	○	○	○	○
40. Eating calcium rich foods means changing your diet which is hard to do.	○	○	○	○	○
41. In order to eat more calcium rich foods, you have to give up other foods that you like.	○	○	○	○	○
42. Calcium rich foods have too much cholesterol.	○	○	○	○	○
43. You eat a well-balanced diet.	○	○	○	○	○
44. You look for new information related to health.	○	○	○	○	○
45. Keeping healthy is very important to you.	○	○	○	○	○
46. You try to discover health problems early.	○	○	○	○	○
47. You have a regular health check-up even when you are not sick.	○	○	○	○	○
48. You follow recommendations to keep you healthy.	○	○	○	○	○
49. Vitamin D containing foods cost too much.	○	○	○	○	○
50. You do not like vitamin D containing foods. (Continued)	○	○	○	○	○

	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
51. Eating vitamin D rich foods means changing your diet which is hard to do.	○	○	○	○	○
52. In order to eat more vitamin D rich foods, you have to give up other foods that you like.	○	○	○	○	○
53. Vitamin D rich foods have too much cholesterol.	○	○	○	○	○
54. An adequate vitamin D intake can be easily achieved from foods alone, for those who live in Northern latitudes	○	○	○	○	○

APPENDIX F. THE OSTEOPOROSIS SELF-EFFICACY SCALE WITH VITAMIN D

ITEMS (OSES-D)

We are interested in learning how confident you feel about doing the following activities. We all have different experiences, which will make us more or less confident in doing the following things. Thus, there are no right or wrong answers to this questionnaire. It is your opinion that is important. In this questionnaire, EXERCISE means activities such as walking, swimming, golfing, biking, and aerobic dancing. Please mark the box that you feel best describes your confidence level.

1. Begin a new or different exercise program

2. Change your exercise habits

3. Put forth the effort required to exercise

4. Do exercises even if they are difficult

5. Maintain a regular exercise program

6. Exercise for the appropriate length of time

7. Do exercises even if they are tiring

8. Stick to your exercise program

9. Exercise at least three times a week

10. Do the type of exercises that you are supposed to do

11. Begin to eat more calcium rich foods

12. Increase your calcium intake

13. Consume adequate amounts of calcium rich foods

14. Eat calcium rich foods on a regular basis

15. Change your diet to include more calcium rich foods

16. Eat calcium rich foods as often as you are supposed to

17. Select appropriate foods to increase your calcium intake

18. Stick to a diet which gives an adequate amount of calcium

19. Obtain foods that give an adequate amount of calcium

20. Remember to eat calcium rich foods

21. Take calcium supplements if you don't get enough calcium from your diet

22. Begin to eat more Vitamin D rich foods

23. Increase your Vitamin D intake

24. Consume adequate amounts of Vitamin D rich foods

25. Eat Vitamin D rich foods on a regular basis

26. Change your diet to include more Vitamin D rich foods

27. Eat Vitamin D rich foods as often as you are supposed to

28. Select appropriate foods to increase your Vitamin D intake

29. Stick to a diet which gives an adequate amount of Vitamin D

30. Obtain foods that give an adequate amount of Vitamin D

31. Remember to eat Vitamin D rich foods

32. Take Vitamin D supplements if you don't get enough vitamin D from your diet

APPENDIX G. DEMOGRAPHIC QUESTIONS

Please provide your first and last name.

☐

What is your instructor's name for Nutr 125

☐

What is your gender?

☐ Male

☐ Female

What is your age in years?

☐

What is the highest level of education you have completed?

☐ High School

☐ GED

☐ Some Undergraduate College

☐ Completion of Undergraduate Degree

☐ Some Graduate School

☐ Completion of Graduate Degree

☐ Other

Which Race/Ethnicity do you identify with?

☐ White

☐ Asian or Pacific Islander

☐ Hispanic/Latino

☐ Black

☐ American Indian or Alaskan Native

☐ Other

What is your marital status?

- ☐ Single

- ☐ Married

- ☐ Separated/divorced

- ☐ Widowed

- ☐ Cohabitating

What is your height in inches?

[   ]

What is your weight in pounds?

[   ]

What is your Major?

[   ]

During the school year, where do you purchase the majority of your food?

[   ]

Do you exercise?

- ☐ Yes

- ☐ No

If you answered yes to the question above, please describe the types of exercise you do, how many times per week and for how long you do each type of exercise. If you answered no to the question above, please leave the blank empty.

[   ]

Do you use vitamin or mineral supplements?

- ☐ Yes

- ☐ No

If you answered yes to using supplements, please describe the type, amount and how frequent you take each supplement. If you answered no to supplement use, please leave the box empty.

Do you know someone with osteoporosis?

☐   Yes

☐   No

Do you have a relative that has osteoporosis?

☐   Yes

☐   No

If you have a relative with osteoporosis, is that relative a blood-relative? (i.e. related by blood)

☐   Yes

☐   No

☐   N/A

[<< Previous]   [Submit]

APPENDIX H. DESCRIPTION OF TREATMENT TWO (HANDS-ON ACTIVITIES)

1-*Determining risk and protective effects on bone mass (15 minutes)* – Jenga (Hasbro

Inc. Pawtucket, RI) game to represent bone instability. The Jenga game had newly

created cards that indicated risk factors for osteoporosis (such as low BMI, low dietary

calcium intake, low vitamin D intake, eating disorders, use of alcohol, smoking, etc.

that required a person to pull one or two pieces of the game. This was meant to

symbolize things that could decrease bone mass. Similarly, there were protective

factors such as weight bearing exercise, adequate calcium, or adequate vitamin D that

allowed a participant to pull zero pieces which was meant to symbolize the protective

effects and how these factors maintain bone mass.

2-*Determining Susceptibility (15 minutes)* - Measuring height and weight; risk factor

quiz Additional questions asking about risk factors such as using alcohol, being

menopausal, being female, family history, previous falls etc (See appendix A2 for an

example of the risk factor quiz).

3-*Overcoming barriers (10 minutes)* – Serving size and portion size games: Identify

correct portion sizes of calcium-rich and vitamin D rich foods; Guess the calcium and

vitamin D in a product: skim milk, sweetened soy milk, dark chocolate almond milk,

Greek yogurt, light yogurt, cheddar cheese, vanilla ice cream, salmon, and eggs.

Participants guessed the calcium and vitamin D contents in food packages; Class led

discussion on vitamin D and calcium dietary sources, as participants generated calcium

and vitamin D sources and the instructor recorded them on the board. Additionally,

participants cut what they believed to be one ounce of cheese, then weighed it; they

poured what they believed to be eight ounces of milk into different sized glasses, then measured; scooped what was believed to be 1⁄2 cup ice cream, then measured.

4-Facts and myths (12 minutes) - supplements, lactose intolerance, calcium and vitamin D sources, vitamin D tasting lactose-free milks; tasting soy milk; practice reading supplement labels. Use of calcium and vitamin D supplements were discussed and different supplement bottles were examined. Taste testing of almond milks (chocolate and regular), soy milk (sweetened vanilla and chocolate) and rice milk. One and a half ounce samples were offered of each beverage.

5-Practice Bone Health- High-calcium and high-vitamin D recipe sharing (10 minutes)- snacks of high-calcium and high-vitamin D foods; recipe contest. Participants used their smartphones or the computer lab to find high calcium and vitamin D recipes. They were shared with the class and participants voted for their favorite.

6-Goal Setting and sharing (5 minutes) – Participants were asked to create a goal for themselves regarding protective factors relating to osteoporosis and how they will meet their goal: such as I will obtain adequate vitamin D intake by taking a 1000IU vitamin D supplement daily. Participants then choose two people to share this goal with in the class.

7-Formative assessment (3 minutes) **–** participants completed a formative assessment of what they liked most about the class, what they liked least and any improvements to the activities that they would have liked to see.

APPENDIX I. LETTER OF CONSENT

NDSU   North Dakota State University

Department of Human Development and Education

NDSU Dept. 2600

PO Box 6050

Fargo, ND 58108-6050

701.231-8211

Title of Research Study: Osteoporosis Education

Dear Participants

My name is Alexa Evenson. I am a graduate student in the College of Human Development and Education at North Dakota State University, and also a faculty member at the College of St. Benedict/St. John's University. I am conducting a research project to determine if different teaching methods influence osteoporosis preventative behaviors.

Because you are a student in NUTR 125, you are invited to take part in this research project. Your participation is entirely your choice, and you may change your mind or quit participating at any time, with no penalty to you.

It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known risks. These known risks include: loss of confidentiality, emotional or psychological distress and pressure felt to participate in the research.

By taking part in this research, you may benefit by increasing your osteoporosis knowledge, osteoporosis health beliefs and intake of calcium and vitamin D. [However, you may not get any benefit from being in this study. Benefits to others are likely to include advancement of knowledge, and /or providing information to future instructors of osteoporosis education.

Participants will complete one three-day food diary as required by the course objectives for course credit. Participants will also be asked to complete a pre-test questionnaire regarding osteoporosis knowledge and health beliefs at the beginning of the vitamins and minerals portion of the course. At the end of the semester, participants will be asked to complete a second questionnaire and complete a second three-day food diary.

It should take about 15 minutes to complete the questionnaire online about osteoporosis knowledge and osteoporosis related health beliefs. It will take an additional 30 minutes to complete a three-day food diary. The questionnaires and food diary will be repeated resulting in a total of approximately 60-90 minutes total time allotted over the course of the semester.

An alternative extra credit opportunity of summarizing four osteoporosis and vitamin D articles will be provided during the course and are also worth 15 points. Only one extra credit opportunity may be completed during the semester.

If you choose to participate in the research project, you may complete the questionnaires on-line via the forms manager link that will be emailed to the class. It can be submitted online and only a research assistant will have access to your submission. A research assistant will provide a paper copy of the questionnaires if needed. At the end of the semester, you will be contacted again via an email to complete the survey a second time and to fill out a second three day food diary. You will receive 5 points for each questionnaire completed (5 points for the pre-test, 5 points for the post-test) and 5 points for the second food diary as the first food diary is part of the course objectives. You will receive a total of 15 points for completing the entire research project. Course instructors will only have access to extra credit points after the final exam has been scored.

We will keep private all research records that identify you, to the extent allowed by law. Your information will be combined with information from other people taking part in the study, we will write about the combined information that we have gathered. You will not be identified in these written materials. We may publish the results of the study; however, we will keep your name and other identifying information private.

If you have any questions about this project, please call or email me, Alexa Evenson at 320-363-5295 , aevenson@csbsju.edu or call or email my advisor at Greg Sanders 701-231-8211, greg.sanders@ndsu.edu

You have rights as a research participant. If you have questions about your rights or complaints about this research, you may talk to the researcher or contact the NDSU Human Research Protection Program at 701.231.8908, ndsu.irb@ndsu.edu, or by mail at: NDSU HRPP Office, NDSU Dept 4000, PO Box 6050, Fargo, ND 58108-6050.

Thank you for your taking part in this research. If you wish to receive a copy of the results, please contact me at aevenson@csbsju.edu

☐ If you agree to participate in the research project, please click here.