OSTEOPOROSIS KNOWLEDGE, BELIEFS, AND BEHAVIORS OF COLLEGE STUDENTS:

UTILIZATION OF THE HEALTH BELIEF MODEL

by

ELLEN TOWNSEND EDMONDS

A DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Health Sciences
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2009

ABSTRACT

The purpose of this study is to determine the level of osteoporosis knowledge, beliefs and behavior among college students. In addition, this study will examine perceived susceptibility, severity, benefits, barriers and self-efficacy related to osteoporosis prevention.

Women and men of all ethnicities at the University of Central Arkansas were asked to participate in the study. The Osteoporosis Knowledge Test, Osteoporosis Health Belief Scale, Osteoporosis Self-Efficacy Scale, and Osteoporosis Preventing Behaviors Survey were utilized. Correlations were used to determine the degree of relationship between variables. After determining which independent variables were significant, a multiple regression was completed to determine prediction.

Participants did not perceive themselves as susceptible to osteoporosis and perceived minimal barriers to physical activity and calcium intake. Their knowledge was minimal concerning alternate sources of calcium and less traditional forms of physical activity. Physical activity was correlated with perceived barriers, health motivation, and calcium intake. Calcium intake was correlated with perceived barriers, health motivation, and knowledge.

Prevention programs should aim to increase osteoporosis knowledge of risk factors and preventing behaviors and to decrease high risk factor behaviors in adolescence when bone health can be increased. Health professionals can attempt to decrease perceived barriers to physical activity in college age individuals by providing comprehensive programs based on supported factors shown to influence behavior, including social support and self-efficacy.

DEDICATION

This dissertation is dedicated to Micah, Mom, and Dad who helped me and guided me through the trials and tribulations of creating this manuscript.

LIST OF ABBREVIATIONS AND SYMBOLS

BMD	Bone mineral density
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
DHS	Department of Health and Human Services
HBM	Health Belief Model
NIH	National Institutes of Health
NOF	National Osteoporosis Foundation
OHBS	Osteoporosis Health Belief Scale
OKT	Osteoporosis Knowledge Test
OSES	Osteoporosis Self-Efficacy Scale
UCA	University of Central Arkansas

ACKNOWLEDGMENTS

I am pleased to have this opportunity to thank the many colleagues, friends, and faculty members who have helped me with this research project. I am most indebted to Dr. Lori Turner, the chairman of this dissertation, for sharing her research expertise and wisdom regarding osteoporosis. It was a rough start, but we pulled through. Thank you for listening and supporting me through every phase of this incredible journey.

I would like to thank all of my committee members, Dr. Deidre Leaver-Dunn, Dr. Brad Lian, Dr. Renee Umstattd, and Dr. Stuart Usdan for their invaluable input, inspiring questions, and support of both the dissertation and my academic progress. I would also like to thank Dr. Jacquie Rainey for her assistance in analyzing statistics.

This research would not have been possible without the support of my friends and family who never stopped encouraging me to persist. I want to thank my parents who stayed up late with me helping me make corrections and double checking the document. I could not have finished in time without you both. Thank you for all the love and support. I also want to thank my husband, Micah, who has taken a back seat to my education and never said a word. Thank you for all the support and love you gave me through this process. We did it!!

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

More than half of Americans suffer from chronic disease (DeVol & Bedroussian, 2007). Forty-four percent of all Americans have at least one chronic condition and 13% have three or more (Horton, 2009). By 2020, the number of people with multiple chronic illnesses will reach 81 million (Bodenheimer, Chen, & Bennett, 2009). The increasing aging population is a major contributor to the rise in chronic disease. By 2030, the number of older Americans will have more than doubled to seventy million (Centers for Disease Control and Prevention [CDC], "Healthy Aging," 2008). Another major contributor is the number of increasingly sedentary and unhealthy lifestyles of younger Americans. The number of people aged twenty to forty-four with more than one chronic disease doubled between 1996 and 2005 (Horton, 2009).

The total impact of these diseases on the economy is $4.2 trillion in treatment costs and lost economic output (DeVol & Bedroussian, 2007). Seventy-eight percent of all health spending is dedicated to people with chronic disease (Anderson & Horvath, 2004), and 76% of Medicare expenditure goes to beneficiaries with more than five chronic conditions (Horton, 2009). However, with modest improvements in prevention and treatment we could avoid forty million cases of chronic disease and reduce the economic impact of disease by $1.1 trillion annually (DeVol & Bedroussian, 2007).

One of these chronic diseases is osteoporosis. By 2020, one in two Americans over age fifty will have or be at risk for developing osteoporosis (U.S. Department of Health and Human Services [USDHHS], 2004). Due to this increase and other predictions, the Surgeon General has identified bone health as a critical component to the overall health and quality of life of Americans (USDHHS, 2004).

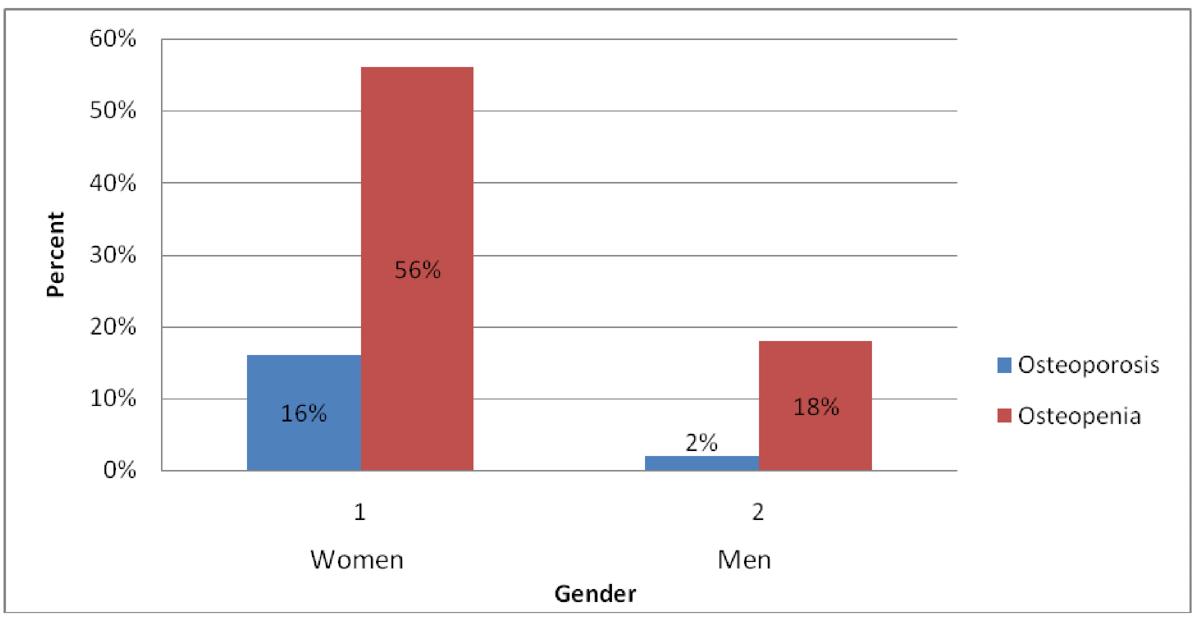
Osteoporosis is a skeletal disorder characterized by compromised bone strength, predisposing an individual to an increase risk of fracture (National Institute of Health [NIH], 2000). The World Health Organization adds to the above definition and defines osteoporosis as a bone mineral density value more than 2.5 standard deviations below the mean for normal young white women (World Health Organization [WHO], 2003). The most common sites of fractures are at the spine, wrist, and hip where trabecular bone predominates. In individuals with osteoporosis, the bands or plates of the trabecular bone become thin and weakened (USDHHS, 2004).

The most common form of osteoporosis is primary osteoporosis. Primary osteoporosis is not caused by specific disorders; it is mainly a disease of the elderly and is also referred to as age-related osteoporosis (Seeman, 2003). It characteristically begins early in life when corrective action might slow down disease progression. Women are at two to three times higher risk than men for primary osteoporosis. The rapid phase of bone loss at menopause due to loss of estrogen is the rationale behind the difference in prevalence between genders. (Riggs, Khosla, & Melton, 2002).

Osteoporosis can develop in many ways. Some of the most important means that may lead to osteoporosis are as follows: genetics, lifestyle, nutrition, calcium and vitamin D deficiency, and decrease in sex hormone production (USDHHS, 2004). Corrective action must be taken through such changes as diet and physical activity to potentially slow down bone loss which may lead to osteoporosis (Riggs, Khosla, & Melton, 2002). For women, the rapid phase of bone loss occurs around the time of menopause (Raisz & Rodan, 2003; Riggs, Khosla, & Melton, 2002) and then a slower continuous phase of bone loss continues throughout the rest of life (Riggs, Khosla, & Melton, 2002). Both the rapid phase and slow phase of bone loss are a result of estrogen deficiency. Bone formation also begins to decrease with age which causes an imbalance between bone resorption and bone formation. This imbalance leads to structural abnormalities, thinning of the cortical outer shell and damage to the trabecular bone structure, that make the skeleton fragile (Ahlborg, Johnell, Turner, Rannevik, & Karlsson, 2003).

Approximately ten million Americans have osteoporosis (National Osteoporosis Foundation [NOF], "America's Bone Health," 2002). Of these, eight million are women and two million are men. In addition to these two million men, another thirty-four million men are estimated to have low bone mass (NOF, 2008). Figure 1 displays the prevalence of low femur bone density in people 50 years of age and older in the U.S by gender.

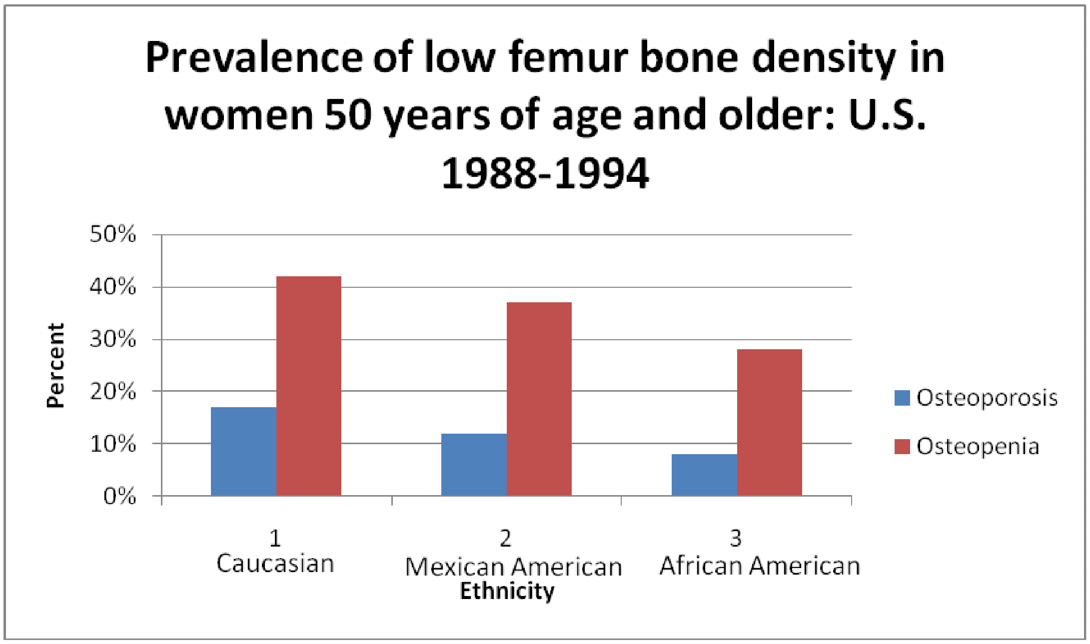
Figure 1.1 Prevalence of low femur bone density in people 50 years of age and older: U.S. 1988-1994.



(National Health and Nutrition Examination Survey [NHANES III], 1988-1994)

In regard to osteoporosis and ethnicity, 20% of Caucasian and Asian women aged fifty and older have osteoporosis, and 52% have low bone mass. Five percent of African-American women over age fifty have osteoporosis, with an additional 35% having low bone mass which also puts this population at some risk of developing osteoporosis. Ten percent of Hispanic women aged fifty and older have osteoporosis, and 49% have low bone mass. Of all ethnic groups, the risk of osteoporosis is increasing most rapidly in Hispanic women (NOF, 2008). However, Caucasian women aged fifty and older still bear the immense burden of this disease (DHS, 2004). Fugure 2 displays the prevalence of low femur bone density in women 50 years of age and older by ethnicity.

Figure 1.2 Prevalence of low femur bone density in women 50 years of age and older: U.S. 1988-1994.



(National Health and Nutrition Examination Survey [NHANES III], 1988-1994)

Bone diseases are more likely to lead to morbidity than to death. Fractures are the foremost and the most devastating problem facing individuals with osteoporosis (Leibson, Tosteson, Gabriel, Ransom, & Melton, 2002). In 1995, osteoporosis fractures contributed to more than half a million hospitalizations and over 800,000 emergency room visits (USDHHS, 2004). Hip fractures are the most disabling type of fracture in people with osteoporosis. More than one in four individuals suffering a hip fracture becomes disabled during the following year because of the fracture. Nearly one in five requires long-term nursing home care. In 1995, 140,000 persons were admitted to nursing homes due to hip fractures (USDHHS, 2004).

Very few people die as a direct result of bone disease or bone disease related problems. Deaths related to bone disease usually have indirect causes. Fractures and their related complications can trigger a downward spiral in health. Approximately 20% of hip fracture patients die within a year of the fracture (Leibson, Tostenson, Gabriel, Ranson, & Melton, 2002). Hip fractures were listed as the cause of death on 12,661 death certificates in 1999 (USDHHS, 2004). Survival rates are lower for men than for women, and black women are more likely to die than white women. Nine out of one hundred women with a hip fracture will die as a result of the fracture (Magaziner et al., 1997). Fractures resulting from osteoporosis can lead to pain, height loss, inability to stand, and inability to walk (Salkeld et al., 2000). Hip fractures are the most disabling type of fracture (Kanis & Johnell, 1999) and usually result in two million person-years of permanent disability (Chrischilles, Shireman, & Wallace, 1994).

The expense of fractures is very costly to the government. The United States government pays for most of the costs of osteoporosis through Medicaid and Medicare (USDHHS, 2004). This is because most people with osteoporosis are over sixty-five years of age. Currently, the annual direct care expenditures for osteoporotic fractures are $12.2 - $17.9 billion per year (Tosteson, 1999). White women incur most of these costs; however, white men represent approximately $3.2 billion of the total cost. Non-white women and men account for $1 billion of the total direct cost of osteoporosis (Ray, Chan, Thamer, & Melton, 1997). Hip fractures are the most ravaging and most costly of all fractures, representing $11.3 billion of the total direct expenditure of osteoporosis. This cost includes both the initial treatment and care following the injury. It is estimated by Gabriel et al. (2002) that $14,600 can be added to a person's annual medical bill one year following fracture surgery.

Prevention of bone disease begins at birth and continues throughout life. According to the Department of Health and Human Services' Surgeon General's Report (2004), the biggest problem with prevention of osteoporosis is the lack of awareness of bone disease in the public and among health care professionals. Many health care professionals do not understand the magnitude of the problem or the ways in which bone disease can be prevented and treated. There is a common misconception that osteoporosis is a disease for older white women (Mudano et al., 2003; Qaseem et al., 2008). This incorrect view can delay prevention and treatment in men and minority women. As a result, physicians frequently fail to diagnose and treat osteoporosis in men and African-Americans. These groups are a small number of people affected but still represent millions of Americans who are suffering from this debilitating disease (USDHHS, 2004).

Bone health prevention needs to include three prevention types: primary, secondary, and tertiary. Primary prevention consists of the measures taken to avert the onset of illness or injury (Cottrell, Girvan, & McKenzie, 1999). It includes encouraging adequate intake of calcium and vitamin D as well as physical activity (USDHHS, 2004). Secondary prevention is the action that leads to an early diagnosis and prompt treatment (Cottrell, Girvan, & McKenzie, 1999) which includes fall prevention and using anabolic agents (USDHHS, 2004). Comprehensive treatment of a fracture is considered tertiary prevention (USDHHS, 2004). In this level, health educators work to retrain, reeducate, and rehabilitate the individual who has already acquired a disability or impairment (Cottrell, Girvan, & McKenzie, 1999).

By utilizing theory, researchers can investigate answers to the questions of “why,” “what,” and “how” health problems should be addressed. Theory guides the search for reasons why people do or do not engage in certain health behavior (National Cancer Institute [NCI], 2005). It also explains behavior and suggests ways to achieve behavior change (Glanz, Rimer, & Lewis, 2002). The Health Belief Model (HBM) has been used to explain change. From this explanation, the HBM can provide a guiding framework for health behavior interventions (Glanz, Rimer, & Lewis, 2002). Janz and Becker (1984) summarized results from previous years and determined perceived barriers to be the most powerful single component of the model. Perceived susceptibility was also found to be a strong predictor of preventive health behavior and perceived severity was the least powerful predictor (Glanz, Rimer, & Lewis, 2002). According to the HBM, women are most likely to make health behavior changes if they perceive themselves to be susceptible to the disease. They are less likely to perform the healthy behavior if they believe they are not susceptible to the disease (Rosenstock, 1974).

By utilizing the HBM, an understanding of health behaviors and reasons for non-compliance are possible. Osteoporosis programs utilize this model to plan and intervene with at-risk populations (Chan, Kwong, Zange, & Wan, 2007; Sedlak, Doheny, & Jones, 2000; Turner, Hunt, DiBrezzo, & Jones, 2004). For example, a reason typically cited for non-compliance to osteoporosis programs is the belief the osteoporosis is not severe (Turner, Hunt, DiBrezzo, & Jones, 2004). Through the HBM, researchers can increase the likelihood of healthy behaviors if people perceive a disease as serious. A questionnaire devised from the HBM, (Kasper, Garber, & Walsdorf, 2007), determined college females perceived breast cancer and heart disease as more significant threats than osteoporosis. Another construct commonly referred to is low perceived susceptibility. Some women assume osteoporosis happens only to elderly women.

The HBM states that people who perceive themselves as not susceptible will not take preventative actions (Turner, Hunt, DiBrezzo, & Jones, 2004).

Purpose

The purpose of this study was to determine the level of osteoporosis knowledge, beliefs, and behavior among college students. In addition, this study examined the constructs of the Health Belief Model (HBM), perceived susceptibility, severity, benefits, barriers, and health motivation, related to osteoporosis prevention.

Significance of the Study

Osteoporosis is still considered a woman's health problem and specifically a white woman's health problem. Many educational and prevention programs have been offered to and evaluated in white women. However, osteoporosis in men and minority women is under diagnosed, undertreated, under-reported and inadequately researched. Even among women with a previous fracture, African-American women reported significantly fewer osteoporosis diagnoses and treatments than white women. Nonetheless, African- American women who have experienced fractures are at greater risk for increased disability, longer hospital stays, and higher mortality (Mudano et al., 2003).

Rates of osteoporosis in men are expected to increase nearly 50% in the next fifteen years, and hip fracture rates are expected to double or triple by 2040. Studies show that osteoporotic fractures in men tend to result in significant morbidity, mortality, and financial expense (Qaseem et al., 2008).

Lifestyle behavior, such as adequate exercise, weight control, balanced nutrition, and adequate calcium and vitamin D intake, influences the development of healthy bones (Morgan, 2008; Sadler & Huff, 2007). Health beliefs often influence these lifestyle choices (Sadler &

Huff, 2007). Primary prevention strategies need to be increased and targeted toward men and African-American women. Osteoporosis is difficult to treat and is still incurable; therefore, prevention is vitally important (Tung & Lee, 2006).

By assessing the knowledge of osteoporosis risk factors and to what extent preventive behaviors, such as adequate calcium intake, physical activity, and smoking cessation are practiced among college students, health care professionals will be better equipped to develop, implement, and evaluate comprehensive osteoporosis educational interventions.

There is limited research concerning osteoporosis knowledge, belief, and self-efficacy concerning college age students of both genders and multiple races. There is also minimal research of these populations' current osteoporosis preventative behaviors. This may stem from the majority of research conducted in these areas on post-menopausal white women. Through this information related to osteoporosis knowledge, belief, and self-efficacy, an intervention can occur with college age students where there is an opportunity to change their current behaviors which can ultimately change osteoporosis risk.

Research Questions

The research questions related to this research problem include:

- What is the correlation between calcium intake and physical activity?
- What is the correlation between osteoporosis knowledge and calcium intake?
- What is the correlation between osteoporosis knowledge and physical activity?
- What is the correlation between osteoporosis attitudes and calcium intake?
- What is the correlation between osteoporosis attitudes and physical activity?
- Are the individual HBM constructs significant predictors of calcium intake?
- Are the individual HBM constructs significant predictors of physical activity?

Assumptions

The assumptions related to this research project included: (a) college students enrolled at the University of Central Arkansas who serve as participants for the study will respond honestly and accurately to the osteoporosis health belief scale, osteoporosis knowledge test, osteoporosis self-efficacy scale and 7-Day recall questionnaires; (b) the questionnaires will be adequate to elicit the appropriate data from the sample; (c) the administration methods of the questionnaires will not exclude any potential subject, and (d) after an explanation is provided in the informed consent cover letter, individuals participating in this study will understand the procedures used to complete the questionnaires.

Limitations

The limitations related to this research project include its sampling method. Convenience sampling is selecting research participants on the basis of being accessible and convenient to the researcher (Baumgartner & Hensley, 2006). This can be accomplished by using students in classes in a particular department (Neutens & Rubinson, 2002). One potential limitation to using a convenience sample is that a claim for representativeness of the population cannot be made. Another limitation is the researcher's ability to generalize findings beyond the actual sample may be limited (Neutens & Rubinson, 2002).

Cook and Campbell (1979) have pointed out that participants tend to report what they believe the researcher expects to see or they wish to present themselves in a socially acceptable manner. Another concern about such data centers on whether subjects are able to accurately recall past behaviors. Cognitive psychologists have warned that the human memory is fallible (Schacter, 1999) and thus the reliability of self-reported data is tenuous on some items.

Delimitations

The delimitations related to this research project include that the study will be restricted to students enrolled in a class in the Health Science Department at the University of Central Arkansas.

Definition of Terms

The following terms are used throughout the present study and are defined as follows:

Bone Mineral Density: the amount of bone mineral within a cubic centimeter of bone. The density of the bone is responsible for the strength of the bone and the resistance to fracture (Germano & Cabot, 2000).

Convenience sample: refers to selecting research participants on the basis of being accessible and convenient to the researcher (Baumgartner & Hensley, 2006).

Health Behavior: refers to the actions of individuals, groups and organizations as well as their determinants, correlates, and consequences, including social change, policy development and implementation, improved coping skills, and enhanced quality of life (Glanz, Rimer, & Lewis, 2002).

Health Belief Model: the Health Belief Model has been used both to explain change and maintenance of health-related behaviors and as a guiding framework for health behavior interventions. It is a value-expectancy theory. The constructs of the Health Belief Model (Rosenstock, 1974) are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action (Hochbaum, 1958), and self-efficacy (Rosenstock, Strecher, & Becker, 1988).

Menopause: the cessation of menstruation, occurring gradually around age fifty. Ovarian function and hormone production diminishes resulting in hot flashes, vaginal wall dryness, depression, and breast changes (Insel & Roth, 2006).

Osteopenia: a reduction of bone mass due to an imbalance between bone breakdown and bone formation. Resorption rates are higher than formation rates, resulting in demineralization and, ultimately, in osteoporosis (Germano & Cabot, 2000). Osteopenia is having a bone mineral density value ranging from 1 to 2.5 standard deviations below the average for young adults who have achieved normal peak bone mass (DHS, 2004).

Osteoporosis: a progressive decrease in bone mass and density, causing skeletal weakness and brittle, fragile bones that are subject to breaking (Germano & Cabot, 2000). Osteoporosis is having a bone mineral density value more than 2.5 standard deviations below the mean for normal young white women (DHS, 2004).

Osteoporosis risk factor: low bone mineral density, family history, personal history of a low-trauma fracture, current history of tobacco use, age of sixty-five years or older, low body weight, estimated calcium intake of less than 1,200 mg daily, and/or no regular weight bearing exercise three times each week for twenty minutes per session.

Perceived Barriers: one's opinion of the tangible and psychological costs of the advised action.

Perceived Benefits: one's belief in the efficacy of the advised action to reduce risk or seriousness of impact.

Perceived Severity: one's opinion of how serious a condition and its consequences are.

Perceived Susceptibility: one's opinion of chances of getting a condition.

Pre-menopause: the time between menarche (the onset of menstruation) and the onset of menopause.

Self-efficacy: one’s confidence in one’s ability to take action (Glanz, Rimer, & Lewis, 2002).

Weight-bearing activity: includes activities such as walking, biking, aerobic exercise, gardening, housekeeping, resistance training, and/or jumping.

CHAPTER 2

LITERATURE REVIEW

Defining Osteoporosis

Osteoporosis is defined by the National Institutes of Health (2007) as a skeletal disorder characterized by compromised bone strength, predisposing to an increase risk of fracture. Osteoporosis is a serious public health concern that affects both men and women. It is more common in Caucasian women but is a growing concern for men and other ethnicities (Tung & Lee, 2006). It is estimated that ten million individuals have osteoporosis and another thirty-four million suffer from low bone density (NOF, "America's Bone Health," 2002). By 2020, approximately sixty-one million individuals will have osteoporosis or low bone density (NOF, "America's Bone Health," 2002). As bone strength decreases, the risk of fractures increases. The increase risk of fractures leads to increased morbidity and mortality of individuals living in the United States (Sharp & Thombs, 2003). It is projected that one in two women and one in four men over age fifty will experience an osteoporotic related fracture (National Institute of Health [NIH], 2007). The estimated cost of osteoporosis will rise to $200 billion by 2040 if prevention efforts do not improve (McBean, Forgac, & Calvert, 1994).

Bone tissue is a distinctive form of connective tissue. However, unlike other connective tissues the extracellular material of bone is hard and calcified. Bones fall into four different classifications: long, short, flat, and irregular. Long bones make up the forearm, and short bones are found in the wrist. The irregular bones consist of the hip bones and vertebrae. These three classifications house the majority of fractures related to osteoporosis (Thibodeau & Patton, 2007).

Two basic types of bone exist, each with a different role and function. Corticol (compact) bone is found on the outer surface of long bones. Spongy (cancellous) bone is present at the ends of the long bones and in the axial skeleton (Lundon, 2000).

Cortical bone is tightly packed; therefore, it serves significant mechanical and protective functions. It serves 80%-85% of the human skeleton. Cortical bone volume is regulated by bone formation or resorption on the endosteal and periosteal surfaces and by remodeling within the haversian systems. Cortical bone is removed in metabolic bone and during the aging process primarily by endosteal resorption and resorption within the haversian canals. The endosteum is a thin membrane that lines the marrow cavity and the internal spaces in the spongy bone of the epiphysis (ends of long bone) (Lundon, 2000).

The periosteum lines the outer surface of the cortical bone. The periosteum and the endosteum play critical roles in the maturing skeleton and in the fracture healing process. However, the overall effect of reduced bone volume seen with age is linked to endosteal resorption (Lundon, 2000).

The haversian systems are the microscopic unit of cortical bone (Herliny & Maebius, 2003). Each haversian system consists of mature osteocytes arranged in concentric circles around large blood vessels. The cortical bone consists of many parallel haversian systems (Lundon, 2000).

Spongy bone constitutes about 20% of total bone mass, but it does not contain haversian systems. Instead, it consists of needlelike bony spicules called trabeculae. The trabeculae are separated by irregular spaces or holes. The spaces are important because they help decrease the weight of the bone, and they contain red bone marrow (Herliny & Maebius, 2003). The spongy bone is located between two layers of cortical bone which define the shape of the bone. The trabecular network provides a large bone surface for mineral exchange and helps maintain skeletal strength and integrity. It is abundant in the spine and at the ends of long bones. These sites are under continuous stress (Kontulainen, Sievanen, Kannus, Pasanen, & Vuori, 2003).

The composition of the mineral and matrix, the structure of the trabecular bone, the porosity of the cortical bone, the presence of micro-fractures, and other damage to bone are all important in determining bone strength. These determining factors could be due to an imbalance between bone resorption and bone formation. There also may be excessive bone breakdown by the osteoclasts. The decrease in bone health is caused by many risk factors which will be discussed later in this chapter (USDHHS, 2004).

The most common form of osteoporosis is primary osteoporosis. Primary osteoporosis is not caused by some other specific disorder (USDHHS, 2004). It is mainly a disease of the elderly. Primary osteoporosis is also referred to as age-related osteoporosis. This type characteristically begins early in life when corrective action might slow down the disease. At this point, corrective action could be taken to slow down its course. Women are two to three times more at risk than men. This is mainly because of the rapid phase of bone loss at menopause (USDHHS, 2004).

This rapid phase begins at menopause and lasts from four to eight years. This phase occurs because of the notable decline in estrogen production by the ovaries at menopause. This loss of estrogen increases bone resorption. This increase in bone resorption coupled with the decline in bone formation leads to damage in the trabecular bone structure and thinning of the bone's outer shell (USDHHS, 2004). These years are followed by a slower, permanent phase that lasts the remaining years of life (Riggs, Khosla, & Melton, 2002). However, men go through only the deliberate, continuous phase which accounts for the increased bone loss in women versus men. The continuous phase of bone loss in both men and women is caused by a combination of factors comprising a decrease in calcium and vitamin D intake, age-related impairment of bone formation, a decrease in physical activity, and a loss of estrogen's positive effects on calcium balance (USDHHS, 2004).

Some forms of osteoporosis are caused by medication, and other forms are caused by pre-existing diseases or conditions. These are known as secondary osteoporosis. Individuals with secondary causes of the disease tend to experience greater bone loss than expected for a normal individual with similar characteristics. This type is most common in premenopausal women as well as in men (Khosla, Lufkin, Hodgson, Fitzpatrick, & Melton, 1994). Several diseases have been linked to secondary osteoporosis. Idiopathic hypercalcuiria, cystic fibrosis, sickle cell disease, Lupus, and Type I diabetes are just a few of the diseases that may lead to secondary osteoporosis (USDHHS, 2004).

Bones of the human skeleton serve two functions. The structural function provides mobility, support, and protection for the body. The reservoir function serves as a storehouse for essential minerals such as calcium and phosphorus. Serving these different functions at the same time leads to competition within the bone which in turn makes bone health difficult to maintain. For the bone to adhere to weight-bearing stress, adequate calcium and phosphorus are needed. However, if these minerals are needed in other systems of the body, hormones remove them from the bone. With too many withdrawals, weakening of the bone can occur which can lead to bone fractures (USDHHS, 2004).

In response to serving two roles, bone constantly changes. Two processes guide these changes: modeling and remodeling. Modeling permits the formation of new bone at one site and the removal of old bone from another site within the same bone. Modeling primarily occurs in childhood and puberty. However, it does continue throughout life in response to weakening of the bone. Remodeling occurs when a small amount of bone on the surface of the trabeculae or in the interior of the cortex is removed and then replaced at the same site. Remodeling becomes the prevailing process in one's 20's, when bone reaches its peak mass. During this process, damage to the skeleton is repaired and the addition of excessive old bone is prevented. Extra old bone can lose its resilience and become brittle. The hope is for modeling and remodeling to occur in the bone; as a result, new bone is laid down outside so despite the bone loss on the inside, the strength of the bone is preserved (USDHHS, 2004).

The process of building the skeleton and continuously reshaping, known as modeling and remodeling, is carried out by cells that form or break down bone. Under the right conditions, osteoblasts form new bone by producing the collagen that forms the bone matrix. This mineral is added to the matrix to form the hard, healthy bone. It is laid down in layers to add strength to the matrix (USDHHS, 2004).

Some of the osteoblasts are buried within the bone matrix as it is being produced; these are know as osteocytes. Osteocytes are connected to each other and to the surface of osteoblasts by a network of small thin extentions. This network allows the bone to respond to mechanical forces and injury. When the skeleton is subjected to impact, bone cells are signaled to alter their activity, either by changing bone resorption or formation (USDHHS, 2004).

The osteoclasts remove bone by dissolving the mineral and breaking down the matrix in a process call bone resorption. Excessive bone breakdown by the osteoclasts is a cause of bone fragility. However, the amount of bone removed can be controlled by modifying the rate of production on new osteoclasts, by blocking their activity, or by altering their lifespan. This can be accomplished by antiresorptive agents (USDHHS, 2004).

The final phase of bone formation now occurs. Remodeling weakens the bone, sometimes for a considerable amount of time. Then formation is carried out by osteoblasts laying down the mineral which forms the layers of the matrix and adds strength. This addition of minerals completes the process of making bone strong (USDHHS, 2004).

To keep bones healthy, diet and physical activity are critical. Mechanical loading of the skeleton is essential for maintenance of normal bone mass and architecture. Another essential for bone health is large amounts of calcium and phosphorus in the diet. The final essential item for bone health is proper functioning of hormones that affect the supply of calcium and phosphorus and the formation and breakdown of bone. The essential hormones are as follows: parathyroid hormone, calcitriol, calcitonin, estrogen, testosterone, growth hormone, thyroid hormone, and cortisol (USDHHS, 2004).

The parathyroid hormone controls the level of calcium in the blood. It also stimulates bone formation and bone resorption. Calcitriol, which is produced from vitamin D, increases intestinal absorption of calcium and phosphorus. Calcitonin is produced by cells of the thyroid gland. It has the ability to block bone breakdown by inactivating osteoclasts. It also maintains bone development and normal blood calcium levels (USDHHS, 2004).

Estrogen acts on osteoclasts and osteoblasts to inhibit bone breakdown at all stages of life, and it also may stimulate bone formation. Testosterone has the ability to stimulate muscle growth which puts greater stress on bone and therefore increases bone formation. Testonsterone is also converted to estrogen in fat cells, therefore providing the protective factor of estrogen in both men and women (USDHHS, 2004).

The growth hormone is produced in the pituitary gland and is important in regulation of skeletal growth. Thyroid hormones increase rates of bone formation and resorption. Cortisol, in small amounts, is necessary for normal bone development. However, in large amounts it blocks bone growth (USDHHS, 2004).

Fractures Associated with Osteoporosis

Approximately, four million to six million women and one million to two million men in the United States have osteoporosis. The most deleterious effects of osteoporosis are fractures. One in three women and one in eight men over fifty years of age will experience fractures due to osteoporosis; these fractures are very costly to both the government and the person. Twenty-four percent of hip fracture patients aged fifty years and older die in the year following the fracture, with higher death rates among men than among women and among non-white women than among white women (CDC, "Healthy Aging," 2008).

The most common sites of fractures are at the spine, wrist, and hip which are where trabecular bone predominates. Spine fractures usually occur in the middle or lower section of the back. Wrist fractures include fractures of the radius, ulna, or the small bones of the wrist. The location of a hip fracture can occur at the intertrochanter or femoral neck. In individuals with osteoporosis, the bands or plates of the trabecular bone become thin and weakened (USDHHS, 2004). Approximately 1.5 million fractures are associated with osteoporosis each year. This includes 300,000 hip fractures, 700,000 vertebral fractures, 250,000 distal forearm fractures and 250,000 fractures at other sites (Sharp & Thombs, 2003). Hip fractures were listed as the cause of death on 12,661 death certificates in 1999 (USDHHS, 2004). However, very few people die as a direct result of bone disease. It is usually an indirect cause of death. The fractures and their related complications can trigger a downward spiral in health. Approximately 20% of hip fracture patients die within a year of the fracture (Leibson, Tostenson, Gabriel, Ranson, & Melton, 2002). Survival rates are lower for men than for women, and black women are more likely to die than white women. Nine out of one-hundred women with a hip fracture will die as a result of the fracture (Magaziner et al., 1997).

Mortality and Morbidity Related to Osteoporosis

Bone diseases are more likely to lead to poor health than to death (USDHHS, 2004). Fractures are the foremost and the most devastating outcome associated with osteoporosis. Most osteoporotic fractures of the wrist or hip will require surgery to treat. Treatment of spinal fractures typically focuses on pain control and increasing levels of mobilization (USDHHS, 2004). In 1995, osteoporosis fractures led to more than half a million hospitalizations, over 800,000 emergency room encounters, more than 2.6 million physician office visits, and the placement of nearly 180,000 individuals into nursing homes (USDHHS, 2004). Hip fractures are the most disabling type of fracture in people with osteoporosis. More than one in four individuals suffering a hip fracture becomes disabled in the following year because of the fracture. Nearly one in five requires long-term nursing home care. In 1995, 140,000 persons were admitted to nursing homes due to hip fractures (USDHHS, 2004).

Fractures resulting from osteoporosis can lead to pain, height loss, inability to stand, and the inability to walk (Salkeld et al., 2000). Patients who have fractures are also at risk for many other complications as well. Only 40%-79% of patients regain their previous function a year after the fracture (USDHHS, 2004). Hip fractures are the most disabling type of fracture and usually result in permanent disability (Kanis & Johnell, 1999).

Costs of Osteoporosis

Fractures are one complication of osteoporosis. The expense of these fractures is very costly to the government. The United States government pays for most of the costs of osteoporosis through Medicaid and Medicare (USDHHS, 2004). This is because most people with osteoporosis are sixty-five years of age or over. In 2002, the annual direct care expenditures for osteoporotic fractures were $12.2 billion - $17.9 billion per year. White women incured most of these costs; however, white men represented approximately $3.2 billion of the total cost. Non-white women and men accounted for $1 billion of the total direct cost of osteoporosis (USDHHS, 2004). Hip fractures are the most ravaging and most costly of all fractures, representing $11.3 billion of the total direct expenditure of osteoporosis. This cost includes both the initial treatment and care following the injury. It was estimated by Gabriel et al. (2002) that $14,600 can be added to a person's annual medical bill one year following fracture surgery.

Osteoporosis Risk Factors

Osteoporosis is more common as one ages and bone density is lost (NOF, "America's Bone Health," 2002). Some people lose bone density faster than others. Over ten million individuals in the United States over age fifty have osteoporosis of the hip (USDHHS, 2004). By 2020, one in two Americans over age 50 is expected to have or to be at risk of developing osteoporosis of the hip (USDHHS, 2004). After ages forty to fifty, bone loss progresses slowly with up to an approximate 25% total loss in both men and women during this time. After age seventy, bone loss continues to decline in both men and women. As the aging poulation increases, the prevalence of bone diseases is going to increase significantly (NOF, "America's Bone Health," 2002). Between 2000 and 2050, the number of people age sixty-five and older is expected to rise from 35 million to 86 million. Between this time, the number of people age eighty-five and older will increase from four twenty million (USDHHS, 2004).

Older white women have a higher prevalence of the disease than other ethnicities and ages. Women over age fifty accounted for over 75% of the total cases in 2002. Women are more at risk than men; this is attributed to the fact that fewer men have low levels of bone density as compared to women. However, men account for two million of the people living with osteoporosis (NOF, 2008). Osteoporosis in men is under-diagnosed, undertreated, under-reported, and inadequately researched. Osteoporotic fractures in men also result in morbidity, mortality and financial expenses just as they do for women (Qaseem et al., 2008). However, men do not think osteoporosis is something they need to be concerned about, and many do not know their risk for the disease and fail to engage in preventative behaviors. Many physicians may also believe osteoporosis is strictly a female disease which leads to the under-reporting in men (Tung & Lee, 2006). About one in eight men aged fifty and over have an osteoporosis related problem (Tung & Lee, 2006).

According to the Surgeon General's Report on Osteoporosis (USDHHS, 2004), genetics accounts for 50%-90% of bone mass in individuals. Genetics sets perimeters on bone structure, rate of bone loss, and skeletal response to environmental stimuli such as nutrition and physical activity (USDHHS, 2004). If either of one's parents had osteoporosis or a history of broken bone, he/she is at higher risk; however, the National Osteoporosis Foundation ("America's Bone Health,"2002) only recognizes history in a first degree relative and only as a risk factor in postmenopausal women. To date, there have been no recommendations for premenopausal women (NOF, 2008). Robitaille et al. (2008) determined that family history of osteoporosis is an important criterion in risk assessment among women over thirty-five years of age. They also found that women at high risk from family history are more likely to participate in preventive behaviors such as taking a calcium supplement, being physically active and taking estrogen (Robitaille et al., 2008).

Fear of being overweight and an obsession with thinness among females may translate into diets that fail to meet their caloric, calcium, or protein needs (Van Loan & Keim, 2000). Research has shown body weight and pubertal development are the preeminent predictors of bone mass in adolescents (USDHHS, 2004). To achieve the fore-mentioned goals, many girls and women begin to diet. Dieting can also affect bone mass by limiting the caloric, calcium, and protein needs. Turner, Kendrick, and Perry (1999) found body weight and total body fatness were predictors of bone density. They also determined that low body mass index (BMI) was a significant risk factor of osteoporotic fractures and fall severity.

Low BMI is associated with low stores of body fat and lower circulating estrogen levels, which help prevent loss of bone tissue (Asomaning, Bertone-Johnson, Nasca, Hooven, & Pekow, 2006). Low BMI may also increase the risk of fracture as a result of a fall due to the low body fat which acts as a cushion when falling. Researchers have also found BMI to possibly be more predictive of osteoporosis than weight alone because it adjusts for differences in height and is more reflective of body composition (Asomaning, Bertone-Johnson, Nasca, Hooven, & Pekow, 2006). Low body weight, unintentional weight loss, and low BMI are particularly problems for the elderly (Korpelaninen, Korpelaninen, Heikkinen, Vaananen, & Keinanen-Kiukaannieme, 2006).

Four out of every ten white women over age fifty will experience a hip, spine, or wrist fracture sometime during the remainder of their lives. Rates of osteoporosis are lower for non-white women, 6% as compared to 17% for white women (USDHHS, 2004). The threat of fracture in minority groups was one-third to one-half that of their white counterparts. However, for certain ethnicities such as Hispanic, hip fracture incidence increased over the last twenty years. Spine fractures among Asians are comparable to whites (USDHHS, 2004). Although African-American women are at a lower risk for osteoporosis related fractures, researchers have found that within three years of sustaining a fracture, African-American women are three times more likely to die than their white counterparts (Sadler & Huff, 2007). Lifestyle behaviors also play an important role in the development of healthy bones (Sadler & Huff, 2007). Some African-American women do not develop primary prevention behaviors because they are not held in high esteem. The African-American culture minimizes the importance of taking measures to strengthen one's bones while young (Sadler & Huff, 2007). This population also typically postpones treatment for disease until the signs and symptoms are life threatening (Sadler & Huff, 2007). African-American women are also at risk for secondary osteoporosis as a result of diseases such as sickle cell, lupus, and thyroid disease (Sadler & Huff, 2007).

Estrogen is enormously important in regulating and maintaining bone strength. Estrogen produced as a child and early in puberty has the prospect to increase bone growth. The hormone estrogen protects bone. Estrogen acts to inhibit bone breakdown and may even stimulate bone formation (NOF, 2008). At the end of puberty, there is a high concentration of estrogen which stops further growth in height by closing the cartilage plates at the ends of long bone. However, at menopause, when estrogen decreases, there is rapid bone loss (USDHHS, 2004). Estrogen deficiency affects calcium metabolism, fracture risk, and bone mineral content (USDHHS, 2004). If one goes through menopause early, her risk of osteoporosis increases (NOF, 2008).

Nutrition is a modifiable factor in the prevention and treatment of osteoporosis, primarily by providing bone building nutrients and by influencing absorption and retention of these nutrients (Morgan, 2008). Nutrition plays an important role in protecting against osteoporosis with approximately 80%-90% of bone mineral content being comprised of calcium and phosphorus. Other dietary components required for normal bone metabolism are vitamins D, K, A, C, protein, zinc, copper, iron, fluoride, and magnesium (Morgan, 2008). Diet can play a vital role in manufacturing and preserving bone mass throughout life. Calcium is considered the building block of bone. Calcium is stored within bone and is essential for the functioning of other body systems (USDHHS, 2004).

Calcium is crucial for achieving peak bone mass in an individual's twenties and thirties of life and for maintaining bone mass for later in life (USDHHS, 2004). Calcium is preserved in the skeleton and is drawn upon in times of reduced intake or excessive loss. The size of this reserve is controlled by the mechanical function of the skeleton, and the body maintains only as much bone as needed to support mechanical loads (Heaney, 2000). Calcium absorption declines with age; therefore, recommendations for dietary intake of calcium are higher for adults age fifty-one years and older (Morgan, 2008). Two additional reasons calcium requirements increase with age are that physical activity typically declines with age and food intake is reduced as individuals grow old (Morgan, 2008).

The recommendation for calcium varies by age. A steady increase in calcium intake is required as children age, beginning with 210 mg per day in infants and rising to 1,300 mg per day in those ages nine to eighteen. Recommended levels drop to 1,000 mg per day in those ages nineteen to fifty, and then increase to 1,200 mg per day for those over age fifty. The same age-dependent recommendations for calcium apply to pregnant or nursing women (USDHHS, 2004). Milk, yogurt, and cheese are the main sources of calcium in the United States diet; other foods such as kale, broccoli, and Chinese cabbage also provide a good source of calcium (Morgan, 2008).

Vitamin D is essential because it aids in the absorption and utilization of calcium (Webb, Kline, & Holick, 1988). Vitamin D is supplied to the body through sunlight. Those who obtain adequate amounts of calcium and vitamin D should have higher bone mass and fewer fractures (USDHHS, 2004). Vitamin D deficiency affects all age groups, but African- Americans see this deficiency more often than other ethnicities. African-Americans tend to cover most of their bodies when entering the sun, or they remain out of the sun's exposure (Morgan, 2008). A deficiency in vitamin D causes a decrease in the effectiveness of intestinal absorption of dietary calcium and phosphorus (Holick, 1999; Holick, 2005).

Vitamin D is a fat-soluble vitamin which means it is stored in the body fat. Therefore, obese persons are only able to increase their blood levels of vitamin D 50% compared with normal-weighted individuals (Wortsman, Matsuoka, Chen, Lu, & Hokick, 2000). In a study conducted by Pfeiffer et al. (2000), 800 IU vitamin D was given daily with calcium to elderly women. The researchers determined that the daily doses were enough to have a 47% reduction in falls and fractures as compared with controls who received only calcium. The recommendation for vitamin D also varies by age. Levels of vitamin D intake are 200IU per day for those under age fifty; 400 IU per day is recommended for those who are fifty-seventy years of age, and 600 IU per day for those over age seventy (USDHHS, 2004).

Phosphorus is an essential element for healthy bones (Heaney, 2004). The recommendation for phosphorus in adults aged fifty years and older is 700 mg/d of phosphorus; adolescents' requirements are higher doses at 1,250 mg/d (USDHHS, 2004). Phosphorus supports building bone and other tissue during growth (Morgan, 2008). Bones house approximately 85% of the phosphorus in our bodies. Most women acquire enough phosphorous; however, 10% of women over age sixty and 15% of women over age eighty obtain less than 70% of the recommended daily allowance (Morgan, 2008; Heaney, 2004). Excessive amounts of phosphorus can potentially be negative to bones (Heaney, 2004).

There must be at all times a delicate balance between phosphorus and dietary calcium (Heaney, 2000; Morgan, 2008). If calcium consumption does not keep tempo with phosphorous consumption, a resulting increase in bone resorption and bone loss will occur (Ilich & Kerstetter, 2000). Phosphorus is found in milk, yogurt, cheese, eggs, and many other foods. It is also contained in soft drinks (USDHHS, 2004). There is a continuing debate about the role of phosphorus in soft drinks and their effects on bone health (Morgan, 2008). Almost one-fourth of adolescents consume more than twenty-six ounces of carbonated beverages every day (Hamack, Stang, & Story, 1999). Heaney and Rafferty (2001) found that the skeletal effects of carbonated beverage consumption are most likely due to milk displacement and not the consumption itself.

Magnesium, another nutrient beneficial to bone, appears to enhance bone quality and potentially improve bone mineral density (USDHHS, 2004). This is specifically seen in white men and women but not in African-American men and women (Ryder et al., 2005). Magnesium deficiency could affect bone growth (Fatemi, Ryzen, Flores, Endres, & Rude, 1991) and may interfere with the ability to process calcium (USDHHS, 2004). The recommendation for magnesium in adolescent males is 410 mg/d and in females 360 mg/d; young adult males need 400 mg/d and females need 310 mg/d, and older adult males need 420 mg/d and females need 320 mg/d. Magnesium is found in food sources such as whole unrefined grains, vegetables, legumes, nuts, seeds, dairy products, and meats (Morgan, 2008).

Potassium and sodium work together to maintain the body's water balance. Potassium helps kidneys retain calcium, and low potassium intake leads to increased losses of calcium in the urine (Morgan, 2008). Dietary potassium is a significant judge of total body BMD and a significant judge of spine BMD (Whiting, Boyle, Thompson, Mirwald, & Faulkner, 2002). The recommendation for potassium varies by age: children between the ages of nine and eighteen need 4,500 mg/d and for ages nineteen and older, 4,700 mg/d is required. Fruits, vegetables, and milk are sources of dietary potassium (Morgan, 2008).

Protein is known as the building blocks of our body. Protein is used to build, repair, and replace tissue throughout life (USDHHS, 2004). There are contraindicating accounts of high protein diets and their effects on BMD. Several studies have shown that a high-protein diet is associated with high BMD (Geinoz et al., 1993; Hannan, Tucker, Dawson-Hughes, Felson, & Kiel, 2000; Promislow, Goodman-Gruen, Slymen, & Barrett-Conner, 2002) and yet other studies indicated no relationship (Henderson, Price, Cole, Gutteridge, & Bhagat, 1995; Mazenss & Barden, 1991) or a negative relationship in young women (Metz, Anderson, & Gallagher, 1993). Munger, Cerhan, & Chiu (1999) determined that higher protein intake was associated with a significantly reduced risk of hip fracture.

Devine, Dick, Islam, Dhaliwal, & Prince (2005) found that increased protein has a positive effect on bone mass in elderly women. The researchers determined that a protein intake of less than 66 g/d above current recommendations is necessary for elderly women to obtain this positive effect on bone mass (Devine, Dick, Islam, Dhaliwal, & Prince, 2005). Protein recommendations are different for men and women. In males ages fifteen to eighteen, 45 g/d is needed and 44 g/d for females in the same age group. In males ages nineteen to twenty-four, 58 g/d is needed, but only 46 g/d is recommended for females. Males ages 25 and older 63 need g/d and females need 50 g/d (Morgan, 2008).

Bone mass is responsive to the load placed on the skeleton. When activity is discontinued, there is a loss of muscle mass which signals less need for bone. This, in turn, leads to the elimination of bone. This process is worsened by other risk factors such as menopause (USDHHS, 2004).

Although there are many documented benefits of physical activity, more than 60% of American women do not engage in the recommended amount of physical activity and 25 % of American women are not active at all (CDC, "Physical Activity for Everyone," 2008). In addition to adults, results from Valois, Umstattd, Zullig, & Paxton (2008) suggest public high school adolescents are not engaging in moderate, vigorous, or strengthening physical activity behaviors. Perceived barriers play an important role in exercise adherence (Ransdell, 2004). Women cite the following barriers to physical activity: multiple role expectations; fear of safety; fear of pain; lack of time; lack of access to facilities; poor instruction; threat of embarrassment; lack of family encouragement; overweight status; older age; poverty status; single parenthood; and cost (Ransdell, 2004).

Physical activity recommendations for healthy adults also match recommendations for improving bone health. Adults should engage in moderate-intensity physical activity for at least thirty minutes one or more days of the week (CDC, "Physical Activity for Everyone," 2008). Adults should engage in vigorous-intensity physical activity three or more days per week for twenty or more minutes per occasion (CDC, "Physical Activity for Everyone," 2008). According to the American College of Sports Medicine's position stand for physical activity and bone health (2004), resistance exercise must be performed two to three times per week for optimal bone health. Weight bearing endurance activities need to be performed three to five times per week to obtain the large amount of the benefits available for bone health (American College of Sports Medicine [ACSM], 2004). The recommendations from the American Heart Association and ACSM (2007) states adults should participate in moderately intense aerobic exercise 30 minutes a day, five days a week. Moderate intensity is defined as a means working hard at about level-six intensity on a scale of 10. The individual should still be able to carry on a conversation during exercise. On a scale relative to an individual's personal capacity, vigorous-intensity physical activity is usually a 7 or 8 on a scale of 0 to 10 (CDC, “Physical Activity for Everyone,” 2008).

ACSM, AHA, and CDC’s recommendations are the minimum needed to maintain and/or improve bone health (NOF, “Physician’s Guide,” 2002). There are more specific recommendations which will add to the above. Lower intensity exercise such as walking will only minimally benefit bone health. More vigorous activity such as jogging or dancing and is weight-bearing will more likely benefit bone. However, these activities must be performed from thirty to sixty minutes (Winters-Stone, 2005).

Physical activity was a greater predictor for fracture than any other associated risk factor (Turner, Leaver-Dunn, DiBrezzo, & Fort, 1998). For that reason, resistance training should be performed per the recommendations and be slightly rigorous to affect bone. It must be high-weight, low-repetition resistance exercise. High-weight refers to weight that cannot be lifted more than eight to twelve times. These resistance exercises must be performed at least two times per week (Winters-Stone, 2005). According to the Physical Activity Guidelines for Americans (DHS, 2008), the minimal levels of physical activity that were significantly associated with reduced fracture risk were at least 9 to 14.9 metabolic equivalent (MET)-hours per week of physical activity, more than 4 hours per week of walking, and more than 1 hour per week of physical activity.

Nonetheless, bone-loading activities must be forceful and load the bone at various angles. Specific bones must be targeted for the best outcome. For instance, to increase bone density in the tibia, activities must include contractions of the large muscles of the lower leg as well as compressive forces on the foot, ankle, and lower leg. In addition, the load applied to the bone needs to increase periodically to continually stimulate bone formation (Bouchard, Blair, & Haskelle, 2007).

Jump training has also been found to offer a quick and simple way to improve bone mass at the hip. Jumping straight up and down fifty to one-hundred times, three to five days a week has proven to offer benefit to bone mass of the hip. Furthermore, as the height of the jump increases or the weight of the person increases, the jump produces more force which will offer more benefit to bone. Studies have shown that older women who jump with their body weight can maintain their hip bone mass over time (Winters-Stone, 2005).

Exercise has other benefits to the body which may lead to a reduced number of falls for the at-risk population. Resistance training improves muscle mass and muscle strength which can bring about improvements in balance and gait. Studies have shown that resistance training alone can reduce falls (Winters-Stone, 2005). When developing an exercise program for women who have low bone density levels, caution should be maintained. Low-impact forms of activity such as walking, step aerobics and low-impact aerobics are recommended. Turner, Bass, Ting, & Brown (2002) found yard work to be a predictor of positive bone density. In this study, yard work included pushing a mower, digging holes, pulling weeds, and carrying soil or other gardening items. High-impact activities are discouraged for this population because of the risk of falls and fractures. Two sessions of strength-training per week and fifteen minutes of muscle conditioning are recommended for women who have low bone density (Pollock & Brechu, 1995; Turner, Bass, Ting, & Brown, 2002).

Smoking is correlated with reduced risk of bone mass and increased fracture risk. Smoking can lower the amount of calcium absorbed from the intestine, and it also has an effect in lowering body weight (Brot, Jorgensen, & Sorensen, 1999; Krall & Dawson-Hughes, 1999). Additionally, the nicotine has a direct effect on bone cells (USDHHS, 2004). Smokers tend to be less physically active than nonsmokers. Smoking also influences estrogen metabolism which means that a higher dose of estrogen hormone therapy is needed to achieve the clinical effects on bone density (Tansavatdi, McClain, & Herrington, 2004). Smoking has also been linked to an increase fracture risk (Law & Hackshaw, 1997). However, researchers have not been able to completely explain this increase risk. They did find there was a 55% higher risk of hip fracture in smokers than in non-smokers (Kanis et al., 2005).

Alcohol inhibits bone remodeling. It may even reduce bone formation or affect vitamin D, which will affect calcium absorption (Laitinen et al, 1991). However, studies have shown that moderate amounts of alcohol might be beneficial to bone health. Women who partake in moderate amounts of alcohol have been shown to have higher bone density. This is not also true in regard to fractures. A moderate amount of alcohol seems to increase the risk of fractures (USDHHS, 2004). However, other studies have determined that moderate alcohol consumption may be associated with a decrease risk of fracture in postmenopausal women (Felson, Zhang, Hannan, Kannel, & Kiel, 1995). Alcohol use, especially during adolescence and young adulthood, affects bone structure and peak bone mass (Sampson, 2002).

The desire for the female athlete to succeed and to achieve a prescribed body weight can advance the development of the female athlete triad symptoms such as eating disorders, amenorrhea, or osteroporosis (Beals, Brey, & Gonyou, 1999). The American College of Sports Medicine has defined the female athlete triad as the interrelationships between energy availability, menstrual function, and bone mineral density. Energy availability is defined as dietary energy intake minus exercise energy expenditure. It is the dietary energy lasting for other body functions after exercise training (ACSM, 2007). The female athlete triad may manifest itself as eating disorders, functional hypothalamic amenorrhea, or osteoporosis (ACSM, 2007). Bone health and development is impaired by low energy availability by inducing amenorrehea and removing estrogen’s control on bone resorption and suppressing the hormones that promote bone formation (ACSM, 2007). Included with this symptom is anorexia nervosa and bulimia nervosa. Anorexia nervosa is defined as restrictive eating behavior when the female is terrified of gaining weight and views herself as overweight. Amenorrehea is a diagnostic criterion for anorexia (ACSM, 2007). Bulimia nervosa is exemplified by repeated cycles of uncontrolled bingeing and purging occurring a minimum two times per week for at least three months (American Psychiatric Association, DSM-IV-TR, 2000). These individuals usually fall in the normal weight range (ACSM, 2007). Those who do not meet all criteria for either anorexia nervosa or bulimia nervous are considered as having an eating disorder not otherwise specified (ACSM, 2007).

Amenorrhea is the absence of three or more consecutive menstrual cycles. Primary amenorrhea is delayed menstruation by age sixteen in a female who contains secondary sex characteristics. Secondary amenorrhea is the absence of three or more consecutive menstrual cycles after menarche. Premature bone loss and inadequate bone formation resulting in low bone mineral density, microarchitectural deterioration, increased skeletal fragility, and increased risk of stress fractures to the extremities, hips, and spine are common in young female athletes with osteoporosis (USDHHS, 2004). Stress fractures are two to four times greater in amenorrheic than eumenorrheic athletes and occur more often in physically active women with menstrual irregularities and/or low BMD (Bennell, Matheson, Meeuwisse, & Brukner, 1999). The bone mineral lost due to the female athlete triad is at least partly irreversible.

Prevention and Treatment

Maintenance of bone health is the overall goal for both prevention and treatment of osteoporosis. Risk factors such as a diet low in calcium and limited weight-bearing physical activity must be minimized to reduce osteoporosis. These risk factors need to be reversed for optimal bone health. In some cases, individuals should be instructed on how to reduce risk of falls. Interventions focusing on maximizing benefits of physical activity and reduction of other risk factors are needed. Prevention is the key to attempt to reduce costs and symptoms associated with osteoporosis (USDHHS, 2004).

However, if an individual is at a high risk of fracture, pharmacotherapy is often needed. These patients are usually started on antiresorptives. These drugs reduce bone loss, stabilize the microarchitecture of the bone, and decrease bone turnover. This therapy includes use of bisphosphonates, estrogen, selective estrogen receptor modulators, calcitonin, and parathyroid hormone (USDHHS, 2004).

Currently the bisphosphonates which are FDA-approved are alendronate (Fosamax®), risedronate (Actonel®), and Ibandronate (Boniva®). The purpose of these medications is to bind to the bone surface and then be taken up by osteoclasts which may lead to a diminished ability for osteoclasts to cause bone loss (USDHHS, 2004). Bisphosphonates are poorly absorbed. They should be taken alone with a full glass of water first thing in the morning and on an empty stomach. Food should not be eaten for at least thirty minutes after taking the drug. Patients should also not lie down for thirty minutes to prevent irritation of the esophagus (USDHHS, 2004).

Alendronate (Fosamax®) has been proven successful by increasing bone mineral density (BMD) by 6%-8 % at the spine and by 3%-6% at the hip over a three year period in postmenopausal women (Black et al., 1996; Liberman et al., 1995). This reserved increase is associated with reducing fracture risk by approximately 50% (Black et al., 1996 & Cranney, Wells, et al., 2002). Furthermore, 95% of postmenopausal women maintained or increased their bone mass by taking alendronate (Black et al., 1996; Lieberman et al., 1995). Alendronate has also been proven to be an effective treatment for both men (Orwoll et al, 2000) and young, postmenopausal women (Fleisch, 2002).

Risedronate (Actonel®), another bisphosphonate, has also been shown to increase BMD and reduce fracture risk. It increases spine BMD by approximately 5% and hip BMD by 2%-3% over three years in postmenopausal women (Harris et al., 1999). Rapid results typically occur, such as reduction in spine fractures (Harris et al., 1999) and hip fractures (McClung et al., 2001). It has been proven to be effective in postmenopausal women with low bone mass who do not have osteoporosis but have osteopenia, steroid induced osteoporosis in men, pre-post menopausal women (Reid et al., 2000) and for the treatment of Paget’s disease (Lyles, Siris, Singer, & Meunier, 2001).

Ibandronate (Boniva®) is a third bisphosphate that is currently FDA-approved for both treatment of and prevention of osteoporosis in postmenopausal women (Delmas et al., 2002). The once daily form significantly reduced vertebral fractures by 49%; lumbar spine BMD was increased 6.5%, and an increase in hip BMD by 3.4% (Bilezikian, 2009). The once monthly form increased both lumbar spine and total hip BMD more than the once-daily form (Bilezikian, 2009).

Another alternative for the prevention and treatment of osteoporosis is hormone therapy. Hormone therapy was first approved in the 1960s for postmenopausal osteoporosis (USDHHS, 2004). This approval was based on the premise that bone is lost after menopause when estrogen levels decrease (Riggs, Khosla, & Melton, 2002) and replacing this estrogen with hormone therapy would increase bone mass (USDHHS, 2004).

However, estrogen alone was discovered to be associated with an increase risk of uterine cancer. Therefore, only women who have had their uterus removed are prescribed estrogen alone. All others are prescribed estrogen combined with progesterone to help protect the uterus (USDHHS, 2004). Postmenopausal hormone therapy increases BMD at the spine 3.5%-7%, increases BMD at the hip 2%-4%, and increases BMD at the forearm 3%-4.5% (Lindsay, Gallagher, Kleerekoper, & Pickar, 2002; Wells et al., 2002; Writing Group, 1996). These changes occur quickly, within the first year of therapy.

It was also determined that estrogen reduces the risk of non-spine fractures by 27% (Torgerson & Bell-Syer, "Nonvertebral Fractures," 2001) and spine fractures by 33% (Torgerson & Bell-Syer, "Vertebral Fractures," 2001). A study by Cauley et al. (2003) established hip and spine fractures were reduced by at least one third and total fractures fell by 24%-30%.

However, many studies have found negative effects of hormone therapy, both estrogen only and combination therapy. These trials found an increase risk of stroke, cognitive impairment, and deep vein thrombosis (Anderson et al., 2004; Rossouw et al., 2002; Shumaker et al., 2003; Shumaker et al., 2004). Breast cancer was increased in only those women who took the combined therapy (Collaborative Group, 1997; Lagro-Janssen, Rosser, & van Weel, 2003). Because of the observations of the above trials and related literature, any decision to use hormone therapy must take into consideration its impact, both positively and negatively, on overall health.

Selective estrogen receptor modulators (SERM) capture the positive effects of estrogen on bone without inviting the negative effects. SERMs interact with estrogen receptors which turn cell activity on and off (McDonnell, 2003). SERMs bind to the estrogen receptors, altering the way they interact with other protein and DNA.

Raloxifene (Evista®), the only FDA-approved SERM, has been proven to increase spine BMD 2%-3% and hip BMD by 2.5% after three years (Ettinger et al., 1999). There was no effect on hip or other non-spine fractures (Cranney, Tugwell, et al., 2002; Ettinger et al., 1999). Spine fractures were reduced by approximately 50% at year one (Maricic et al. 2002). This decrease can be sustained for up to four years if patients remain on therapy (Delmas et al., 2002); however, when therapy is discontinued, bone can return to its previous state.

Calcitonin is a hormone secreted by cells found in the thyroid gland (Silverman, 2003). Calcitonin was one of the first drugs available for the treatment of osteoporosis. Though not utilized often because of the advancement of newer therapies, it is offered as both an injection and through the nasal cavity (USDHHS, 2004). The proposed effect is to 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). More research must be conducted to determine the true effect on BMD and fractures. It is currently approved for the treatment of osteoporosis, but only for women who went through menopause over five years ago.

The parathyroid hormone (PTH) has been approved for the treatment of severe osteoporosis in both men and postmenopausal women. The PTH thickens the outer shell of bones and increases bone strength. It has 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 approximately twenty-one months. Spine fractures decreased by 65%, and non-spine fractures decreased by 53% (Neer et al., 2001). In men, BMD increased by 5.9% and hip BMD increased by 1.2% (Orwoll, 1998).

Healthcare professionals must be able to recognize the warning signs of potential problems with a patient's bone health. These signals apply to both men and women and all ethnicities. Fragility related fractures are one of the strongest indicators of bone disease (Ettinger, Ray, Pressman, & Gluck, 2003; Haentjens et al., 2003). If an individual has a history of fractures related to only mild or moderate trauma, he/she should be assessed further for potential bone disease (USDHHS, 2004).

Another warning sign is a family history of osteoporosis. Healthcare professionals should look for all family members who have bone disease which could lead to early diagnosis and treatment (USDHHS, 2004).

Low body weight is a third warning sign for potential osteoporosis. Low body weight is associated with lower BMD and greater bone loss (Bainbridge, Sowers, Lin, & Harlow, 2004). For the elderly, a weight loss of more than 1% per year is associated with more rapid bone loss and an increase risk of fracture (Ensrud et al., 2003; Hannan et al., 2000; Knoke & Barrett-Conner, 2003).

Warning signs for adolescents include abnormalities of sex hormone function. Late onset of sexual development, cessation of menstrual periods, anorexia nervosa, or athletic amenorrhea syndrome is also risk factors for adolescents (USDHHS, 2004). Other warning signs include calcium and vitamin D deficiency, prolonged immobilization, paralysis, arthritis, kidney disorders, gastrointestinal disorders, and treatment with drugs that affect bone (USDHHS, 2004).

Once a high-risk patient is identified, further evaluation of his/her BMD is demonstrated. Measuring BMD is chosen because bone strength is related to BMD. It is a predictor of fracture risk (USDHHS, 2004). The dual x-ray absortiometry (DXA) is the most common method for measuring BMD. DXA consists of levels of radiation measuring BMD of the spine and hip sites. There are other methods for measuring BMD; however, the WHO's recommendations for interpreting BMD results for diagnosis are based on DXA measurements of the hip or spine (USDHHS, 2004).

To interpret the results, the patient's BMD is compared to the mean value in a reference population (young healthy adults). The difference between an individual's BMD and the mean BMD for the reference population is expressed in standard deviation units. A score of zero indicates a BMD equal to the mean. A score of positive one indicates one standard deviation above the mean, and a score of negative one is one standard deviation below the mean. This standard deviation measurement is known as the T-score (USDHHS, 2004).

Four diagnostic categories were proposed for assessments done with DXA (Kanis, 2002; Kanis, Melton, Christianse, Johnston, & Khaltaev, 1994). The normal category is a hip BMD of no more than 1 standard deviation below the young adult female reference mean. The low bone mass category is a hip BMD between 1 and 2.5 standard deviations below the young adult female mean. The osteoporosis category is a hip BMD that is 2.5 standard deviations or more below the young adult female mean. The severe osteoporosis category is a hip BMD that is 2.5

standard deviations or more below the young adult mean in the presence of one or more fragility fractures (Kanis, 2002; Kanis, Melton, Christianse, Johnston, & Khaltaev 1994).

Another option for expressing BMD is the Z-score, which compares an individual with age, gender, and ethnicity matched norms. Z-scores are not the gold standard for diagnosis; however, they are useful in determining how an individual's BMD compares with another individual similar to him/her. Patients with a low Z-score are in need of an evaluation for secondary causes of osteoporosis. The Z-score is particularly useful in children. T-scores should not be used for children since they have not reached peak bone mass (USDHHS, 2004).

Theoretical Basis

A set of concepts, definitions, and propositions that explain or predict events or situations by illustrating the relationships between variables is known as a theory (NCI, 2005). Why, what, and how are questions that can be answered by using a theory. Theory can also explain and predict health behaviors (Glanz, Rimer, & Lewis, 2002). A challenge to utilizing theory in relation to physical activity is the lack of clarity and consensus encasing terms. For example, defining the terms "mediator" and "moderator" have brought difficulties in understanding methods of physical activity change. Another challenge is the overlap between constructs from different theories. Evaluation needs to take place to determine the overlap and determine the set of variables to be studied in relation to physical activity (King, Stokols, Talen, Brassington, & Killingsworth, 2002).

The Health Belief Model (HBM) is described as an individual-level theory (Rosenstock, 1974). It theorizes beliefs about whether or not people are susceptible to a disease, and if their perceptions of the benefits of trying to avoid a disease influence their readiness to act. Six constructs are used to explain behavior. Perceived susceptibility is defined as the belief about the chances of getting a condition. Perceived severity is defined as the belief about the seriousness of a condition and its consequences. Perceived benefits are the beliefs about the effectiveness of taking action to reduce risk or seriousness. Perceived barriers are the individual's belief about the material and psychological costs of taking action. Cues to action are the factors that activate their readiness to change. Self-efficacy is the confidence in one's ability to take action (Rosenstock, 1974). This was added to allow better accounting of habitual behaviors (Rosenstock, Strecher, & Becker, 1988).

The HBM has many benefits when addressing problem behaviors that evoke health concerns. It is useful in understanding health behaviors in a multicultural setting. However, there is some ambiguity about the relationship of the theoretical constructs to each other. This model also has been found to have inconsistent measurement, and researchers must re-examine the reliability and validity when the HBM is used in different cultural settings (USDHHS, 1999).

The constructs of perceived benefits have been found to have a positive relationship with physical activity, and perceived barriers have been found to have no association to adult physical activity (USDHHS & CDC, 1999). According to the Surgeon General's Report (USDHHS & CDC, 1999), there is mixed evidence regarding the construct perceived severity and its relationship to both physical activity and adherence to exercise programs. Additionally, perceived susceptibility to illness also unrelated to adult adherence to exercise programs. When dividing the population into subgroups, self-efficacy is positively related to physical activity among men, women, younger adults, older adults, Latinos, overweight persons, and persons with injuries or disabilities (USDHHS & CDC, 1999).

Dietary restraint refers to the use of cognitive cues to lose or maintain weight. High dietary restrainers reported high calcium barriers as compared to low dietary restrainers. One possible reason for this difference is the perception of calcium rich foods high in fat and calories would most likely be a barrier to their consumption, especially for those trying to lose or maintain weight (Gammage, Francoeur, Mack, & Klentrou, 2009). High dietary restrainers also had greater overall health motivation. These individuals pay more attention to their weight and behaviors that influence their weight; therefore, they may also be more concerned with their overall health (Gammage, Francoeur, Mack, & Klentrou, 2009).

Perceived susceptibility relates to calcium intake in postmenopausal women (Blalock et al., 1996) but not in college women (Kasper, Peterson, Allegrante, Galsworthy, & Gutin , 1994; Wallace, 2002). Perceived benefits of calcium for prevention of osteoporosis have been examined to relate positively to calcium intake among college women. However, perceived barriers negatively relate to calcium intake among college women (Ali, 1996). In a study conducted by Schmiege, Aiken, Sander, & Gerend (2007), it was discovered that perceived barriers and self-efficacy directly predicted intentions to consume calcium among young women. Through utilization of the OSES, it has been found the strongest predictor of calcium consumption is self-efficacy (Ali, 1996; Wallace, 2002). Research from Hazavehei, Taghdisi, & Saidi (2007) determined that greater knowledge and perceived susceptibility to osteoporosis can positively change behavior of calcium intake. This determination was made after an applied intervention addressing these issues (Hazavehei, Taghdisi, & Saidi, 2007).

By utilizing the HBM, an understanding of health behaviors and reasons for non-compliance are possible. Osteoporosis programs utilize this model to plan and intervene with at risk populations. For example, a reason typically cited for non-compliance to osteoporosis programs is the belief that osteoporosis is not severe. Drozdzowska, Pluskiewicz, & Skiba (2004) found 50% of women believed osteoporosis is a minor health problem, and 53% think it is a curable disease. Through the HBM, researchers can increase the likelihood of healthy behaviors if people perceive a disease as severe. In a program conducted by Turner, Hunt, DiBrezzo, & Jones (2004), presenting the negative outcomes associated with osteoporosis such as death, fractures, physical pain and emotional suffering was an attempt to modify perceived severity. A questionnaire devised from the HBM, Kasper, Garber, & Walsdorf (2007) determined college females perceive breast cancer and heart disease as a more significant threat than osteoporosis. Perceived severity was higher for women with a first degree relative with osteoporosis than for other women in a study conducted by Chang (2007).

Another commonly referred to construct is low perceived susceptibility. Some women assume osteoporosis only happens to elderly women. The HBM states people who perceive themselves as not susceptible will not take preventative actions (Turner, Hunt, DiBrezzo, & Jones, 2004). Patients who were told they had osteoporosis by a doctor or nurse were more likely to start medication; however, even among this group only 102 of 164 patients actually started treatment (Yood et al., 2008). In women with a first degree relative who had osteoporosis, perceived susceptibility was higher than women without this family history (Chang, 2007).

Outcome expectations of engaging in preventative osteoporosis behaviors influence health motivation and are used to determine the likelihood of engaging in the osteoporosis preventative behaviors (Glanz, Rimer, & Lewis, 2002). Previous studies have examined the association between HBM constructs and osteoporosis preventative behaviors. The majority of studies identified barriers as the most common factor impacting behavior (Wallace, 2002). Wallace (2002) utilized the Osteoporosis Health Belief Scale to establish information regarding the HBM and osteoporosis.

Many young adults do not perceive themselves at risk for osteoporosis; therefore, they do not practice preventative lifestyle habits. In addition, several perceive osteoporosis as a "women's health" issue affecting only older women. Very little attention has been paid to men or to women of ethnicities other than Caucasian (Johnson, McLeod, Kennedy, & McLeod, 2008). In a study conducted by Johnson, McLeod, Kennedy, & McLeod (2008), it was determined that susceptibility scores were considerably lower in young adults compared to the older age groups. Women found themselves more susceptible than men in each corresponding age group (Johnson, McLeod, Kennedy, & McLeod, 2008). However, they also found no significant differences in severity and health motivation across age and gender groups. Most were not aware of the severe consequences of osteoporosis, and therefore, these individuals are less likely to make behavioral change to prevent osteoporosis. It has also been found that 65% of young women eighteen to twenty-five years of age thought osteoporosis is a disease of women more than seventy years of age (Hazavehei, Taghdisi, & Saidi , 2007).

The study of health beliefs in men is scarce. However, there are a few studies which address this population. Men did not view themselves as susceptible to osteoporosis but were neutral to the severity of osteoporosis. They agreed in the benefits of physical activity and calcium intake in the prevention of osteoporosis and disagreed they were facing barriers to both. They also had a high health motivation in preventing the development osteoporosis (Yin-King Lee & King-Fai Lai, 2006). Johnson, McLeod, Kennedy, & McLeod (2008) discovered men have low perceived severity concerning osteoporosis and are unlikely to make any behavior modifications to combat the disease. Men also did not perceive themselves as susceptible to osteoporosis (Johnson, McLeod, Kennedy, & McLeod, 2008).

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 is not informed (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 the intense educational program, the subjects consisted of thirty-one college age women. They were to meet for three educational sessions over a three week period. This group met with the program developers. The intermediate program consisted of a community sample of thirty-five women between the ages of twenty-two and eighty-three years. They participated in a three hour program on osteoporosis. A panel of health professionals presented the educational content. Lastly, the brief program consisted of eighteen nurses who participated in a forty-five minute continuing education program. The majority of the nurses were between the ages of thirty-five and forty-five years. This program was conducted by the program developers.

Through utilization of the Osteoporosis Knowledge Test, Osteoporosis Health Belief Scale, and Osteoporosis Preventing Behaviors Survey, Sedlak, Doheny, and Jones (2000) provided a finding from all the programs is participants' knowledge increased concerning osteoporosis prevention. This is consistent with findings from Ailinger, Braun, Lasus, & Whitt (2005), where they found that individuals who had received previous information about osteoporosis had more knowledge. However, although participants knew more, this knowledge did not promise a change in health beliefs or behavior (Sedlak, Doheny, & Jones, 2000). This is consistent with physical activity literature. Most know that physical activity is beneficial to health, but few persons actually participate in physical activity (Marcus et al., 1992). Kasper, Peterson, & Allegrante (2001) also found similar information regarding knowledge and preventative behaviors. In their study, 325 college age women's knowledge about getting adequate calcium intake and physical activity for prevention of osteoporosis did not influence their exercise or calcium behaviors (Kasper, Peterson, & Allegrante, 2001).

In numerous studies, researchers have determined osteoporosis knowledge through the use of questionnaires. Ribeiro, Blakeley, & Laryea (2000) questioned 185 women who were members of church groups in Canada and discovered that even in well educated women, osteoporosis knowledge was deficient. Without knowledge these women will not be able to determine their risk of developing osteoporosis, request diagnostic tests, or take preventative actions toward warding off this disease. They also did not identify that osteoporosis starts well before menopause which may lead them to think that prevention does not need to take place until after menopause (Ribeiro, Blakeley, & Laryea, 2000). There was also inadequate knowledge of the use of hormone replacement therapy. Few participants knew the benefits or its risks and precautions. Knowledge in the area of prevention and treatment allows individuals to make informed choices regarding the use of medication or prompt treatment of potential side effects (Ribeiro, Blakeley, & Laryea, 2000).

Through utilization of the OKT, Martin et al. (2004) discovered similar findings concerning osteoporosis knowledge. In their research population, 107 adolescent girls in grades six through ten lacked knowledge of risk factors, calcium-rich foods, dietary calcium requirements, and the type of exercise needed to reduce the risk of osteoporosis. This population did correctly identify cheese and yogurt as good sources of dietary calcium but were not able to identify dietary sources of calcium when the choices did not include an obvious dietary source.

For example, when given the choice between watermelon, corn, and canned sardines, the majority chose corn (33%), 18% chose watermelon, and only 15% chose canned sardines.

Ailinger, Braun, Lasus, & Whitt (2005) also found similar findings regarding osteoporosis knowledge. Ailinger and associates added the variable of ethnicity to their study. There were 255 respondents, all of which resided in an eastern university community. This study consisted of both genders, 215 women and 37 men. Sixty percent were white; 18% were African-American; 7% were Asian; and 5% were Hispanic. The majority of the respondents were premenopausal. In line with osteoporosis literature, this community had a knowledge deficit about osteoporosis. However, educational level was not correlated with osteoporosis knowledge. This is in contrast with Gemalmaz & Oge's (2008) findings where younger and better-educated women knew more about osteoporosis. Age was correlated with a higher knowledge score. This is attributed to the fact menopausal women had higher scores. Therefore, menopausal women had greater knowledge than premenopausal women (Ailinger, Braun, Lasus, & Whitt, 2005; Larkey, Hoelscher, Houtkooper, & Renger, 2003). However, Larkey, Hoelscher, Houtkooper, & Renger (2003) discovered that no matter which age, women seem to have misconceptions concerning forms of exercise and other prevention factors.

Another factor which correlated with knowledge was if the individual knew someone with osteoporosis. This indicates that exposure to a person with osteoporosis either motivates an individual to learn more about the disease or increases one's understanding of the problem (Ailinger, Braun, Lasus, & Whitt, 2005). In contrast to these findings, Chang (2007) found that individuals with a first degree relative with osteoporosis did not contain more osteoporosis knowledge. They were aware of some osteoporosis related information but did not take part in actual preventive behaviors (Chang, 2007). Yood et al. (2008) found that patients who were told they had osteoporosis and started treatment scored higher on questions testing knowledge, but this difference was modest. In a study conducted by Gemalmaz and Oge (2008), women who reported having osteoporosis did not have a better knowledge than those who did not report having osteoporosis.

Kasper, Peterson, and Allegrante (2001) conducted research on 325 women enrolled in college classes at Valdosta State University. After administering a questionnaire, they discovered that this population was able to identify the risk factors of lack of physical activity and low calcium intake, but few were able to identify the risk factors of early menopause, post-menopause status, or menstrual irregularities. This study produced information concerning methods of learning which women prefer concerning osteoporosis knowledge. They found that women prefer handouts, brochures, magazine articles, and short five-minute counseling sessions during medical office visits. Ailinger, Braun, Lasus, and Whitt (2005) noticed similar findings concerning the method of acquiring osteoporosis knowledge. They found that community health nurses who distribute osteoporosis information would have a positive impact on knowledge. In a study of ethnically diverse college-aged women, no differences were found between those at high and low risk for developing osteoporosis and the information sources that they were most likely to use to learn about the disease (Kasper, Peterson, & Allegrante, 2001).

Osteoporosis knowledge has been assessed in various groups. In a community based study, limited knowledge about osteoporosis was discovered in African-American and Hispanic women (Geller & Derman, 2001). This follows the same patterns of knowledge and misperceptions in white women (Kasper, Peterson, & Allegrante, 2001; Larkey, Hoelscher, Houtkooper, & Renger, 2003). In another community based study, two hundred women of different ethnicities were questioned regarding their knowledge and behaviors related to osteoporosis. Hispanic women showed less knowledge concerning physical activity and eating meat but were more likely to agree that increased weight may protect against osteoporosis (Larkey, Hoelscher, Houtkooper, & Renger, 2003). Older men's knowledge of osteoporosis was assessed in a study of 138 men at community centers, and findings indicated that men had minimal knowledge of osteoporosis (Sedlak, Doheny, & Jones, 2000). Similarly, a study of 145 seniors found that men were not as knowledgeable about osteoporosis as women (Juby & Davis, 2001).

The national action plan for bone health is aimed at improving overall health and quality of life by enhancing the underlying bone health of all individuals, including women, men, racial and ethnic minorities, children, adolescents, and adults. Great improvements in bone health can be made by applying what is already known about early prevention, assessment, diagnosis, and treatment. Individuals can do a lot to promote their own bone health by choosing to engage in regular physical activity, follow a bone-healthy diet, and avoid behaviors that can damage bone. Health care professionals can play a significant role in supporting individuals in making these choices and identifying high risk individuals.

CHAPTER 3

METHODOLOGY

The purpose of this study was to assess osteoporosis knowledge, beliefs, and preventive behaviors among college students. In addition, this study examined perceived susceptibility, severity, benefits, barriers, and self-efficacy related to osteoporosis prevention.

The study was submitted to the Institutional Review Board of the University of Central Arkansas and the University of Alabama for review. Approval from both institutions was obtained prior to the start of data collection.

Survey Instruments

A questionnaire was developed by compiling several existing surveys, which was disseminated to college students. Permission to use the Osteoporosis Health Belief Scale (OHBS), Osteoporosis Knowledge Test (OKT), and Osteoporosis Self-Efficacy Scale (OSES) was obtained. The above instruments were chosen based on their record of use throughout the literature. The Osteoporosis Preventing Behaviors Survey (OPBS) was also utilized. It was selected because there is a limited amount of literature reviewing osteoporosis beliefs, knowledge, and self-efficacy with current preventative behaviors of populations. Refer to Appendix D for the complete detailed instrument.

Osteoporosis Health Belief Scale

The OHBS developed by Kim, Horan, & Gendler (1991) is a 42-item instrument consisting of seven subscales addressing health beliefs. The subscales address susceptibility, severity, benefits to exercise, benefits to calcium intake, barriers to exercise, barriers to calcium intake, and health motivation. Appendix A separates each question into the specific subscales.

Each item was rated by the subject using a 5 point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Agree or strongly agree are correct responses.

Scores had a possible range of 42 to 210 for the total health belief score and a possible range of 6 to 30 for each subscale score. Preliminary testing of women revealed the test-retest reliability for the total instrument as 0.90 and the subscale test-retest reliabilities ranged from 0.52 to 0.84 (Kim, Horan, & Gendler, 1991). Concurrent validity was established through assessment of calcium and exercise behaviors along with the Health Belief Model (HBM) instrument.

Osteoporosis Knowledge Test

The OKT also developed by Kim, Horan, & Gendler (1991) is a twenty-four item tool consisting of two subscales addressing exercise (16 items) and calcium intake (17 items). One question addressing exercise is "how many days a week do you think a person should exercise to strengthen the bones?" One question addressing calcium is "how much milk must an adult drink to meet the recommended amount of calcium?" The OKT calcium and OKT exercise subscales both share 9 common items which are knowledge of overall osteoporosis risk factors. Each item is rated by the subject using ML = more likely, LL = less likely, NT = neutral, and DK = don't know. Scores for OKT exercise had a possible range of 0 to 16, and scores for OKT calcium had a possible range of 0 to 17. For items 1-9, responses 'neutral' and 'don't know' are incorrect. For items 10-24, 'don't know' is considered incorrect. Through preliminary testing of the instrument on a sample population of women, the test-retest reliability coefficient for OKT calcium was 0.72 and OKT exercise was 0.69 (Kim, Horan, & Gendler, 1991).

Osteoporosis Self-Efficacy Scale

The OSES also developed by Kim, Horan, and Gendler (1991) utilized a 12-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 6 items. A question related to the self-efficacy of exercise is their confidence in changing exercise habits. The self-efficacy for calcium intake was determined using 6 items. A question related to self-efficacy of calcium is their confidence in increasing their calcium intake. Kim, Horan, & Gendler (OSES, 1991) 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. Due to the possible confusing nature of this format, the responses were modified for this study to SD = strongly disagree, D = disagree, N = neutral, A = agree, and SA = strongly agree. The questions remained the same. Previous research demonstrated test-retest reliability coefficients of both subscales at 0.90 (Kim, Horan, & Gendler, 1991).

Osteoporosis Preventing Behaviors Survey

The Osteoporosis Preventing Behaviors Survey (OPBS) (Doheny & Sedlak, 1995) is a 39-item self-report descriptive survey that addresses osteoporosis preventing behaviors involving the categories of activities/exercise, dietary intake of calcium, and other risk factors (smoking, alcohol use, use of hormonal therapy, use of non-hormonal therapy and other medications that affect bone density) and included other demographic items. The instrument was modified from the 39-item survey to an 8-item survey to include specific items related to college students and to eliminate items which do not relate to college age students such as questions related to menopause.

Questions related to calcium intake include 4 items. Each item in questions 1-3 is rated by the subject by using 1 = none per week, 2 = one per week, 3 = two per week, 4 = three per week, 5 = four per week, 6 = five per week, 7 = six per week, 8 = one per day, 9 = two per day, 10 = three per day. Question 4 is rated as 1 = no and 2 = yes to answer the question of intake of a calcium supplement. For analysis of the behavior calcium intake, three groupings were established (Sizer & Whitney, 2008). Less than four servings a week fell into the inadequate intake group. Five servings a week to one serving a day fell into the moderate intake group. Two to three servings a day fell into the adequate intake group.

Questions 5 and 6 relate to activity/exercise. These questions are rated by the subject using 1 = less than 10 minutes per week; 2 = 10 to 15 minutes, 1 to 2 times per week; 3 = 10 to 15 minutes, 3 to 4 times per week; 4 = 10 to 15 minutes, 5 to 7 times per week; 5 = 20 to 30 minutes, 1 to 2 times per week; 6 = 20 to 30 minutes, 3 to 4 times per week; 7 = 20 to 30 minutes, 5 to 7 minutes per week; 8 = more than 30 minutes per day. Questions 7 through 10 include information on gender, ethnicity, family history, and age.

Also included in the OPBS is a physical activity seven day recall (7dPAR) instrument. The 7dPAR is one of the most widely used physical activity assessments. The popularity of this measure stems largely from its versatility and relative ease of use. The 7dPAR provides details regarding the duration and intensity of physical activity and can therefore be used for a variety of applications. Because it utilizes a one-week time frame, data from the 7dPAR are often considered representative of typical activity patterns (Blair et al., 1998; Dunn et al., 1997, Sallis et al., 1985). The reliability of the 7dPAR was determined by using Pearson correlation coefficient. Sallis et al. (1985) determined the reliability to be .67. The compendium of physical activities (Ainsworth et al., 2000) was used to code each recorded activity for analysis. The compendium provides a coding scheme that links a 5-digit code, representing the specific activities performed with their respective metabolic equivalent (MET) intensity levels. A MET is considered a resting metabolic rate obtained during quiet sitting and is a commonly used method for capturing intensity. The 7dPAR was analyzed by computing the weekly MET/minute for each participant. The 7dPAR of each subject was analyzed by the researcher. Each activity was found on the compendium and assigned a MET value. The researcher took the MET value and multiplied it by the total number of minutes the subject participated in that activity. This process was completed for every activity listed per day. To determine the weekly MET/minute, the totals for each day were added together. The 7dPAR holds a test-retest reliability of .90 (Morrow, Jackson, Disch, & Mood, 2005).

Study Setting

This study was conducted at the University of Central Arkansas (UCA) in Conway, Arkansas. UCA is the second-largest university in Arkansas, with approximately thirteen thousand students enrolled. The Health Education degree program is housed in the College and has one hundred majors. Through the general education classes and major classes offered, approximately 1,340 students were anticipated to be enrolled in the spring 2009 semester.

Study Design

The study used a cross-sectional survey design. Enrolled college students from the Health Science Department of the University of Central Arkansas in February 2009 were sampled. Convenience sampling was employed in the recruitment of participants.

Subject Enrollment

The study population was limited to college students. Students are defined as any person enrolled in a class in the Health Science Department at UCA. Students enrolled in sixteen courses ranging from entry level to upper division were surveyed. The researcher contacted the instructors of these classes and obtained permission to survey students during class time. The researcher organized a schedule for entering each class in the Spring semester of 2009.

When the researcher entered each class, she disseminated the survey and provided instructions per the script (See Appendix C). Topics emphasized were the purpose, volunteer nature, instructions not to include their name, and instructions for completing the survey. A copy of the complete survey is found in Appendix D. The survey took twenty to thirty minutes to complete. If a student was in more than one class, he/she will complete the survey only once. This was determined beforehand by reviewing a roster for each class and verifying which students were enrolled in more than one class.

Approximately thirty students were enrolled in each health science course in the spring 2009 semester. All sections of the sixteen health courses completed the surveys. All eligible students were approached during the selected time period and asked to participate. If students were enrolled in numerous health education classes, they were considered ineligible after completion of the survey in the first class. Ineligible students for each class were identified beforehand by the researcher through a class roster for each class available on URSA or through the instructor. Therefore, a total of 792 participants were included in this study. Originally, 825 questionnaires were completed; however, due to incompletion of the demographic section 33 questionnaires were eliminated. Therefore, there was a 96% completion rate.

Data Entry

After completion of administration of the questionnaire to subjects, the primary researcher entered all data in an excel file. A research assistant verbally stated the responses to improve accuracy. Validation checks were conducted every tenth subject. Next, data was converted to an SPSS file. Missing data was coded as 99. Next, variables were coded with a numerical code. A test for outliers was also conducted. Three extreme outliers were discovered and were recoded.

Data Management

All data entry and analysis was conducted using the Statistical Package for the Social Sciences version 15.0 for Windows (SPSS Inc., 2006). Electronic data files were stored on a drive that resided on a secure server at the University of Central Arkansas and hardcopy completed surveys were stored in a locking file cabinet in a secured office. All completed questionnaires were shredded and destroyed at the conclusion of this study per IRB recommendations.

Data Analyses

Descriptive statistics were generated on all variables. Correlations were used to determine the degree of relationship between variables. To display the relationship between two variables scatter plots are provided (See Appendix E). The scatter diagram plots the value of each pair of bivariate observations at the point of the vertical line through the X value on the abscissa and of the horizontal line through the Y value on the ordinate (Kuzma & Bohnenblust, 2001). From the scatter plot, one is able to determine if there is a positive relationship or negative relationship between variables (Trochim, 2006).

The strength of the correlation is another important item to examine between variables. The correlation coefficient is a measure of the strength of the linear association between two variables. It may take on values between -1 and +1. A correlation coefficient of zero symbolizes no relationship between variables. The closer the coefficient comes to either +1 or -1, the stronger the relationship and the more closely it resembles a straight line (Kuzma & Bohnenblust, 2001).

The correlation assumptions are as follows: 1) for each value of X there is a normally distributed subpopulation of Y values; 2) for each value of Y there is a normally distributed subpopulation of X values; 3) the joint distribution of X and Y is a normal distribution called the bivariate normal distribution; 4) the subpopulations of Y values all have the same variance; and 5) the subpopulations of X values all have the same variance (Daniel, 1999).

If the values were normally distributed, the Pearson correlation technique was to be utilized. This technique is useful to determine the relationship between two or more variables. If the values are not normally distributed, the Spearman rank-order correlation technique was utilized. The Pearson correlation technique is preferable to the Spearman correlation techniques because the power of Pearson is greater than that of the Spearman (Kuzma & Bohnenblust, 2001).

If n is small, it leads to a question in reliability of the correlation. When plotting a scatter plot, the researcher checked to see if there were outliers. Outliers may suggest erroneous data and could give misleading results. The most important problem of correlations is that a high correlation can easily be taken to imply a cause and effect relationship when using cross-sectional data. This procedure does not determine cause and effect relationships (Kuzma & Bohnenblust, 2001).

The following are the research questions which were tested using a correlation analysis.

- What is the correlation between calcium intake and physical activity?
- What is the correlation between osteoporosis knowledge and calcium intake?
- What is the correlation between osteoporosis knowledge and physical activity?

- What is the correlation between osteoporosis attitudes and calcium intake?
- What is the correlation between osteoporosis attitudes and physical activity?

Linear regression is a prediction equation that estimates the value of Y for any given X. It uses means to describe a linear relationship between two variables. The multiple linear regression models assume there is a linear relationship between the dependent variable and multiple independent variables. The assumptions of multiple regression analysis are as follows: 1) the independent variables are nonrandom, fixed variables; 2) for each set of independent variable values there is a subpopulation of dependent values; 3) the variances of the subpopulations of the dependent variables are all equal; 4) normality (Daniel, 1999). The purpose of this regression is to examine the variables that are significant in the bivariate correlation analysis and enter them into a regression model to see what combinations of variables are significant. The benefit is obtaining and predicting of variables rather than determining only relationships between variables and to observe the combinations of variables.

The dependent variables for the multiple regression analysis are calcium intake and physical activity. The independent variables are osteoporosis knowledge, attitudes, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, gender, ethnicity, family history, age, calcium intake, and physical activity.

The following are the research questions which were tested using a multivariate multiple regression analysis.

- Are the individual HBM constructs significant predictors of calcium intake?
- Are the individual HBM constructs significant predictors of physical activity?

After determining which independent variables were significant, a multiple regression analysis was completed. Multicolinearity of each independent variable was assessed. To determine reliability, Cronbach alpha was utilized. Cronbach alpha is a useful and flexible tool that can be used to investigate the reliability of test results. Reliability is an estimate of the consistency of a set of items when they are administered to a particular group of students at a specific time under particular conditions for a specific purpose. Cronbach alpha is used to estimate the proportion of variance that is systematic or consistent in a set of test scores (Pallant, 2007). A reliability coefficient of .70 or higher is considered acceptable in most social science research situations (Daniel, 1999).

CHAPTER 4

RESULTS

The purpose of this study was to determine the level of osteoporosis knowledge, beliefs, and behavior among college students. In addition, this study examined the constructs of the Health Belief Model (HBM), perceived susceptibility, severity, benefits, barriers, and health motivation, related to osteoporosis prevention.

This chapter includes a description of the study sample, descriptive statistics of the study variables, Spearman's correlations of the dependent variable calcium intake and physical activity with osteoporosis knowledge and health beliefs, and hierarchical regression of both calcium intake and physical activity.

Study Sample

A response rate of 96 % was obtained. This study included 792 men and women who attended a course in the Health Science department during the spring 2009 semester at the University of Central Arkansas. Originally, the questionnaire was given to 825 students; however, 33 were eliminated due to incompletion of the demographic questions. The majority of the sample were nineteen to twenty-one years of age (58.5%), and the study sample was comprised of more female (57.3%) than male students and more white (64.5%) than any other ethnicity. This is consistent with the overall UCA population which is comprised of 57% women and 42% men. The ethnicity breakdown of UCA is 71% white, 16.5% African American, and the remaining 12.5% would fall into the other category. Table 4.1 presents the demographics of the sample.

Table 4.1

Demographics of the Study Sample (n=792).

Demographic		n (%)
Age (years)		
	16-18	121 (15.3%)
	19-21	463 (58.5%)
	22-24	152 (19.2%)
	25-27	24 (3%)
	28-30	13 (1.6)
	31 or over	19 (2.4%)
Gender		
	Male	338 (42.7%)
	Female	454 (57.3%)
Ethnicity		
	White	511 (64.5%)
	African American	209 (26.4%)
	Hispanic American	16 (2%)
	Other	56 (7%)

Osteoporosis Health Belief Scale

Table 4.2 presents the response results to each statement comprising the Osteoporosis Health Belief Scale. The answers provided by the highest proportion of respondents are bolded for each of the statements.

Overall, participants did not perceive themselves to be susceptible to osteoporosis and strongly disagreed with the statement “family history makes it more likely” (35.4 %). However, they found themselves neutral to the statement “your chances of getting osteoporosis are high” (31.2 %).

Approximately 45% (45.3) agreed that it would be very serious to get osteoporosis, 35.5% also agreed with the statement “osteoporosis would be very costly”, and 33.5% agreed with the statement “the thought of having osteoporosis scares them”. However, participants did not agree with the statement “osteoporosis would be crippling” (36.1 %) and did not agree with the statement “I get depressed when thinking of osteoporosis” (31.8 %).

All participants indicated agreement with statements of exercise and calcium intake as protective toward osteoporosis, and students disagreed with statements designed to assess perceived barriers to physical activity or calcium intake. The participants were neutral (39.0 %) on the barrier statement “calcium rich foods have too much cholesterol.”

Although many participants disagreed with the statement “you have a regular health check-up” (29.2 %), overall there was agreement with statements designed to assess health motivation.

Table 4.2

Osteoporosis Health Belief Scale: Response by Subscale Category (n=792).

Statement	Level of Agreement				
Susceptibility	SD	D	N	A	SA
Your chances of getting osteoporosis are high	22.6%	28.2%	31.2%	14.4%	3.4%
You are more likely to develop osteoporosis	23.7%	33.7%	27.5%	12.9%	2.1%
Extremely likely you will get osteoporosis	30.3%	32.2%	28.5%	6.9%	2.0%
Good chance you will get osteoporosis	23.9%	33.2%	28.3%	12.5%	2.1%
More likely than average to get osteoporosis	30.1%	36.2%	21.2%	10.2%	2%
Family history makes it more likely	35.4%	34.1%	18.9%	9.8%	1.8%
Seriousness					
Thought of having osteoporosis scares you	13.9%	18.6%	21.5%	33.5%	12.5%
Osteoporosis would be crippling	20.2%	36.1%	25.9%	14.4%	3.0%
Feelings about yourself would change	18.4%	26.1%	22.9%	27.8%	4.5%
Very costly if you got osteoporosis	8.6%	16.0%	28.7%	35.5%	11.2%
You get depressed thinking about osteoporosis	31.8%	29.3%	23.0%	11.7%	4.2%
Very serious if you got osteoporosis	7.3%	12.9%	16.8%	45.3%	17.4%
Benefits Exercise					
Exercise prevents problems from osteoporosis	4.7%	7.8%	14.3%	45.8%	27.1%
Feel better when you exercise to prevent	5.6%	5.8%	23.0%	41.7%	24.0%
Exercise helps build strong bones	4.9%	6.2%	7.4%	43.1%	38.4%
Exercise improves way your body looks	6.1%	4.9%	9.8%	38.5%	40.4%
Exercise cuts down on chances of broken bones	4.9%	9.2%	14.8%	44.8%	26.3%
You feel good about self when you exercise	4.2%	5.6%	20.8%	41.4%	27.9%
Benefits of Calcium Intake					
Calcium prevents problems from osteoporosis	3.9%	9.1%	17.0%	47.3%	22.6%
Lots to gain from taking calcium	4.7%	6.3%	16.8%	47.9%	24.2%
Calcium prevents painful osteoporosis	4.5%	7.6%	24.6%	45.5%	17.8%
You would not worry if you took calcium	4.2%	11.1%	25.8%	43.6%	15.4%
Calcium reduces your chance of broken bones	3.5%	6.8%	15.2%	51.5%	22.9%
You feel good when you take calcium	4.4%	6.8%	25.8%	44.7%	18.2%

Barrier Exercise					
Not strong enough to exercise	40.3%	28.7%	10.6%	12.2%	8.2%
No place where you can exercise	59.5%	25.6%	7.1%	5.7%	2.1%
Family discourages you from exercising	65.9%	18.4%	7.4%	5.9%	2.1%
Starting new habit hard for you to do	35.5%	25.9%	15.8%	18.6%	4.2%
Exercising makes you uncomfortable	45.6%	31.7%	14.6%	6.2%	1.8%
Exercising upsets your daily routine	40.0%	29.4%	12.9%	15.3%	2.3%
Barriers Calcium Intake					
Calcium rich foods cost too much	29.7%	34.1%	23.9%	9.3%	3.0%
Calcium rich foods do not agree with you	37.6%	33.7%	17.4%	8.7%	2.5%
You do not like calcium rich foods	40.5%	33.7%	16.2%	7.8%	1.8%
Changing your diet is hard for you to do	30.2%	36.6%	19.2%	11.5%	2.4%
You give up other foods you like	26.5%	36.2%	18.4%	16.7%	2.0%
Calcium rich foods have too much cholesterol	17.6%	33.2%	39.0%	7.8%	2.1%
Health Motivation					
You eat a well-balance diet	9.8%	23.7%	28.8%	30.2%	7.4%
You look for new health information	8.8%	18.8%	29.9%	33.8%	8.6%
Keeping healthy is important to you	4.2%	6.9%	15.4%	49.9%	23.5%
You try to discover health problems early	4.2%	8.7%	27.3%	45.3%	14.5%
You have a regular check-up	12.2%	29.2%	26.3%	23.1%	9.2%
You follow recommendations to keep healthy	5.7%	9.7%	31.4%	42.4%	10.7%

Note: Most frequent responses are bolded.

Since this study was examining each separate construct, the six questions per construct were computed into a new variable named for each construct. Table 4.3 presents the mean and standard deviation for each health belief construct.

For the construct of perceived susceptibility, the possible score is 6-30 with a greater number representing greater susceptibility for osteoporosis. The sample had a mean of 13.64 and standard deviation of 5.09 for the construct susceptibility which indicates low perceived susceptibility for osteoporosis.

For the construct of perceived seriousness, the possible score is 6-30 with a greater number representing a perception of osteoporosis being serious. The sample had a mean of 17.34 and standard deviation of 4.37 for the construct seriousness, which indicates a view of osteoporosis as moderately serious.

For the construct of perceived benefits for both physical activity and calcium intake, the possible score is 6-30, with a greater number representing a positive view of exercise and calcium intake. The mean for the construct perceived benefits of physical activity was 23.23 with a standard deviation of 5.33. The mean for perceived benefits of calcium intake was 22.26 with a standard deviation of 4.61. These scores represent a positive view of both constructs.

For both perceived barriers to physical activity and calcium intake, the possible score is 6-30 with a higher number representing fewer barriers. The mean for perceived barriers to physical activity is 24.27 (standard deviation of 4.62). The mean for perceived barriers to calcium intake is 22.83 (standard deviation of 4.57). These scores show that participants had few reported barriers to either physical activity or calcium intake.

The last construct of the Health Belief Model was perceived health motivation. The possible score is 6-30 with a higher number representing higher motivation for health. The mean is 19.87 with a standard deviation of 4.34 which indicates a positive motivation for health just above the mean.

Table 4.3

Osteoporosis Health Belief Scale-Total constructs (n=792).

Constructs	Mean (SD) Possible score 6-30	Interpretation related to osteoporosis
Perceived Susceptibility	13.64 (± 5.09)	Low perceived susceptibility
Perceived Severity	17.34 (± 4.37)	Moderate perceived seriousness
Perceived Benefits of Exercise	23.23 (± 5.33)	High perceived benefits
Perceived Benefits of Calcium Intake	22.26 (± 4.61)	High perceived benefits
Perceived Barriers to Exercise	24.27 (±4.62)	Low perceived barriers
Perceived Barriers to Calcium Intake	22.82 (± 4.57)	Low perceived barriers
Perceived Health Motivation	19.87 (± 4.34)	Positive view of health

Osteoporosis Knowledge Test

Table 4.4 presents the responses by category for osteoporosis knowledge. The correct response to each question is in parentheses. For the nine items listed, the participant was to decide if the statement would affect a person's chance of becoming at risk for osteoporosis.

Most participants incorrectly thought neither having ovaries surgically removed (34.4 %) nor being a white woman with fair skin (38.4 %) increased the risk of acquiring osteoporosis. They also did not view having big bones (38.9 %) as being a protective factor to osteoporosis.

Table 4.4

Osteoporosis Knowledge Test (n=792).

Statement	More likely	Neutral	Least Likely	Don't Know
Eating a diet low in milk products	**(76.1%)**	8.1%	11.9%	3.7%
Being menopausal	**(48.4%)**	24.4%	10.1%	16.2%
Having big bones	9.5%	**38.9%**	(32.8%)	17.6%
Diet high in leafy vegetables	6.3%	23.5%	**(53.3%)**	15.8%
Relative with osteoporosis	**(69.3%)**	10.9%	10.4%	8.7%
White woman with fair skin	(22.2%)	**38.4%**	14.6%	23.0%
Ovaries surgically removed	(15.2%)	**34.3%**	15.7%	32.7%
Taking cortisone	**(47.0%)**	9.0%	15.4%	26.8%
Exercising on a regular basis	10.2%	11.4%	**(72.0%)**	5.8%

Note: Correct responses are in parentheses. Most frequent responses are bolded.
Note: Responses for each statement are based on the potential of becoming at risk for osteoporosis.
Note: Not all statements may equal 100% due to missing data.

Table 4.5 presents the responses for osteoporosis knowledge of physical activity and calcium intake. The correct response to each question is in parentheses. Correctly, participants identified jogging/running for exercise (76.8 %) and aerobic dancing (77.4 %) as physical activity which reduces chances of osteoporosis. Incorrectly, a majority of participants identified swimming (50.8 %) as being a protective factor for osteoporosis.

Correctly, the participants thought it will take three or more days of physical activity a week (80.3 %) and a minimum of twenty to thirty minutes (75.9 %) a day of physical activity to protect against osteoporosis.

In regards to foods which are good sources of calcium, the participants correctly recognized cheese (89.0 %), broccoli (50.8 %), yogurt (87.1 %), and ice cream (66.2 %). As stated above, participants correctly identified traditional sources of calcium; however, they were not able to recognize alternate sources of calcium such as canned sardines (23.5%).

Participants knew the recommended amount of milk is two or more glasses daily (45.6 %). However, they incorrectly identified the recommended amount of calcium intake for adults as 400mg-600mg daily (39.8%). Eleven percent recognized the correct amount of calcium needed by adults as 800mg or more a day.

Table 4.5

Osteoporosis Knowledge Test: Risk Factors (n=792).

Risk Factors			
Exercises			
DK 12.8%	Swimming 50.8%	Kitchen Chores 1.9%	(Brisk Walk 34.1%)
DK 13.9%	(Biking 42.4%)	Yoga 40.3%	Housecleaning 3.4%
DK 11.4%	(Jog/run 76.8%)	Golf w/cart 4.2%	Gardening 7.6%
DK 10.6%	Bowling 4.2%	Doing laundry 7.7%	(Aerobic dance 77.4%)
Days a week to exercise			
DK 2.8%	1/week 1.5%	2/week 15.4%	(3 or more/week 80.3%)
Least time to exercise			
DK 5.3%	< 15 min 12.6%	(20-30 min 75.9%)	> 45 min 6.1%
Source of calcium			
DK 2.7%	Apple 5.6%	(Cheese 89.0%)	Cucumber 2.8%
DK 34.1%	Watermelon12.2%	Corn 30.1%	(Canned Sardines 23.5%)
DK 22.1%	Chicken 19.8%	(Broccoli 50.8%)	Grapes 7.3%
DK 3.2%	(Yogurt 87.1%)	Strawberries 4.7%	Cabbage 5.1%
DK 10.2%	(Ice cream 66.2%)	Grape fruit 16.0%	Radishes 7.6%
Rec. calcium DK 35.9%	100mg-300mg 12.4%	400mg-600mg 39.8%	(> 800mg/day 11.7%)
Rec. milk DK 9.3%	½ glass/day 3.7%	1 glass/day 41.4%	(> 2 glasses/day 45.6%)

Note: Correct responses are in parentheses. Most frequent responses are bolded.

Osteoporosis Self-Efficacy Scale

Table 4.6 presents the response results to each statement comprising the Osteoporosis Self-Efficacy Scale. The answers provided by the highest proportion of respondents are bolded for each of the statements.

Participants expressed a high self-efficacy for both exercise experiences and calcium intake experiences. Their confidence for performing all listed behaviors was high. However, a greater number of participants expressed a low confidence (SD or D) with the exercise experiences, and a slightly higher confidence was reported for the calcium experiences.

Table 4.6

Osteoporosis Self-Efficacy Scale (n=792).

Experiences	SD	D	N	A	SA
New exercise program	6.1%	9.5%	16.3%	**43.7%**	24.4%
Change exercise habits	5.3%	10.1%	16.1%	**47.8%**	20.6%
Effort required to exercise	4.0%	6.4%	14.9%	**48.9%**	25.7%
Do difficult exercises	5.6%	8.0%	15.6%	**45.8%**	25.1%
Exercise for appropriate time	5.2%	7.8%	13.7%	**48.5%**	24.8%
Do type of exercise	4.9%	7.0%	13.1%	**48.3%**	26.7%
Increase calcium intake	2.9%	6.4%	15.9%	**52.6%**	22.2%
Include more calcium foods	3.7%	7.5%	17.3%	**51.8%**	19.7%
Eat rec. calcium foods	2.8%	8.1%	21.2%	**48.5%**	19.3%
Select calcium foods	2.9%	7.4%	17.2%	**53.2%**	19.2%
Stick to calcium diet	3.2%	8.0%	22.3%	**48.4%**	18.0%
Obtain calcium foods	3.6%	7.3%	14.9%	**54.1%**	20.1%

Note: Most frequent responses are bolded.

Osteoporosis Preventing Behaviors Survey

Table 4.7 represents the students' current calcium intake behaviors. The responses were divided into three categories: inadequate, moderate, and adequate. Inadequate represents a response of zero to four servings of calcium a week. Moderate represents a response of five servings of calcium a week to one serving of calcium a day. Adequate represents a response of two servings to three servings of calcium a day. The answers provided by the highest proportion of respondents are bolded for each of the statements.

Sixty-two percent of participants consumed inadequate amounts of milk and only 13% consumed an adequate amount of milk to meet calcium standards. Over 90% did not consume adequate amounts of yogurt. Cheese was the most popular source of calcium with 14% consuming adequate amounts. However, over 50% still did not consume enough cheese to meet recommendations for calcium intake. Approximately 10% of participants took a calcium supplement.

Table 4.7

Osteoporosis Preventing Behaviors Survey (n=792).

Behavior		Percent
Glasses of milk		
	Inadequate	**62.5%**
	Moderate	24.1%
	Adequate	13.1%
Eight-ounce servings of yogurt	Inadequate	**94.0%**
	Moderate	4.5%
	Adequate	1.4%
Servings of cheese	Inadequate	**56.0%**
	Moderate	29.5%
	Adequate	14.2%
Calcium Supplement	No	**89.3%**
	Yes	10.7%

Note: Inadequate = Less than 4 servings of calcium a week. Moderate = 5 servings of calcium a week to 1 serving a day. Adequate = 2 servings of calcium a day to 3 servings a day.
Note: Most frequent responses are bolded.

Table 4.8 represents the participants' physical activity behavior. The answers provided by the highest proportion of respondents are bolded for each of the statements. Twenty-three percent of the population took part in weight bearing physical activity twenty to thirty minutes, three to four times per week. However, 13% participated in less than ten minutes of weight bearing physical activity per week. More than 50% participated in less than ten minutes of non-weight bearing physical activity per week with only 14.8 % participating in non-weight bearing physical activity ten to fifteen minutes, one to two times per week.

Table 4.8

Osteoporosis Physical Activity Behaviors Survey (n=792).

Physical Activity		Percent
Weight Bearing	<10 min/week	13.3%
	10-15 min, 1-2 times/week	13.3%
	10-15 min, 3-4 times/week	8.6%
	10-15 min, 5-7 times/week	4.0%
	20-30 min, 1-2 times/week	12.2%
	20-30 min, 3-4 times/week	**23.4%**
	20-30 min, 5-7 times/week	9.6%
	>30 min/day	15.7%
Non-Weight Bearing	<10 min/week	**57.7%**
	10-15 min, 1-2 times/week	14.8%
	10-15 min, 3-4 times/week	4.8%
	10-15 min, 5-7 times/week	2.0%
	20-30 min, 1-2 times/week	8.5%
	20-30 min, 3-4 times/week	6.2%
	20-30 min, 5-7 times/week	3.0%
	>30 min/day	3.0%

Note: Most frequent responses are bolded.

Assumptions

Figure 4.1 presents the normal distribution of the dependent variable calcium intake. Calcium intake met the following assumptions: normality, multicollinearity, and homoscedasticity. However, it was found to be non-linear.

Figure 4.2 presents the distribution of the dependent variable physical activity in weekly MET/minute. Physical activity met the following assumptions: multicollinearity and homoscedasticity. However, it was found to be non-linear. Normality was also not met. The physical activity data was then transformed by taking the square root of weekly MET/minute (Phelan, Roberts, Lang, & Wing, 2007) which enhanced normality of the data. Figure 4.3 presents the distribution of the dependent variable physical activity in weekly MET/minute squared. Normality was enhanced with this alteration; however, this variable is still considered to violate this assumption. Transformed physical activity data were used in all analyses for this study.

Figure 4.1

Distribution of Scores: Calcium Intake per Week (n=791).

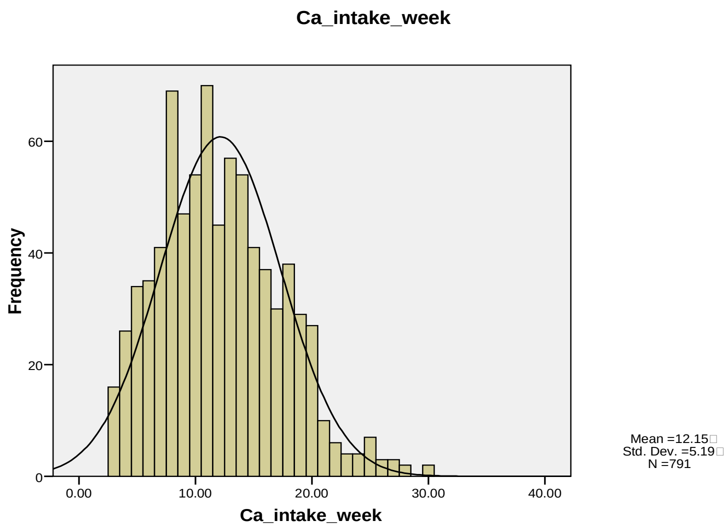


Figure 4.2

Distribution of Scores: MET minutes per Week

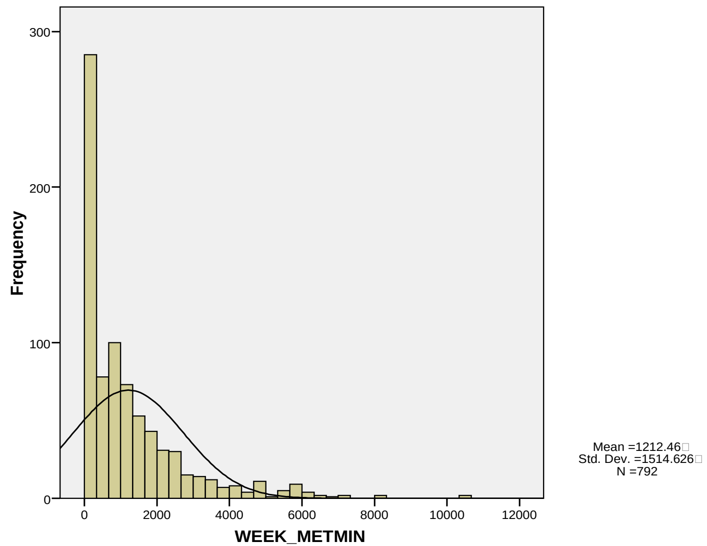
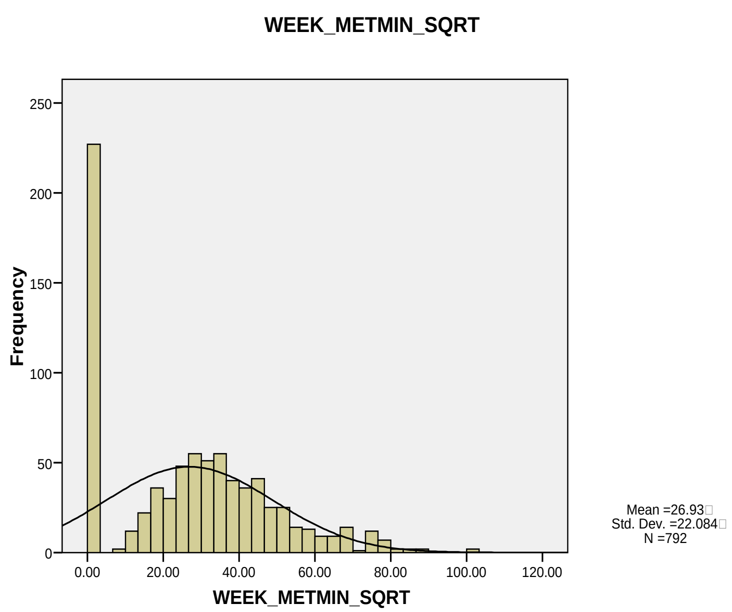


Figure 4.3

Distribution of Scores: Square Root of MET minutes per Week



Spearman's rho Correlation Matrix

The relationship between physical activity (as measured by calculating MET minutes/ week and taking the square root) and calcium intake (as measured by the Osteoporosis Behavior scale) was investigated using Spearman's rho correlation coefficient (Table 4.9). There was a small to moderate positive correlation between physical activity and perceived barriers to physical activity (r = .287, n = 788, p = .000), with high levels of physical activity associated with low perceived barriers to physical activity.

There was also a positive correlation between calcium intake and health motivation (r = .204, n = 790, p = .000), with high levels of calcium intake associated with a high motivation to health. Calcium intake was positively correlated with physical activity (r = .201, n = 791, p = .000), with high levels of calcium intake associated with high levels of physical activity.

Physical activity had a non-significant, low correlation to perceived benefits of physical activity (r = -.017, n = 787, p = .636). Physical activity also had a low correlation to age that did not reach statistical significance (r = -.028, n = 792, p = .433).

Calcium intake had a non-significant, low correlation to perceived barriers to physical activity (r = .041, n = 787, p = .217). However, calcium intake also had a low correlation to perceived benefits of calcium intake that did not reach statistical significance (r = .050, n = 788, p = .159).

Table 4.9

Spearman Correlation Matrix for Physical Activity and Calcium Intake

Variable	SQRT MET/MIN	Ca Intake
SQRT MET-MIN	1	.201**
Ca Intake	.201**	1
Age	-.028	.110**
HBM Total	.112**	.108**
Barriers to PA	.287**	.041
Barriers to Ca	.135**	.185**
Susceptibility	-.126**	-.055
Severity	-.063	-.055
Benefits of PA	-.017	.044
Benefits of Ca	.049	.050
Health Motivation	.164**	.204**
OKT Total	.052	.167**

Notes: ** $p < .01$ level (2-tailed); * $p < .05$ level (2-tailed).

Multiple Regression

Multiple regression was used to assess the ability of six independent variables (ethnicity, health motivation, age, perceived barriers to physical activity, perceived barriers to calcium intake, and physical activity) to predict calcium intake (Table 4.11). Preliminary analyses were conducted to ensure normality, multicollinearity, and homoscedasticity were not violated. However, as previously mentioned, calcium intake was not found to be linear.

After entry of the variables the total variance explained by the model was 12.2%, $p < .05$. In the final model, all predictors were statistically significant, with ethnicity recording a higher beta value ($\beta = -.173$, $p < .05$) than other variables.

Table 4.11

Summary of Multiple Regression Analysis for Variables Predicting Calcium Intake

Variable	B	SE B	β
Barriers/PA	-.193	.048	-.171*
Ethnicity	-1.069	.211	-.173*
MET-MIN	.038	.008	.162*
Barriers/Ca	.191	.046	.168*
Health Motivation	.186	.043	.154*
Age	.428	.183	.080*

Note: R Square = .122; *p < .05.

Multiple regression was used to assess the ability of five independent variables (gender, perceived barrier to physical activity, perceived benefits to physical activity, health motivation, and calcium intake) to predict physical activity (measured by the square root of MET minutes/week) (Table 4.12). Preliminary analyses were conducted to ensure multicollinearity and homoscedasticity were not violated. However, physical activity was not found to be linear or normally distributed.

After entry of the variables the total variance explained by the model was 15.5%, $p < .05$. In the final model, all predictors were statistically significant, with perceived barriers to physical activity recording a higher beta value ($\beta = .271$, $p < .05$) than other variables.

Table 4.12

Summary of Multiple Regression Analysis for Variables Predicting Physical Activity

Variable	B	SE B	β
Barriers/PA	1.297	.167	.271*
Benefits/PA	-.587	.150	-.142*
Health Motivation	.448	.186	.088*
Ca/Intake	.582	.144	.137*
Gender	-8.683	1.507	-.195*

Note: R Square = .155; *p < .05.

Measures of Internal Consistency

Internal consistency measures estimate how consistently individuals respond to the items within a scale. In social science research the cut-off is that alpha should be .70 or higher for a set of items to be considered a scale. The scales used and the associated reliability measures are presented in Table 4.12. All reliability coefficients are within the acceptable range except the osteoporosis knowledge test which yielded a coefficient of .69.

Table 4.12

Measures of Internal Consistency

	Cronbach's Alpha	Number of Items
Osteoporosis Knowledge	.69	24
Osteoporosis Health Belief		
Susceptibility	.90	6
Severity	.70	6
Benefits physical activity	.91	6
Benefits calcium intake	.86	6
Barriers physical activity	.78	6
Barriers calcium intake	.83	6
Health motivation	.77	6
Osteoporosis Self-Efficacy	.94	12

CHAPTER 5

DISCUSSION

The aim of this chapter was to identify and outline workable research problems from the data collected during this study, to evaluate why it is important to osteoporosis prevention, and to express the practical significance of what research need to be completed.

The purpose of the study was to determine the level of osteoporosis knowledge, beliefs, and behavior among college students. This study also examined the perceived susceptibility, severity, benefits, barriers, and self-efficacy related to osteoporosis prevention.

This chapter presents 1) a summary of the results, 2) conclusions based on the research objectives, 3) discussion, 4) implications, and 5) recommendations for future research.

Summary of the Results

Many studies linked with osteoporosis have spotlighted knowledge of and the health beliefs of individuals. The majority of studies observe white, pre and postmenopausal women, and few studies have examined men or multiple ethnicities.

Prevention is the most effective way to promote bone health. It is critically important to build and to maintain strong, healthy bones throughout life. To accomplish this, everyone should understand the basics of the prevention of osteoporosis. Two behaviors are essential in developing healthy bones: physical activity, specifically weight bearing activities, and calcium intake (USDHHS, 2004). Review of the literature exposed a consensus that most individuals are not engaging in preventative measures for osteoporosis.

Researchers are attempting to determine which variables lead some individuals to perform these behaviors and which variables hinder a person's performance. Knowledge of osteoporosis is limited in all populations, and even if an individual has knowledge of osteoporosis, it does not increase the likelihood he/she will engage in the preventative behaviors. Other important variables in possibly increasing behaviors that prevent osteoporosis are whether the person feels susceptible, whether the person feels osteoporosis is severe, the view of the benefits of physical activity and calcium intake, the view of the barriers of physical activity and calcium intake, and the motivation for positive health.

Of the 792 participants in the study, 459 (57.3%) were female, 511 (64.5%) were white, and 463 (58.5%) were between the ages of nineteen and twenty-one. The study sample was representative of students attending the University of Central Arkansas who took classes in the Health Science department.

The HBM proposes that if individuals are to take osteoporosis prevention measures, they must feel susceptible to osteoporosis, believe that occurrence of osteoporosis would have a severe impact on their lives, and conclude that preventive measures are beneficial, outweighing any barriers involved in taking the actions (Rosenstock, 1974). Participants in this study did not feel susceptible to osteoporosis, and according to the HBM, they will not take preventative measures to ward off the disease. Questions examining the construct of perceived severity were answered with mixed results. Overall, they did not believe that osteoporosis would significantly affect their lives. In this study, the benefits of physical activity and calcium intake did outweigh the barriers. The study population had positive views of both physical activity and calcium intake and reported few barriers to both activities.

Lack of osteoporosis knowledge is well documented among both genders and different ethnicities. Prevention and treatment in controlling osteoporosis are effective; however, unless individuals are familiar with them and are able to make informed choices regarding available treatments, those measures are useless. Kasper, Peterson, & Allegrante (2001) reported knowledge concerning the risk of a lack of physical activity and low calcium intake. They also determined the inability to identify risk factors of skipped menstrual periods and postmenopausal status (Kasper, Peterson, & Allegrante, 2001). This study produced similar results. The majority of participants were able to identify risks of a lack of physical activity and low calcium intake but were unable to identify the risks inherent in white women, the risks that come with the removal of ovaries, and the benefits to big-boned individuals.

Participants in the study seemed to possess knowledge that calcium plays a role in keeping bones strong. However, they were unable to correctly identify the recommended amount of calcium for adults. They were also unable to identify alternate sources of calcium.

Regarding the role of physical activity in bone health, the participants of this study seemed to lack the understanding that weight bearing physical activity was the only type that has a positive influence on skeletal health. Fifty percent of participants identified swimming as having a positive affect on bone health. They were able to correctly identify biking, jogging, and aerobic dance as most beneficial to bone health. However, these choices may be due to the fact they were the highest intensity of the answer choices, which may have led more respondents to choose these answers when in actuality they did not choose them for their weight bearing qualities.

Participants in this study consumed inadequate amounts of calcium per day. Sixty-two percent did not consume adequate milk, 94% did not consume adequate yogurt, and 56% did not consume adequate servings of cheese to meet the recommended calcium intake. Most did not take a calcium supplement.

Weight bearing physical activity is very important to bone health. In this study, 23% reported participation in twenty to thirty minutes of weight bearing physical activity, three to four times per week. This amount of weight bearing physical activity falls into the appropriate recommendation. However, 57% participated in less than ten minutes per week of non-weight bearing activity.

Conclusions Based on the Research Questions

The questions assessed through data collection and analysis and how the independent variables were associated with each of the dependent variables were evaluated and described according to each of the eight research questions for the study.

1. What is the correlation between calcium intake and physical activity?

The Spearman correlation was small but significant between calcium intake and physical activity as $\rho = .201$ ($p < .01$). Therefore, higher levels of calcium intake are associated with higher levels of physical activity. After calculating the coefficient of determination, .201 x .201 = .04, it can be determined that 4% of the variance is shared between these two variables.

2. What is the correlation between osteoporosis knowledge and calcium intake?

The Spearman correlation was small but significant between osteoporosis knowledge and calcium intake as $\rho = .167$ ($p < .01$). Therefore, higher levels of osteoporosis knowledge are associated with higher levels of calcium intake. After calculating the coefficient of determination, .167 x .167 = .028, it can be determined that 2.8% of the variance is shared between these two variables.

3. What is the correlation between osteoporosis knowledge and physical activity?

The Spearman correlation between osteoporosis knowledge and physical activity was ρ = .052 and was not significant ($p = .142$). After calculating the coefficient of determination, .052 x .052 = .002, it can be determined that .2% of the variance is shared between these two variables.

4. What is the correlation between osteoporosis attitudes and calcium intake?

The Spearman correlation was small but significant between attitudes and calcium intake as $\rho = .108$ ($p < .01$). Therefore, a positive attitude is associated with higher levels of calcium intake. After calculating the coefficient of determination, .108 x .108 = .012, it can be determined that 1.2% of the variance is shared between these two variables.

5. What is the correlation between osteoporosis attitudes and physical activity?

The Spearman correlation was small but significant between attitudes and physical activity as $\rho = .112$ ($p < .01$). Therefore, a positive attitude is associated with higher levels of physical activity. After calculating the coefficient of determination, .112 x .112 = .013, it can be determined that 1.3% of the variance is shared between these two variables.

6. What is the correlation between the HBM constructs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and health motivation) and calcium intake?

The Spearman correlation was a negative correlation between perceived susceptibility and calcium intake as $\rho = -.055$ and not significant ($p > .05$). There was a negative correlation between perceived severity and calcium intake as $\rho = -.055$, and it was not significant ($p > .05$). There was a small but significant correlation of $\rho = .185$ between perceived barriers to calcium intake and calcium intake ($p < .01$). Therefore, low perceived barriers to calcium intake are associated with higher levels of calcium intake. The perceived barriers construct was reverse coded so a higher score relates to low barriers. After calculating the coefficient of determination,

.185 x .185 = .034, it can be determined that 3.4% of the variance is shared between these two variables. There was a $\rho = .050$, non-significant correlation between perceived benefits of calcium and calcium intake ($p > .05$). There was a small but significant correlation between health motivation and calcium intake of $\rho = .204$ ($p < .01$). After calculating the coefficient of determination, .204 x .204 = .041, it can be determined that 4.1% of the variance shared between by these two variables.

7. What is the correlation between the HBM constructs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and health motivation) and physical activity?

The Spearman correlation was small and negative between perceived susceptibility and physical activity as $\rho = -.126$ and significant at $p < .01$. After calculating the coefficient of determination, .126 x .126 = .016, it can be determined that 1.6% of the variance is shared between these two variables. There was a negative correlation between perceived severity and physical activity as $\rho = -.063$ and was significant ($p > .05$). There was a small almost moderate, significant correlation of $\rho = .287$ between perceived barriers to physical activity and physical activity ($p < .01$). The perceived barriers construct was reverse coded so a higher score relates to low barriers. Therefore, a low level of perceived barriers to physical activity is associated with high levels of physical activity. After calculating the coefficient of determination, .287 x .287 = .082, it can be determined that 8.2% of the variance is shared between these two variables. There was a $\rho = -.017$ non-significant correlation between perceived benefits of physical activity and physical activity ($p > .05$). There was a small but significant correlation between health motivation and physical activity of $\rho = .164$ ($p < .01$). After calculating the coefficient of determination, .164 x .164 = .027, it can be determined that 2.7% of the variance is shared between these two variables.

8. Are the individual HBM constructs significant predictors of calcium intake?

The multiple regression final model for calcium intake included independent variables of perceived barriers to physical activity, health motivation, ethnicity, age, perceived barriers to calcium intake, and physical activity. After entering all independent variables, a total of 12.2% variance was explained.

9. Are the individual HBM constructs significant predictors of physical activity?

The multiple regression final model for physical activity included independent variables of gender, perceived barriers to physical activity, perceived benefits to physical activity, health motivation, and calcium intake. After entering all independent variables, a total of 15.5% variance was explained.

Discussion

One of the findings from this study was a lack of perceived susceptibility towards osteoporosis among college age students. This is consistent with Kasper, Garber, and Walsdorf's (2007) findings that stated college females perceive breast cancer and heart disease as greater threats than osteoporosis. Johnson, McLeod, Kennedy, and McLeod (2008) reported that perceived susceptibility was considerably lower in young adults compared to older age groups, and Drozdzowska, Pluskiewicz, and Skiba (2004) determined that 50% of their study population believed osteoporosis was a minor health problem. One possible explanation for young women not perceiving themselves as susceptible is the thought that osteoporosis is mainly an older woman's disease. Hazaveheir, Taghdisi, and Saidi (2007) concluded that 65% of women ages eighteen to twenty-five thought osteoporosis was a disease of women over seventy years of age.

Another finding was this population thought osteoporosis to be moderately severe. However, Turner, Hunt, DiBrezzo, and Jones (2004) found that perceived severity was an important construct when determining non-compliance in preventative behavior. In other words, the less severe a person believes osteoporosis to be, the less likely he/she is to participate in behaviors which shield him/her from osteoporosis. In an article by Drozdzowska, Pluskiewicz, and Skiba (2004), 53% of women thought osteoporosis was a curable disease; this idea would therefore lower their perceived severity of the disease.

A contradictory finding from this study is that a majority of the study population had low perceived barriers to physical activity and to calcium intake. However, only 23.4% of the population participated in weight bearing physical activity twenty to thirty minutes, three to four times a week. Similarly, the participants consumed inadequate amounts of calcium. This is in contrast to findings from Wallace (2002) who determined that perceived barriers were the most common factor impacting behavior. If perceived barriers were high, the population would not engage in preventative behaviors. However, this population's perceived barriers were low, typically meaning behaviors would be high; however, this population contradicts this rule by not participating in the recommended amount of physical activity or acquiring the recommended amount of calcium.

Knowledge about osteoporosis is inconsistent in the study population, with a moderate understanding of the need to include calcium rich foods and an understanding of the forms of physical activity that could help prevent osteoporosis. However, in the physical activity questions, there was one choice response which was a more traditional type of exercise and the other choices were more everyday types of physical activity. This may have led the study population to choose the traditional exercise response without actually having knowledge of which enhanced the prevention of osteoporosis.

Furthermore, walking has only recently been identified as an exercise that probably does not supply sufficient stress to bone to contribute to bone building; thus misconceptions about the benefits of walking for osteoporosis prevention are prevalent. Comparably, Turner, Bass, Ting, & Brown (2002) found that yard work was a strong predictor for positive bone density. Yard work is an activity that involves weight bearing motions and therefore contributes to positive bone health. However, this could also lead to misconception regarding the benefits of yard work for osteoporosis prevention. Therefore, the specific mode of yard work must be highlighted for the general population to gain benefit from these activities.

Calcium intake is significant in the prevention of osteoporosis, especially during adolescence (Lysen & Walker, 1997). However, as stated above, the majority of the participants in this study are not consuming adequate amounts of calcium to prevent bone disease. However, calcium intake during adolescence can reduce osteoporosis by as much as 50% (Lysen & Walker, 1997) by increasing bone mineral density. An adequate amount of calcium is also recommended to maximize the positive effects of physical activity on bone during the growth period (Specker & Binkley, 2003). Prince et al. (1995) similarly determined that the combination of calcium and physical activity appears to be more effective in increasing bone mass than calcium alone. An adequate amount of calcium is also important as one enters young adulthood when bone formation and bone resorption are balanced. However, there are few studies focusing on young adults and calcium intake; most studies focus on younger or older individuals. Welten, Kemper, Post, and van Staveren (1995) associated calcium intake as having a positive effect on BMD in young adults.

In this study, participants with more osteoporosis knowledge consumed a higher amount of calcium than those with lower osteoporosis knowledge. This is consistent with previous findings by Harel, Riggs, Vaz, White, and Menzies (1998) who determined that individuals with knowledge about the importance of calcium for bone health consumed higher amounts of calcium than individuals without this knowledge. Chang (2006) also determined that low calcium intake is correlated with low osteoporosis knowledge.

Perceived barriers to calcium intake, in this study, were associated with increased calcium intake. This population did not have many barriers to calcium intake. Similarly, Swaim, Barner, and Brown's (2008) study participants did not view barriers to calcium intake to be problematic. Our results are also supported by Chang (2006) who determined that calcium intake corresponded with lower perceived barriers.

Lastly, calcium intake was positively associated with physical activity. Few studies have looked at the correlation among risk factors; therefore, overall health motivation is examined. Participation in both preventative behaviors is likely associated with overall health motivation. This finding is consistent with Swaim, Barner, and Brown (2008) who found that health motivation was associated with increased likelihood of participating in physical activity and consuming adequate amounts of calcium. However, Uusi-Rasi, Sievanen, Pasanen, Beck, and Kannus (2008) did not find an interaction between calcium intake and physical activity. This is important when developing an intervention because if the individuals overall health motivation can be increased then, as found in this study, an increased likelihood of increasing preventive behaviors will occur.

Furthermore, a multiple regression was conducted for calcium intake. Ethnicity was chosen as an independent variable due to the literature revealing that older, white women aged fifty and older are more likely to have osteoporosis (NOF, 2008). Ethnicity contributed the most to the model. Chang (2006) determined that perceived barriers to calcium intake were associated with calcium intake; however, it was not found to be a major factor in predicting calcium intake. Chang (2006) surveyed young adult women and found knowledge of osteoporosis to be the most important factor in predicting calcium intake. In this study, osteoporosis knowledge was found to be a significant predictor of calcium intake; however, osteoporosis knowledge was found to be the least important factor for perceived barriers to calcium intake, perceived barriers to physical activity, and physical activity.

Weight bearing physical activity plays an important role in bone health because as strain is placed on bones, it signals the need to build more bone. Negatively, reductions in weight bearing activity which lead to loss of muscle mass signals less need for bone, which leads to the elimination of bone (USDHHS, 2004). Physical activity is one of the most important controllable lifestyle changes to help prevent chronic disease; however, many Americans do not engage in regular physical activity (USDHHS, 2000). This is consistent with this study's population. During adulthood, when the body is not building bone, weight bearing physical activity is important to maintain bone health. Conversely, several studies have found a modest but positive effect from exercise on BMD in this population (Kelley, Kelley, & Tran, 2001; Wallace & Cumming, 2000; Wolff, van Croonenborg, Kemper, Kostense, & Twisk, 1999).

In this study, lower perceived barriers to physical activity were associated with higher levels of physical activity. This is consistent with literature from Rosenstock (1974) which states that the more barriers an individual faces, the less likely he/she is to participate in the behavior. In stark contrast to these findings, the DHS & CDC (1999) stated that perceived barriers were found to have no association to adult physical activity. Similarly to this study, Wallace (2002) discovered that identified barriers were the most common factor impacting behavior. Therefore, if an individual's perceived barriers to physical activity can be decreased; their weekly physical activity will increase.

For the participants in this study, age was negatively correlated with physical activity which means the younger the individual, the more physical activity he/she engages in during the week. This finding is consistent with Healthy People 2010 (USDHHS, 2000) who determined that individuals age's eighteen to twenty-four participated in physical activity as compared to approximately 30% of individuals ages sixty-five to seventy-four.

A multiple regression was conducted for physical activity, while controlling for gender. Gender was chosen from the literature on osteoporosis. Of the ten million Americans who have osteoporosis, eight million of those are women (USDHHS, 2004). After controlling for gender, barriers to physical activity were the greatest predictor of physical activity. This is consistent with the findings of Wallace (2002) who determined barriers to be the greatest predictor of behavior. Biddle, Sallis, and Cavill (1988) found individuals who participated in no physical activity perceived greater barriers to physical activity.

Strengths of the Study

In addition to having a high response rate, the strengths of the study included high statistical power because of the large sample size. The data collection method was strengthened by the fact that only two researchers collected the data. The collection method was consistent in each class. The primary researcher inputted all data; therefore, it was controlled and closely monitored. Data entry verification was conducted preceding data analysis. This was carried out by verifying every ten entries were correct.

Limitations of the Study

The study results had several limitations. First, all variables were self-reported which begs the question of reliability? Cook and Campbell (1979) stated that participants tend to report what they believe the researcher expects to see or report what reflects positively on their own abilities, knowledge, beliefs, or opinions. This exaggeration will positively skew the data. Another concern about such data centers on whether subjects are able to accurately recall past behaviors. Recall bias could have potentially occurred specifically on the physical activity recall section of the questionnaire since the subjects were recalling seven days prior to the questionnaire date. One quandary with this study population was that they completed the questionnaire during class and some might have answered a certain way in order to leave class early. For example, with the physical activity recall section, participants might have marked "no physical activity" instead of writing out all the activities they participated in during that week. Participants may have misunderstood the terminology or the phrasing of the study questionnaire which also could have introduced error. However, self report data is used throughout the literature and is seen as valid and reliable (Kuzma & Bohnenblust, 2001).

A second limitation is the use of convenience sampling. Convenience sampling does not represent the entire population, and so it is considered biased; therefore, the findings may not actually represent the entire population. Findings from a convenience sample would be considered less definitive and would usually require replication in a more controlled setting. However, this sample was representative of the UCA population. There were comparable percents regarding gender and ethnicity. Convenience sampling is often used in social science research and is considered a reliable sampling technique (Kuzma & Bohnenblust, 2001).

A third limitation is the use of a cross sectional survey design. In this type of survey design, information is gathered on a population at a single point in time. This type of survey design is used throughout social science literature (Kuzma & Bohnenblust, 2001); however, it does not show a cause and effect relationship between variables.

Another limitation is that in this study the internal consistency of the osteoporosis knowledge questionnaire was $\alpha = .70$. This could indicate that the knowledge of the study population was not being consistently measured. As compared to the original reliability coefficients of the questionnaire developed by Kim, Horan and Gendler (OKT, 1991), this study's reliability coefficients were much lower on many of the questionnaires as well as the individual constructs. This may be due to the difference in study population. Kim, Horan and Gendler (OKT, 1991) developed the questionnaire for postmenopausal women, whereas this study utilized college-aged individuals. Future research should examine measurement validity in a younger sample. However, other researchers have utilized the OKT, OHBS, OSES, and OPBS in younger populations including college age individuals (Sedlak, Doheny, & Jones, 2000; Martin et al., 2004; Ziccardi, Sedlak, & Doheny, 2004; Wallace, 2002).

Finally, a limitation of the osteoporosis behaviors questionnaire is the way the questions were worded. For the question "How many times a week do you participate in weight bearing exercise such as a walking program, jogging and/or aerobic dancing?" there might have been confusion because weight lifting was not included as an example. Many participants chose the response which put them in the category of inadequate weight bearing physical activity, but when recording their activity on the physical activity recall section, they included weight lifting on numerous days. Therefore, several of the participants might actually have fallen into the adequate category. Similarly, the question "How many times a week do you participate in non-weight bearing exercises such as swimming or biking?" could have had a similar problem. If the participants did not participate in swimming or biking, they may have marked a lower amount than actually occurred.

Implications and Recommendations

Young adults are heading in a direction that will add them to the national burden of osteoporosis. Coupled with a greater number of our population living longer, osteoporosis is becoming an increasing public health concern. Health People 2010 (DHS, 2000) targeted osteoporosis prevention in two national objectives. The first objective strives to reduce the proportion of adults with osteoporosis from 10% to 8%. The second objective attempts to reduce the proportion of adults sixty-five years of age and older who are hospitalized for vertebral fractures associated with osteoporosis from 17.5 to 14 per 10,000 individuals. Research indicates the importance of prevention in the fight against osteoporosis (USDHHS, 2004). Prevention programs should aim to increase knowledge and to decrease risk factor behaviors in adolescence when bone health can be increased. This would help adolescents achieve a higher bone mass as a means of helping them prevent or delay the development of osteoporosis (Kasper, Peterson, Allegrante, Galsworthy, & Gutin, 1994).

Research has both agreed (Wallace, 2002) and disagreed (USDHHS & CDC, 1999) with the finding of this study in which lower barriers to physical activity were an important predictor of participating in physical activity among the study subjects. Many studies (Desmond, Conrad, Montgomery, & Simon, 1993; Godin, Desharnais, Valois, & Bradet, 1995; Neuberger, Kasal, Smith, Hassanein, & DeViney, 1994) have found no association between adult physical activity and perceived barriers. Nonetheless, the cumulative body of evidence supports the conclusion that expectations of negative behavioral outcomes are associated with physical activity among adults (Ali & Twibell, 1995; Dishman & Steinhardt, 1990; Horne, 1994). Health professionals can attempt to decrease barriers to physical activity in college age individuals by providing comprehensive programs based on concepts that influence behavior including social support and increasing self-efficacy (USDHHS, 1999).

The instruments utilized in the study were not originally developed for college age adults; they were developed for the use with adult women (Kim, Horan, & Gendler, "OKT," "OHBS," "OSES," 1991). To obtain more accurate information, instruments for beliefs, knowledge, and self-efficacy of osteoporosis need to be developed specifically for college adults of both genders and all ethnicities. This future research would include test-retest concerning osteoporosis knowledge, focus groups to obtain qualitative data, and pilot testing of the new instruments. In regard to the osteoporosis behaviors survey, the seven day physical activity recall is appropriate for this population; however, it would be more accurate if administered using person to person interviews which is the original and tested format (Sallis, Buono, Roby, Micale, & Nelson, 1993). Another method that would strengthen future studies would be the use of random sampling instead of convenience sampling to increase the generalizeability of the findings across the entire population.

Physical activity that involves high-intensity skeletal loading is recommended to optimize and to maintain bone mass in young adults (ACSM, 2004). There are few studies which specifically focus on young adults and physical activity to promote bone health (Beck & Snow, 2003; Duppe, Gardsell, Johnell, Nilsson, & Ringsberg, 1997; Groothausen, Siemer, Kemper, Twisk, & Welten, 1997; Snow, 1996; Weaver et al., 2001). Therefore, it would be beneficial to evaluate how physical activity in young adults is related with osteoporosis prevention as well as the characteristics, knowledge, beliefs, and other preventative behaviors of those who perform weight-bearing physical activity versus those who perform non weight-bearing physical activity.

Although there are studies related to college students' nutritional habits, calcium intake, physical activity, and osteoporosis risk factors, studies addressing osteoporosis prevention among both genders and multiple ethnicities are limited. Evidence that this population lacks knowledge about osteoporosis risk factors, calcium intake, and physical activity related to bone health makes it important to provide educational opportunities in several venues to increase knowledge. The importance of this is supported by Kasper, Peterson, and Allegrante (2001) who found that individuals with greater knowledge related to the importance of calcium intake and physical activity are more likely to participate in those behaviors than those who do not have this knowledge. In providing health education one must go beyond knowledge alone, recognizing that knowledge alone does not translate to behavior (Ribeiro, Blakeley, & Laryea, 2000). However, without knowledge, behavior change is not informed, and individuals must be aware of osteoporosis before they can be expected to take preventive steps.

When developing interventions for this population, it is important to segment audiences to take into account age and culture. One type of intervention that has not been utilized in osteoporosis prevention is online programs.

Other recommendations for future research include incorporating qualitative data to supplement the quantitative data to add to the understanding of osteoporosis prevention and risk among young adults. Identifying availability of information and resources available for college age adults is important when initiating research with this population.

REFERENCES

Ahlborg, H.G., Johnell, O., Turner, C.H., Rannevik, G., & Karlsson, M.K. (2003). Bone loss and bone size after menopause. *New England Journal of Medicine,* 349(4): 327-334.

Ailinger, R.L., Braun, M.A., Lasus, H., & Whitt, K. (2005). Factors influencing osteoporosis knowledge: A community study. *Journal of Community Health Nursing, 22(3),* 135-142.

Ainsworth, B.E., Haskell, W.L., Whitt, M.C., Irwin, M.L., Swartz, A.M., Strath, S.J., O'Brien, W.L., Bassett, D.R., Schmitz, K.H., Emplaincourt, P.O. Jacobs, D.R., & Leon, A.S. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise, 32(9),* S498-S516.

Ali, N. S. (1996). Predictors of osteoporosis prevention among college women. *American Journal of Health Behavior, 20,* 379–388.

Ali, N.S. & Twibell, R.K. (1995). Health promotion and osteoporosis prevention among postmenopausal women. *Preventive Medicine, 24,* 528-534.

American College of Sports Medicine. (2004). Physical activity and bone health. *Medicine & Science in Sports & Exercise, 36(11),* 1985-1996.

American College of Sports Medicine. (2007). The female athlete triad. *Medicine & Science in Sports & Exercise, 39(10), 1867-1882.*

American College of Sports Medicine & American Heart Association. (2007). Physical activity and public health guidelines. Retrieved June 1, 2009, http://www.acsm.org/AM/Template.cfm?Section=Home_Page&TEMPLATE=/CM/HTMLDisplay.cfm&CONTENTID=7764#Over_65_or_50_64

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (DSM-IV-TR) (4th ed.). Washington, DC: Author.

Anderson, G. & Horvath, J. (2004). The growing burden of chronic disease in America. *Public Health Reports,* 119: 263-270.

Anderson, G.L., Limacher, M., Assaf, A.R., Bassford, T., Beresford, S.A., Black, H., et.al. (2004). Effects of conjugated equine estrogen in postmenopausal women with hysterectomy: The women's health initiative randomized controlled trial. *JAMA, 291(14),* 1701-1712.

Asomaning, K., Bertone-Johnson, E., Nasca, P., Hooven, F., & Peko, P. (2006). The association between body mass index and osteoporosis in patients referred for a bone mineral density examination. *Journal of Women's Health , 15* (9), 1028-1034.

Bainbridge, K.E., Sowers, M., Lin, X., & Harlow, S.D. (2004). Risk factors for low bone mineral density and the 6-year rate of bone loss among premenopausal and perimenopausal women. *Osteoporosis International, 15(6),* 439-446.

Baumgartner, T.A. & Hensley, L.D. (2006). *Conducting and reading research in health and human performance* (4th ed.). New Yourk: McGraw-Hill.

Beals, K.A., Brey, R.A., & Gonyou, J.B. (1999). Understanding the female athlete triad: Eating disorders, amenorrhea, and osteoporosis. *Journal of School Health, 69(8),* 337-340.

Bennell, K., Matheson, G., Meeuwisse, W., & Brukner, P. (1999). Risk factors for stress fractures. *Sports Medicine, 28,* 91-122.

Biddle, S., Sallis, J., Cavill, N. (Eds.), 1988. Young and Active: Physical Activity Guidelines for Young People in the UK. Health Education Authority, London.

Bilezikian, J.P. (2009). Efficacy of bisponsphonates in reducing fracture risk in postmenopausal osteoporosis. *The American Journal of Medicine, 122(2A),* S14-S21.

Black, D.M., Cummings, S.R., Karpf, D.B., Cauley, J.A., Thompson, D.E., Nevitt, M.C, Bauer, D.C., Genant, H.K., Haskell, W.L., Marcus, R., et al. (1996). Randomised trial of effect of alendronate on risk of fracture in women with existing vertebral fractures. Fracture Intervention Trial Research Group. *Lancet, 348(9041),* 1535-1541.

Blair, S. N., Applegate, W. B., Dunn, A. L., Ettinger, W. H., Haskell, W. L., King, A. C., Morgan, T. M., Shih, J. H., & Simons-Morton, D. G. (1998). Activity Counseling Trial (ACT): Rationale, design, and methods. *Medicine & Science in Sports and Exercise, 30,* 1097-1106.

Blalock, S. J., DeVellis, R. F., Giorgino, K. B., DeVellis, B. M., Gold, D. T., Dooley, M. A., et al. (1996). Osteoporosis prevention in premenopausal women: Using a stage model approach to examine the predictors of behavior. *Health Psychology, 15,* 84–93.

Bodenheimer, T., Chen, E., & Bennett, H.D. (2009). Confronting the growing burden of chronic disease: Can the U.S. health care workfoce do the job? *Health Affairs, 28(1),* 64-74.

Bouchard, C., Blair, S., & Haskelle, W. (2007). *Physical Activity and Health.* Champaign, IL: Human Kinetics.

Brot, C., Jorgensen, N.R., & Sorenson, O.H. (1999). The influence of smoking on vitamin D status and calcium metabolism. *European Journal of Clinical Nutrition, 53(12),* 920-926.

Cauley, J.A, Robbins, J., Chen, Z., Cummings, S.R., Jackson, R.D., LaCroix, A.Z., LeBoff, M., Lewis, C.E., McGowan, J., Neuner, J., et al.; Women's Health Initiative Investigators. (2003). Effects of estrogen plus progestin on risk of fracture and bone mineral density: The Women's Health Initiative randomized trial. *JAMA, 290(13),* 1729-1738.

Centers for Disease Control & American college of Sports Medicine. (1998, October). *Physical Activity and Public Health: A Recommendation from the CDC and ACSM*. Retrieved January 22, 2008, from http://wonder.cdc.gov/wonder/prevguid/p0000391/P0000391.asp

Centers for Disease Control and Prevention. (2008). *Healthy Aging*. Retrieved October 14, 2008, from http://www.cdc.gov/aging/

Centers for Disease Control. (2008). *Physical Activity for Everyone*. Retrieved January 25, 2008, from http://www.cdc.gov/nccdphp/dnpa/physical/recommendations/index.htm

Chan, M.F., Kwong, W.S., Zang, Y., & Wan, P.Y. (2007). Evaluation of an osteoporosis prevention education programme for young adults. *Journal of Advanced Nursing,* (57)3: 270-285.

Chang, S.F. (2006). A cross-sectional survey of calcium intake in relation to knowledge of osteoporosis and beliefs in young adult women. *International Journal of Nursing Practice, 12*, 21-27.

Chang, S.F. (2007). Knowledge, health beliefs and health-related behaviours of first-degree relatives of women suffering from osteoporosis in Taiwan: A questionnaire survey. *Journal of Clinical Nursing, 17,* 1280-1286.

Chesnut, 3rd, C.H., Silverman, S., Andriano, K., Genant, H., Gimona, A., Harris, S., Kiel, D., LeBoff, M., Maricic, M., Miller, P., et al. (2000). A randomized trial of nasal spray salmon calcitonin in postmenopausal women with established osteoporosis: The Prevent Recurrence of Osteoporotic Fractures study. PROOF Study Group. *The American Journal of Medicine, 109(4),* 267-276.

Chrischilles, E., Shireman, T. & Wallace, R. (1994). Costs and health effects of osteoporotic fractures. *Bone,* 15(4): 377-386.

Collaborative Group on Hormonal Factors in Breast Cancer. (1997). Breast cancer and hormone replacement therapy: Collaborative reanalysis of data from 51 epidemiological studies of 52,705 women with breast cancer and 108,411 women without breast cancer. *Lancet, 350(9084),* 1047-1059.

Cook, T., & Campbell, D. (1979). *Quasi-experimentation: Design and analysis issues.* Boston, MA: Houghton Mifflin Company.

Cottrell, R.R., Girvan, J.T., & McKenzie, J.F. (1999). *Principles & Foundations of Health Promotion and Education.* Needham Heights, MA: Allyn & Bacon.

Cranney, A., Wells, G., Willan, A., Griffith, L., Zutaruk, N., Robinson, V., Black, D., Adachi, J., Shea, B., Tugwell, P., and Guyatt, G. (2002). Meta-analyses of therapies for postmenopausal osteoporosis. II. Meta-analysis of alendronate for the treatment of postmenopausal women. *Endocrine Review, 23(4),* 508-516.

Cranney, A., Tugwell, P., Zytaruk, N., Robinson, V., Weaver, B., Adachi, J., Wells, G., Shea, B., & Guyatt, G. (2002). Osteoporosis Methodology Group and the Osteoporosis Research Advisory Group. Meta-analyses of therapies for postmenopausal osteoporosis. IV. Meta-analysis of raloxifene for the prevention and treatment of postmenopaussal osteoporosis. *Endocrine Review, 23(4),* 524-528.

Daniel, W. W. (1999). *Biostatistics: A Foundation for Analysis in the Health Sciences* (7th ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Delmas, P.D., Ensrud, K.E., Adachi, J.D., Harper, K.D., Sarkar, S., Gennari, C., Reginster, J.Y., Pos, H.A., Recker, R.R., Harris, S.T., et al.; Multiple Outcomes of Raloxifene Evaluation Investigators. (2002). Efficacy of raloxifene on vertebral fracture risk reduction in postmenopausal women with osteoporosis: Four-year results from a randomized clinical trial. *Journal of Clinical Endocrinology Metabolism, 87(8)*, 3609-3617.

Desmond, A.W., Conrad, K.M., Montgomery, A., & Simon, K.A. (1993). Factors associated with male workers' engagement in physical activity. *AAOHN Journal, 41*, 73-83.

Devine, A., Dick, I., Islam, A., Dhaliwal, S., & Prince, R. (2005). Protein consumption is an important predictor of lower limb bone mass in elderly women. *American Journal of Clinical Nutrition , 82*, 1423-1428.

DeVol, R. & Bedroussian, A. (2007). An unhealthy america: The economic burden of chronic disease. *Medical Benefits*, 24(22): 1-2.

Dishman, R.K. & Steinhardt, M. (1990). Health locus of control predicts free-living, but not supervised, physical activity: A test of exercise-specific control and outcome-expectancy hypotheses. *Research Quarterly for Exercise and Sport, 61*, 383-394.

Doheny, M., & Sedlak, C. (1995). Osteoporosis Preventing Behaviors Survey. (Unpublished).

Drozdzowska, B., Pluskiewicz, W., & Skiba, W. (2004). Knowledge about osteoporosis in a cohort of Polish females: The influence of age, level of education and personal experiences. *Osteoporosis international*, 15, 645-648.

Dunn, A. L., Marcus, B. H., Kampert, J. S., Garcia, M. E., Kohl, H. W. I., & Blair, S. N. (1997). Reduction in cardiovascular disease risk factors: 6-month results from Project *Active*. Preventive Medicine, 26, 883-892.

Ensrud, K.E., Ewing, S.K., Stone, K.L., Cauley, J.A., Bowman, P.J., Cummings, S.R.; Study of Osteoporotic Fractures Research Group. (2003). Intentional and unintentional weight loss increase bone loss and hip fracture risk in older women. *Journal of the American Geriatric Society, 51(12),* 1740-1747.

Ettinger, B., Black, D.M., Mitlak, B.H., Knickerbocker, R.K., Nickelsen, T., Genant, H.K., Christiansen, C., Delmas, P.D., Zanchetta, J.R., Stakkestad, J., etal. (1999). Reduction of vertebral fracture risk in postmenopausal women with osteoporosis treated with raloxifene: Results from a 3 year randomized clinical trial. Multiple outcomes of Raloxifene evaluation (MORE) investigators. *JAMA, 282(7),* 637-645.

Ettinger, B., Ray, G.T., Pressman, A.R., & Gluck, O. (2003). Limb fractures in elderly men as indicators of subsequent fracture risk. *Archives of Internal Medicine, 163(22),* 2741-2747.

Fatemi, S., Ryzen, E., Flores, J., Endres, D., & Rude, R. (1991). Effect of experimental human magnesium depletion on parathyroid hormone secretion and 1.25 dihydroxyvitamin D metabolism. *Journal of Clinical Endocrinology Metabolism , 73*, 1067-1072.

Felson, D.T., Zhang, Y., Hannan, M.T., Kannel, W.B., & Kiel, D.P. (1995). Alcohol intake and bone mineral density in elderly men and women: The Framingham Study. *American Journal of Epidemiology, 142(5),* 485-492.

Fleisch, H. (2002). Development of bisphosphonates. *Breast Cancer Research, 4(1),* 30-34.

Gabriel, S.E., Tosteson, A.N., Leibson, C.L., Crowson, C.S., Pond, G.R., Hammond, C.S., Melton, 3rd., L.J. (2002). Direct medical costs attributable to osteoportic fractures. *Osteoporosis International, 13(4),* 323-333.

Gammage, K.L., Francoeur, C., Mack, D.E., & Klentrou, P. (2009). Osteoporosis health beliefs and knowledge in college students: The role of diietary restraint. *Eating Behaviors, 10,* 65-67.

Geinoz, G., Rapin, C., Rizzoli, R., Kraemer, R., Buchs, B., Slosman, D., et al. (1993). Relationship between bone mineral density and dietary intakes in the elderly. *Osteoporosis International , 3*, 242-248.

Geller, S.E. & Derman, R. (2001). Knowledge, beliefs, and risk factors for osteoporosis among African-American and Hispanic women. *Journal of the National Medical Association, 93*, 13-21.

Gemalmaz, A. & Oge, A. (2008). Knowledge and awareness about osteoporosis and its related factors among rural Turkish women. *Clinical Rheumatology, 27*, 723-728.

Germano, C. & Cabot, W. (2000). *The osteoporosis solution: New therapies for* *prevention and treatment*. New York: Kensington Books.

Glanz, K., Rimer, B., & Lewis, F. M. (2002). *Health Behavior and Health Education, 3rd ed.* San Francisco: Jossey-Bass.

Godin, G., Desharnais, R., Valois, P., & Bradet, R. (1995). Combining behavioral and motivational dimensions to identify and characterize the stages in the process of adherence to exercise. *Psychology and Health, 10,* 333-344.

Haentjens, P., Autier, P., Collins, J., Velkeniers, B., Vanderschueren, D., & Boonen, S. (2003). Colles fracture, spine fracture, and subsequent risk of hip fracture in men and women: A meta-analysis. *Journal of Bone Joint Surgery, 85A(10),* 1936-1943.

Hamack. L., Stang, J., & Story, M. (1999). Soft drink consumption among U.S. children and adolescents: Nutritional consequences. *Journal of the American Dietetic Association, 99,* 436-441.

Hannan, M.T., Felson, D.T., Dawon-Hughes, B., Tucker, K.L., Cupples, L.A., Wilson, P.W., & Kiel, D.P. (2000). Risk factors for longitudinal bone loss in elderly men and women: The Framingham Osteoporosis Study. *Journal of Bone Mineral Research, 15(4),* 710-720.

Hannan, M.T., Tucker, K.L., Dawson-Hughes, B., Felson, D.T., & Kiel, D.P. (2000). Effect of dietary protein on bone loss in elderly men and women: The Framingham Osteroporosis Study. *Journal of Bone Mineral Research, 15,* 2504-2512.

Harel, Z., Riggs, S., Vaz, R., White, L., & Menzies, G. (1998). Adolescents and calcium: What they do and do not know and how much they consume. *Journal of Adolescent Health, 22,* 225-228.

Harris, S.T., Watts, N.B., Genant, H.K., McKeever, C.D., Hangartner, T., Keller, M., Chesnut 3rd., C.H., Brown, J., Eriksen, E.F., Hoseyni, M.S., et al. (1999). Effects of risedronate treatment on vertebral and nonvertebral fractures in women with postmenopausal osteoporosis: A randomized ceontrolled trial. Vertebral Efficacy with Risedronate Therapy (VERT) Study Group. *JAMA, 282(14),* 1344-1352.

Hazavehei, S.M., Taghdisi, M.H., & Saidi, M. (2007). Application of the health belief model for osteoporosis prevention among middle school girl students, Garmsar, Iran. *Education for Health, 20(1),* 1-11.

Heaney, R.P. (2000). Calcium, dairy products and osteoporosis. *Journal of American college Nutrition, 19,* 83S-99S.

Heaney, R.P. (2004). Phosphorus nutrition and the treatment of osteoporosis. *Mayo Clinic Proceedings, 79(1),* 91-97.

Heaney, R.P. & Rafferty, K. (2001). Carbonated beverages and urinary calcium excretion. *American Journal of Nutrition, 74(3),* 343-347.

Henderson, N.K., Price, R.I., Cole, J.H., Gutteridge, D.H., & Bhagat, C.I. (1995). Bone density in young women in associated with body weight and muscle strength but not dietary intakes. *Journal of Bone Mineral Research, 10,* 384-393.

Herliny, B. & Maebius, N.K. (2003). *The human body in health and illness* (2nd ed.). St. Louis: Saunders.

Hochbaum, G.M. (1958). *Public participation in medical screening programs: A sociopsychological study* (PHS Publication No. 572). Washington, DC: U.S. Government Printing Office.

Holick, M.F. (1999). Vitamin D: Photobiology, metabolism, mechanism of action, and clinical applications. *Primer on the Metabolic Bone Diseases an dDisorders of Mineral Metabolism* (5th ed.). Philadelphis: Lippincott.

Holick, M.F., (2005). The vitamin D epidemic and its health consequences. *Journal of Nutrition, 135,* 2739S-2748S.

Horne, T.E. (1994). Predictors of physical activity intentions and behaviour for rural homemakers. *Canadian Journal of Public Health, 85,* 132-135.

Horton, R. (2009). Tackling the burden of chronic diseases in the USA. *The Lancet,* 373(9659):185.

Ilich, J.Z. & Kerstetter, J.E. (2000). Nutrition in bone health revisited: A story beyond calcium. *Journal of American College of Nutrition, 19(6),* 715-737.

Insel, P.M. & Roth, W.T. (2006). *Core concepts in health* (10th ed.). New York: McGraw-Hill.

Janz, N.K. & Becker, M.H. (1984). The health belief model: A decade later. *Health Education & Behavior, 11(1),* 1-47.

Johnson, C. S., McLeod, W., Kennedy, L., & McLeod, K. (2008). Osteoporosis health beliefs among younger and older men and women. *Health Education and Behavior , 35* (5), 721-733.

Juby, A.G. & Davis, P. (2001). A prospective evaluation of the awareness, knowledge, risk factors and current treatment of osteoporosis in a cohort of elderly subjects. *Osteoporosis International, 12,* 617-622.

Kanis, J.A. (2002). Osteoporosis III: Diagnosis of osteoporosis and assessment of fracture risk. *Lancet, 359(9321),* 1929-1936.

Kanis, J.A., & Johnell, O. (1999). The burden of osteoporosis. *Journal of Endocrinology*

Investment, 22(8), 583-588.

Kanis, J.A., Johnell, O., Oden, A., Johansson, H., De Laet, C., Eisman, J.A., Fujiwara,S., Kroger, H., McCloskey, E.V., Mellstrom, D., Melton, L.J., Pols, H., Reeve, J., Silman, A., & Tenenhouse, A. (2005). Smoking and fracture risk: A meta-analysis. *Osteoporosis International, 16(2),* 155-162.

Kanis, J.A., Melton, 3rd, L.J., Christianse, C., Johnston, C.C., & Khaltaev, N. (1994). The diagnosis of osteoporosis. *Journal of Bone Mineral Research, 9(8),* 1137-1141.

Kasper, M.J., Garber, M., & Walsdorf, K. (2007). Young women's knowledge and beliefs about osteoporosis: Results from a cross-sectional survey of college females. *American Journal of Health Education,* 38(4): 186-193.

Kasper, M.J., Peterson, G.E., & Allegrante, J.P. (2001). The need for comprehensive educational osteoprosis prevention programs for young women: Results from a second osteoporosis prevention survey. *Arthritis Care Research, 45,* 28-34.

Kasper, M. J., Peterson, G. E., Allegrante, J. P., Galsworthy, T. D., & Gutin, B. (1994). Knowledge, beliefs, and behaviors among college women concerning the prevention of osteoporosis. *Archives of Family Medicine, 3,* 696–702.

Kelley, G.A., Kelley, K.S., & Tran, Z.V. (2001). Resistance training and bone mineral density in women: A meta-analysis of controlled trials. *American Journal of Physical Medicine and Rehabilitation, 80(1),* 65-77.

Khosla, S., Lufkin, E.G., Hodgson, S.F., Fitzpatrick, L.A., & Melton, 3rd., L.J. (1994). Epidemiology an dclinical features of osteoporosis in young individuals. *Bone, 15(5),* 551-555.

King, A. C., Stokols, D., Talen, E., Brassington, G., & Killingsworth, R. (2002).

Theoretical approaches to the promotion of physical activity: Forging a transdisciplinary paradigm. *American Journal of Preventive Medicine , 23* (2S), 75-25.

Knoke, J.D. & Barrett-Conner, E. (2003). Weight loss: A determinant of hip bone loss in older men and women. The Rancho Bernardo Study. *The American Journal of Epidemiology, 158(12),* 1132-1138.

Kontulainen, S., Sievanen, H., Kannus, P., Pasanen, M., & Vuori, I. (2003). Effect of long-term impact-loading on mass, size, and estimated strength of humerus and radius of female racquet-sports players: A peripheral quantitative computed tomography study between Young an dold starters and controls. *Journal of Bone Mineral Research, 18(2),* 352-359.

Korpelainen, R., Korpelainen, J., Heikkinen, J., Vaananen, K., & Keinanen-Kiukaannieme, S. (2006). Lifelong risk factors for osteoporosis and fractures in elderly women with low body mass index-A population based study. *Bone , 39* (2), 385-391.

Krall, E.A & Dawson-Hughes, B. (1999). Smoking increases bone loss and decreases intestinal calcium absorption. *Journal of Bone Mineral Research, 14(2),* 215-220.

Kuzma, J. W., & Bohnenblust, S. E. (2001). *Basic Statistics for the Health Sciences* (4th ed.). Mountain View, CA: Mayfield Publishing Company.

Lagro-Janssen, T., Rosser, W.W., & van Weel, C. (2003). Breast cancer and hormone-replacement therapy: Up to general practice to pick up the pieces. *Lancet, 362(9382),* 414-415.

Laitinen, K., Lamber-Allardt, C., Tunninen, R., Karonen, S.L., Ylikahri, R., & Valimaki, M. (1991). Effects of 3 weeks' moderate alcohol intake on bone and mineral metabolism in normal men. *Bone Mineral, 13(2),* 139-151.

Larkey, L.K., Hoelscher Day, S., Houtkooper, L., & Renger, R. (2003). Osteoporosis prevention: Knowledge and behavior in a southwestern community. *Journal of Community Health, 28(5),* 377-388.

Law, M.R. & Hackshaw, A.K. (1997). A meta-analysis of cigarette smoking, bone mineral density and risk of hip fracture: Recognition of a major effect. *BMJ, 315(7114),* 973-980.

Leibson, C.L., Tosteson, A.N., Gabriel, S.E., Ransom, J.E., & Melton, L.J. (2002). Mortality, disability, and nursing home use for persons with and without hip fracture: A population-based study. *Journal of American Geriatric Society, 50(10)*, 1644-1650.

Liberman, U.A., Weiss, S.R., Broll, J., Minne, H.W., Quan, H., Bell, N.H., Rodriguez-Portales, J., Downs, Jr, R.W., Dequeker, J., and Favus, M. (1995). Effect of oral alendronate on bone mineral denssity and incidence of fracture in postmenopausal osteoporosis. The Alendronate Phase III Osteoporosis Treatment Study Group. *New England Journal of Medicine, 333(22),* 1437-1443.

Lindsay, R., Gallagher, J.C., Kleerekoper, M., & Pickar, J.H. (2002). Effect of lower doses of conjugated equine estrogens with and without medroxyprogesterone acetate on bone in early postmenopausal women. *JAMA, 287(20),* 2668-2678.

Lundon, K. (2000). *Orthopedic Rehabilitation Science: Principles for Clinical Management of Bone.* Butterworth-Heinemann: Woburn, MA.

Lyles, K.W., Siris, E.S., Singer, F.R., & Meunier, P.J. (2001). A clinical approach to diagnosis and management of Paget's disease of bone. *Journal of Bone Mineral Research, 16(8),* 29-36.

Lysen, V.C. & Walker, R. (1997). Osteoporosis risk factors in eighth-grade students.

Journal of School health, 67, 317-321.

Maganziner, J., Lydick, E., Hawkes, W., Fox, K.M., Zimmerman, S.I., Epstein, R.S., & Hebel, J.R. (1997). Excess mortality attributable to hip fracture in white women aged 70 years and older. *American Journal of Public Health, 87(10),* 1630-1636.

Marcus, B.H., Bnspach, S.W., Lefebvre, R.C., Rossi, J.S., Carleton, R.A. & Abrams, D.B. (1992). Using the stages of change model to increase the adoption of physical activity among community participants. *American Journal of Health promotion, 6(6),* 424-429.

Maricic, M., Adachi, J.D., Sarkar, S., Wu W., Wong, M., & Harper, K.D. (2002). Early effects of raloxifene on clinical vertebral fractures at 12 months in postmenopausal women with osteoporosis. *Archives of Internal Medicine, 162(10),* 1140-1143.

Martin, J.T., Coviak, C.P., Gendler, P., Kim, K.K., Cooper, K., & Rodrigues-Fisher, L. (2004). Female adolescents' knowledge of bone health promotion behaviors and osteroporosis risk factors. *Orthopaedic Nursing, 23)4,* 235-244.

Mazess, R., & Barden, H. (1991). Bone density in premenopausal women: Effects of age, dietary intake, physical activity, smoing and birth-control pills. *American Journal of Clinical Nutrition, 58,* 537-542.

McBean, L.D., Forgac, T., & Calvert, S.F. (1994). Osteoporosis: Visions for care and prevention-A conference report. *Journal of American Dietetic Association,* 94: 668-671.

McClung, M.R., Geusens, P., Miller, P.D., Zippel, H., Bensen, W.G., Roux, C., Adami, S., Fogelman, I., Diamond, T., Eastell, R., et al. (2001). Effect of risedronate on the risk of hip fracture in elderly women. Hip Intervention Program Study Group. *New England Journal of Medicine, 344(5),* 333-340.

McDonnell, D.P. (2003). Mining the complexities of the estrogen signaling pathways for novel therapeutics. *Endocrinology, 144(10),* 4237-4240.

Metz, J., Anderson, J., & Gallagher, P. (1993). Intakes of calcium, phosphorus, and protein, and physical activity level are related to radial bone mass in young adult women. *American Journal of Clinical Nutrition , 58*, 132-142.

Morgan, K.T. (2008). Nutritional determinants of bone health. *Journal of Nutrition for the Elderly*, 27(1/2): 3-27.

Morrow, J.R., Jackson, A.W., Disch, J.G., & Mood, D.P. (2005). *Measurement and evaluation in human performance* (3rd ed.). Human Kinetics: IL.

Mudano, A.S., Casebeer, L., Patino, F., Allison, J.J., Weissman, N.W., Kiefe, C.I., Person, S., Gilbert, D., & Saag, K.G. (2003). Racial disparities in osteoporosis prevention in a manged care population. *Southern Medical Journal*, 96(5): 445-451.

Munger, R., Cerhan, J., & Chiu, B. (1999). Prospective study of dietary protein intake and risk of hip fracture in postmenopausal women. *American Journal of Clinical Nutrition , 69* (1), 147-152.

National Cancer Institute. (2005). *Theory at a Glance.* Washington, DC: National Institues of Health.

National Health and Nutrition Examination Survey: 1988-1994 (Version 3) [Data file]. Atlanta, GA: National Center for Health Statistics.

National Institutes of Health (2007). *Osteoporosis: Handout on health.* Retrieved February 17, 2009 from http://www.niams.nih.gov/Health_Info?Bone?Osteoporosis/osteoporosis_hoh.pdf

National Institue of Health Consensus Statement Online 2000 March 27-29; [cited 2009

Jan 22]; Osteoporosis Prevention, Diagnosis, and Therapy, 17(1): 1-36.

National Osteoporosis Foundation. (2002). *American's bone health: The state of osteoporosis and low bone mass in our nation.* Washington, DC: National Osteoporosis Foundation.

National Osteoporosis Foundation. (2002). *Physician's guide to prevention and treatment of osteoporosis.* Washington, DC: Nation Osteoporosis Foundation.

National Osteoporosis Foundation. (2008). Retrieved October 14, 2008, from National Osteoporosis Foundation - Osteoporosis Facts: http://www.nof.org/osteoporosis/diseasefacts.htm#cost

Neer, R.M., Arnaud, C.D., Zanchetta, J.R., Prince, R., Gaich, G.A., Reginster, J.Y., Hodsman, A.B., Eriksen, E.F., Ish-Shalom, S., Genant, H.K., et al. (2001). Effect of parathyroid hormone (1-34) on fractures and bone mineral density in postmenopausal women with osteoporosis. *New England Journal Of Medicine, 344(19),* 1434-1441.

Neuberger, G.B., Kasal, S., Smith, K.V., Hassanein, R., & DeViney, S. (1994). Determinants of exercise and aerobic fitness in outpatients with arthritis. *Nursing Research, 43,* 11-17.

Neutens, J.J. & Rubinson, L. (2002). *Research Techiques for Health Sciences* (3rd ed.). New Jersey: Benjamin-Cummings.

Orwoll, E.S. (1998). Osteoporosis in men. *Endocrinology Metabolism Clinical North American, 27(2),* 349-367.

Orwoll, E., Ettinger, M., Weiss, S., Miller, P., Kendler, D., Graham, J., Adami, S., Weber, K., Lorenc, R., Pietschmann, P., Vandormael, K., & Lombardi, A. (2000). Alendronate for the treatment of osteoporosis in men. *New England Journal of Medicince, 343(9),* 604-610.

Osteoporosis Health Belief Scale. Developed by Katherine Kim, Ph.D., Mary Horan, Ph.D., and Phyllis Gendler, Ph.D. (1991). Grand Valley State University, with support from the Grand Valley State University Research Grant-in-Aid.

Osteoporosis Knowledge Test. Developed by Katherine Kim, Ph.D., Mary Horan, Ph.D., and Phyllis Gendler, Ph.D. (1991). Grand Valley State University, with support from the Grand Valley State University Research Grant-in-Aid.

Osteoporosis Self-Efficacy Scale. Developed by Katherine Kim, Ph.D., Mary Horan, Ph.D., and Phyllis Gendler, Ph.D. (1991). Grand Valley State University, with support from the Grand Valley State University Research Grant-in-Aid. Modified by jeanne Bleeker, M.S. and Lori W. Turner, Ph.D., University of Arkansas.

Pallant, J. (2007). *SPSS Survival manual* (3rd ed.). United Kingdom: McGraw Hill.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., et al. (1995). A recommendation from the centers for disease control and prevention and the american college of sports medicine. *JAMA , 273* (5), 402-407.

Pfeiffer, M., Begerow, B., Minne, H.W., Abrams, C., Machtigall, D., & Hansen, C. (2000). Effects of a short term vitamin D and calcium supplementation on body sway and secondary hyperparathyroidism in elderly women. *Journal of Bone Mineral Research, 15,* 1113-1118.

Phelan, S., Roberts, M., Lang, W., & Wing, R. (2007). Empirical evaluation of physical activity recommendations for weight control methods. *Medicine and Science in Sports and Exericse, 39(10)*, 1832-1836.

Pollock, M. & Brechu, W.F. (1995). Exercise guidelines for the older woman. *Woman's Health Digest, 1*, 31-33.

Prince, R. P., Devine, A., Dick, I., Criddle, A., Kerr, D., Kent, N., Price, R., & Randell, A. (1995). The effects of calcium supplementation (milk powder or tablets) and exercise on bone density in post-menopausal women. *Journal* of *Bone and Mineral Research, 10***,** 1068-1075.

Promislow, J., Goodman-Gruen, D., Slymen, D., & Barrett-Conner, E. (2002). Protein consumption and bone mineral density in the elderly: The rancho bernardo study. *American Journal of Epidemiology , 155*, 636-644.

Qaseem, A., Snow, V., Shekelle, P., Hopkins, R., Forciea, M.A.,& Owens, D.K. (2008). Screening for osteoporosis in men: A clinical practice guidelin from the american college of physicians. *Annals of Internal Medicine*, 148(9):680-684.

Raisz, L.G., & Rodan, G.A. (2003). Pathogenesis of osteoporosis. *Endocrinology Metabolism Clinics of North America*, 32(1), 15-24.

Ransdell, L. (2004). Can physical activity interventions change perceived exercise benefits and barriers? *American Journal of Health Studies, 19(4),* 195-204.

Ray, N.F., Chan, J.K., Thamer, M., & Melton, L.J. 3rd. (1997). Medical expenditures for the treatment of osteoporotic fractures in the United States in 1995: Report from the National Osteoporosis Foundation. *Journal of Bone Mineral Research, 12(1),* 24-35.

Reid, D.M., Hughes, R.A., Laan, R.F., Sacco-Gibson, N.A., Wenderoth, D.H., Adami, S., Eusebio, R.A., & Devogelaer, J.P. (2000). Efficacy and safety of daily risedronate in the treatment of corticosteroi-induced osteoporosis in men and women: A randomized trial. *Journal of Bone Mineral Research, 15(6),* 1006-1013.

Ribeiro, V., Blakeley, J., & Laryea, M. (2000). Women's knowledge and practices regarding the prevention and treatment of osteoporosis. *Health Care for Women International, 21,* 347-353.

Riggs, B.L., Khosla, S., Melton, L.J. 3rd. (2002). Sex steroids and the construction and conservation of the adult skeleton. *Endocrine Reviews*, 23(3), 279-302.

Robitaille, J., Yoon, P., Moore, C., Liu, T., Irizarry-Delacruz, M., Looker, A., et al. (2008). Prevalence, family history, and prevention of reported osteoporosis in U.S. women. *American Journal of Preventive Medicine , 35* (1), 47-54.

Rosenstock, I.M. (1974). The health belief model and preventive health behavior. *Health Education Monographs , 2*: 328-335

Rosenstock, I., Strecher, V., & Becker, M. (1988). Social learning theory and the health belief model. *Health Education Quarterly , 15*, 175-183.

Rossouw, J.E., Kooperberg, C., Stefanick, M.L., Jackson, R.D., Beresford, S.A., Howard, B.V., & Johnson, K.C. (2002). Risks and benefits of estrogen plus profestin in healthy postmenopausal women: Principal results from the Women's Health Initiative randomized controlled trial. *JAMA, 288(3),* 321-333.

Ryder, K., Shorr, R., Bush, A., Kritchevsky, S., Harris, T., Stone, K., et al. (2005). Magnesium intake from food and supplements is associated with bone mineral density in healthy older white subjects. *Journal of the American Geriatric Society , 53* (11), 1875-1880.

Sadler, C. & Huff, M. (2007). African American women health beliefs, lifestyle, and osteoporosis. *Orthopaedic Nursing, 26(2),* 96-103.

Sallis, J. F., Buono, M. J., Roby, J. J., Micale, F. G., & Nelson, J. A. (1993). Seven-day recall and other physical activity self-reports in children and adolescents. *Medicine & Science in Sports & Exercise, 25,* 99-108.

Sallis, J. F., Haskell, W. L., Wood, P. D., Fortmann, S. P., Rogers, T., Blair, S. N., & Paffenbarger, R. S. (1985). Physical activity assessment methodology in the five-city project. American Journal of Epidemiology, 121, 91-10

Salkeld, G., Cameron, I.D., Cumming, R.G., Easter, S., Seymour, J., Kurrle, S.E., et al. (2000). Quality of life related to fear of falling and hip fracture in older women: A time trade off study. *British Medical Journal, 320(7231)*, 341-346.

Sampson, H.W. (2002). Alcohol and other factors affecting osteoporosis risk in women. *Alcohol Research Health, 26(4),* 292-298.

Schmiege, S.J., Aiken, L.S., Sander, J.L., & Gerend, M.A. (2007). Osteoporosis prevention among young women: Psychosocial models of calcium consumption and weight-bearing exercise. *Health Psychology, 26(5),* 577-587.

Schacter, D. (1999). The seven sins of memory: Insights from psychology and cognitive neuroscience. *American Psychology , 54,* 182-203.

Seeman E. (2003). Invited Review: Pathogenesis of osteoporosis. *Journal of Applied Physiology*, 95(5), 2142-2151.

Sedlak, C.A., Doheny, M.O., & Jones, S.L. (2000). Osteoporosis education programs: Changing knowledge and behaviors. *Public Health Nursing*, 17(5): 398-402.

Sharp, K. & Thombs, D.L. (2003). A cluster analytic study of osteoprotective behavior in undergraduates. *American Journal of Health Behavior, 27(4),* 364-372.

Shumaker, S.A., Legault, C., Rapp, S.R., Thal, L., Wallace, R.B., Ockene, J.K., Hendrix, S.L., Jone, 3rd, B.N., Assaf, A.R., Jackson, R.D., et al. (2003). Estrogen plus progestin and the incidence of dementia and mild cognitive impairment in postmenopausal women: The Women's Health Initiative Memory Study: A randomized controlled trial. *JAMA, 289(20),* 2651-2662.

Shumaker, S.A., Legault, C., Kuller, L., Rapp, S.R., Thal, L., Lane, D.S., Fillit, H., Stefanick, M.L., Hendrix, S.L., Lewis, C.E., et al. (2004). Conjugated equine estrogens and incidence of probable dementia and mild cognitive impairment in postmenopausal women. The Women's Health Initiative Memory Study. *JAMA, 291(24),* 2947-2958.

Silverman, S.L. (2003). Calcitonin. *Endocrinology Metabolism Clinics of North American, 32(1),* 273-284.

Sizer, F. & Whitney, E. (2008). *Nutrition: Concepts and controversies.* (11th ed). Thomson-Wadsworth: KY.

Specker, B. & Binkley, T. (2003). Randomized trial of physical activity and calcium supplementation on bone mineral content in 3 to 5 year old children. *Journal of Bone Mineral Research, 18(5),* 885-892.

SPSS Inc. (2006). *Statistical Package for the Social Sciences.* Chicago, IL: from http://www.spss.com/

Swaim, R.A., Barner, J.C., & Brown, C.M. (2008). The relationship of Ca intake and exercise to osteoporosis health beliefs in postmenopausal women. *Research in Social and Administrative Pharmacy, 4,* 153-163.

Tansavatdi, K., McClain, B., & Herrington, D.M. (2004). The effects of smoking on estradiol metabolism. *Minerva Ginecologica, 56(1),* 105-114.

Thibodeau , G.A. & Patton, K.T. (2007). *Anatomy and Physiology (*6th ed.). St. Louis: Mosby Elsevier.

Torgerson, D.J. & Bell-Syer, S.E. (2001). Hormone replacement therapy and prevention of nonvertebral fractures: A meta-analysis of randomized trials. *JAMA, 285(22),* 2891-2897.

Torgerson, D.J. & Bell-Syer, S.E. (2001). Hormone replacement therapy and prevention of vertebral fractures: A meta-analysis of randomised trials. *BMC Musculoskeletal Disorders, 2(1),* 7-10.

Tosteson, A.N.A. (1999). Economic impact of fractures. In Orwoll, E.S. (eds.), *Osteoporosis in men: The effects of gender on skeletal health* (pp. 15-27). San Diego: Academic Press.

Trochim, W. M. (2006). *Correlation.* Retrieved November 19, 2008, from Research Methods: Knowledge Base: http://www.socialreserachmethods.net/kb/statcorr.php.

Tung, W.C. & Lee, I.F.K. (2006). Effects of an osteoporosis educational program for men. *Journal of Advanced Nursing, 56(1),* 26-34.

Turner, L.W., Bass, M.A., Ting, L., & Brown, B. (2002). Influence of yard work and weight training on bone mineral density among older U.S. women. *Journal of Women & Aging, 14(3/4),* 139-147.

Turner, L.W., Hunt, S.B., DiBrezzo, R., & Jones, C. (2004). Design and implementation of an osteoporosis prevention program using the health belief model. *American Journal of Health Studies,* 19(2): 115-121.

Turner, L.W., Kendrick, O., Perry, B.A. (1999). Study classifies low body mass index as risk factor for osteoporotic fracture among older U.S. women. *The Journal of the Arkansas Medical Society, 96(4),* 138-141.

Turner, L.W., Leaver-Dunn, D., DiBrezzo, R., & Fort, I. (1998). Physical activity and osteoporotic fracture among older women. *Journal of Athletic Training, 33(3),* 207-210.

U.S. Department of Health and Human Services and Centers for Disease Control and Prevention. (1999). *Physical activity and health: A report of the surgeon general.* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services. (2008). Physical activity guidelines for Americans: Advisory Committee Report. Retrieved June 1, 2009 from http://www.health.gov/paguidelines/Report/

U.S. Department of Health and Human Services & Centers for Disease Control and Prevention. (2004). *Bone Health and Osteoporosis: A Report of the Surgeon General.* Atlanta, GA.

U.S. Department of Health and Human Services. (2000). *Health People 2010. 2nd ed. With Understanding and Improving Health, and Objectives for Improving Health.* 2 Vols. Washington, DC: U.S. Government Printing Office.

Uusi-Rasi, K., Sievanen, H., Pasanen, M., Beck, T.J., & Kannus, P. (2008). Influence of calcium intake and physical activity on proximal femur bone mass and structure among pre- and postmenopausal women: A 10-year prospective study. *Calcification Tissue International, 82,* 171-181.

Valois, R.F., Umstattd, M.R., Zullig, K.J., & Paxton, R.J. (2008). Physical activity behaviors and emotional self-efficacy: Is there a relationship for adolescents? *Journal of School Health, 78(6),* 321-327.

Van Loan, M.D. & Keim, N.L. (2000). Influence of cognitive eating restraint on total-body measurements of bone mineral density and bone mineral content in premenopausal women aged 18-45y: A cross-sectional study. *American Journal of Clinical Nutrition, 72(3),* 837-843.

Wallace, B.A. & Cumming, R.G. (2000). Systematic review of randomized trials of the effect of exercise on bone mass in pre- and postmenopausal women. *Calcified Tissue International, 67(1),* 10-18.

Wallace, L. (2002). Osteoporosis prevention in college women: Application of the expanded health belief model. American Journal of Health Behavior , 26, 163-172.

Webb, A.R., Kline, L., Holick, M.F. (1988). Influence of season and latitude on the cutaneous sythesis of viatmin D3: Exposure to winter sunlight in Boston and Edmonton will not promote viatmin D3 synthesis in human skin. *Journal of Clinical Endocrinology Metabolism, 67(2),* 373-378.

Wells, G., Tugwell, P., Shea, B., Guyatt, G., Peterson, J., Zytaruk, N., Robinson, V., Henry, D., O'Connell, D., Cranney, A; Osteoporosis Methodology Group and the Osteoporosis Research Advisory Group. (2002). Meta-analyses of therapies for postmenopausal osteoporosis. V. Meta-analysis of the efficacy of hormone replacement therapy in treating and preventing osteoporosis in postmenopausal women. *Endocrine Review, 23(4),* 529-539.

Welten, D.C., Kemper, H.C., Post, G.B., & van Staveren. W.A. (1995). A meta-analysis of the effect of calcium intake on bone mass in young and middle aged females and males. *Journal of Nutrition, 125(11),* 2802-2813.

Whiting, S., Boyle, J., Thompson, A., Mirwald, R., & Faulkner, R. (2002). Dietary protein, phosphorus and potassium are beneficial to bone mineral density in adult men consuming adequate dietary calcium. *Journal of the American College of Nutrition , 21*, 239-244.

Winters-Stone, K. (2005). *Action plan for osteoporosis: Your guide to stronger, healthier bones.* Human Kinetics: Champaign, IL.

Wolff, I., van Croonengorg, J.J., Kemper, H.C., Kostense, P.J., & Twisk. J.W. (1999). The effect of exercise training programs on bone mass: A meta-analysis of published controlled trials in pre- and postmenopausal women. *Osteoporosis Internation, 9(1),* 1-12.

World Health Organization. (2003). *The burden of musculoskeletal conditions at the start of the new millennium* (WHO Techinical Report Series 919). Geneva, Switzerland: World Health Organization.

Wortsman, J., Matsuoka, L.Y., Chen, T.C., Lu, Z., & Holick, M.F. (2000). Decreased bioavailability of vitamin D in obesity. *American Journal of Clinical Nutrition, 72,* 690-693.

Writing Group for the PEPI. (1996). Effects of hormone therapy on bone mineral density: Results from the Postmenopausal Estrogen/Progestin Interventions (PEPI) Trial. *JAMA, 276(17),* 1389-1396.

Yin-King Lee, L. & King-Fai Lai, K. (2006). Osteoporosis in older Chinese men: Knowledge and health beliefs. *Journal of Clinical Nursing, 15,* 353-355.

Yood, R.A., Mazor, K.M., Andrade, S.E., Emani, S., Chan, W., & Kahler, K.H. (2008). Patient decision to initiate therapy for osteoporosis: The influence of knowledge and beliefs. *Journal of General Internal Medicine, 23(11)*, 1815-1821.

APPENDIX A

42 Items Related to the Different Constructs

Constructs	Number of Items
Perceived Susceptibility	1-6
Perceived Seriousness	7-12
Benefits of Physical Activity	13-18
Benefits of Calcium Intake	19-24
Barriers to Physical Activity	25-30
Barriers to Calcium Intake	31-36
Health Motivation	37-42

APPENDIX B

Class List

Class Number	Class Title	Number of Sections
HED 1320	Concepts of Lifetime Health/Fitness	14
HED 2200	Personal Health	2
HED 2201	First Aid	10
HED 2320	Mental Health	2
HED 3300	Health Education Methods and Materials	1
HED 3301	Theoretical Bases of Health Education	1
HED 3305	Human Sexuality	2
HED 3315	Theory Practice and Prevention	1
HED 3320	Epidemiological Research	2
HED 4300	Community Health Problems	1
HED 4301	Health Education in Medical Care Setting	1
HED 4312	Drug Education	1
HED 4320	Health Promotion Interventions	1
HED 4331	Program Planning & Evaluation	1
HED 4370	Administration of Health Programs	1
HED 4395	Health Concerns: Women	1

APPENDIX C

Survey Script

I am a graduate student in the Department of Health Sciences at the University of Alabama. I am here to conduct a study that will look at your understanding of osteoporosis.

Before we begin, I would like to take a minute to explain why I am inviting you to participate and what I will be doing with the information you provide to me. Please stop me at any time if you have any questions. After I've told you a bit more about my project, you can decide whether or not you would like to participate.

I am doing this research as part of my studies in the Department of Health Sciences at the University of Alabama. I will be surveying college students who take classes in the Health Education department of UCA and will use this information as the basis for my Doctoral Dissertation. I may also use this information in articles that might be published, as well as in academic presentations.

Participation should take about 20-30 minutes. Participation is on a purely voluntary basis. You will be asked to complete a survey. Please make sure you answer each question and check all pages to be sure you have not skipped a page. Please do not put your name on the survey; only answer the questions asked of you. The information you give will be entered into a computer and the surveys will be destroyed. There will be no name or identifiable information which can be traced back to you.

If at any time and for any reason, you would prefer not to answer any questions, please feel free not to. If at any time you would like to stop participating, please tell me. We can take a break, stop and continue at a later date, or stop altogether. You will not be penalized in any way for deciding to stop participation at any time.

If you have questions, you are free to ask them now. If you have questions later, you may contact me at eedmonds@uca.edu or by phone at 852-2681.

APPENDIX D

Survey Instrument

OSTEOPOROSIS KNOWLEDGE TEST

Osteoporosis (os-te-o-po-ro-sis) is a condition in which the bones become 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. After you read each statement, think about if the person is: MORE LIKELY, or LESS LIKELY TO GET OSTEOPOROSIS, or IT HAS NOTHING TO DO WITH (NEUTRAL) GETTING OSTEOPOROSIS, or YOU DON'T KNOW.

When you read each statement, circle one of the 4 choices for your answer.

ML = MORE LIKELY, **NT** = NEUTRAL, **LL** = LESS LIKELY, **DK** = DON'T KNOW

1. Eating a diet LOW in milk products — ML NT LL DK
2. Being menopausal; "change of life" — ML NT LL DK
3. Having big bones — ML NT LL DK
4. Eating a diet high in dark green leafy vegetables — ML NT LL DK
5. Having a mother or grandmother who has osteoporosis — ML NT LL DK
6. Being a white woman with fair skin — ML NT LL DK
7. Having ovaries surgically removed — ML NT LL DK
8. Taking cortisone (steroids e.g. Prednisone) for long time — ML NT LL DK
9. Exercising on a regular basis — ML NT LL DK

For the next group of questions, choose only one answer from the 4 choices. Choose only one answer. If you think there is more than one answer, choose the best answer. If you are not sure, circle D.

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

A. Swimming
B. Walking briskly
C. Doing kitchen chores, such as washing dishes or cooking
D. Don't Know

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

A. Bicycling
D. Don't Know

B. Yoga
C. Housecleaning

12. How many days a week do you think a person should exercise to strengthen the bones?

A. 1 day a week
B. 2 days a week
C. 3 or more days a week
D. Don't Know

13. What is the LEAST AMOUNT OF TIME a person should exercise on each occasion to strengthen the bones?

A. Less than 15 minutes
B. 20 to 30 minutes
C. More than 45 minutes
D. Don't Know

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

A. Just a little faster
B. So fast that talking is not possible
C. Much faster, but talking is possible
D. Don't Know

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

A. Jogging or running for exercise
B. Golfing using golf cart
C. Gardening
D. Don't Know

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

A. Bowling
B. Doing laundry
C. Aerobic dancing
D. Don't Know

Calcium is one of the nutrients our body needs to keep bones strong.

17. Which of these is a good source of calcium?

A. Apple
B. Cheese
C. Cucumber
D. Don't Know

18. Which of these is a good source of calcium?

A. Watermelon
B. Corn
C. Canned Sardines
D. Don't Know

19. Which of these is a good source of calcium?

A. Chicken
B. Broccoli
C. Grapes
D. Don't Know

20. Which of these is a good source of calcium?

A. Yogurt
B. Strawberries
D. Don't Know

C. Cabbage

21. Which of these is a good source of calcium?
    A. Ice cream
    B. Grape fruit
    C. Radishes
    D. Don't Know

22. Which of the following is the recommended amount of calcium intake for an adult?
    A. 100 mg - 300 mg daily
    B. 400 mg - 600 mg daily
    C. 800 mg or more daily
    D. Don't Know

23. How much milk must an adult drink to meet the recommended amount of calcium?
    A. 1/2 glass daily
    B. 1 glass daily
    C. 2 or more glasses daily
    D. Don't Know

24. Which of the following is the best reason for taking a calcium supplement?
    A. If a person skips breakfast
    B. If a person does not get enough calcium from diet
    C. If a person is over 45 years old
    D. Don't Know

OSTEOPOROSIS HEALTH BELIEF SCALE

Below are some questions about osteoporosis. There is no right or wrong answers. After reading each statement, circle 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. Circle one best option that explains what you believe.

SD = STRONGLY DISAGREE
D = DISAGREE
N = NEUTRAL
A = AGREE
SA = STRONGLY AGREE

SD D N A SA 1. My chances of getting osteoporosis are high.

SD D N A SA 2. Because of my body build, I am more likely to develop osteoporosis.

SD D N A SA 3. It is extremely likely that I will get osteoporosis.

SD D N A SA 4. There is a good chance that I will get osteoporosis.

SD D N A SA 5. I am more likely than the average person to get osteoporosis.

SD D N A SA	6. My family history makes it more likely that I will get osteoporosis.
SD D N A SA	7. The thought of having osteoporosis scares me.
SD D N A SA	8. If I had osteoporosis I would be crippled.
SD D N A SA	9. My feelings about myself would change if I got osteoporosis.
SD D N A SA	10. It would be very costly if I got osteoporosis.
SD D N A SA	11. When I think about osteoporosis I get depressed.

SD = STRONGLY DISAGREE, **D** = DISAGREE, **N** = NEUTRAL
A = AGREE, **SA** = STRONGLY AGREE

SD D N A SA	12. It would be very serious if I got osteoporosis.
SD D N A SA	13. Regular exercise prevents problems that would happen from osteoporosis.
SD D N A SA	14. I feel better when I exercise to prevent osteoporosis.
SD D N A SA	15. Regular exercise helps to build strong bones.
SD D N A SA	16. Exercising to prevent osteoporosis also improves the way my body looks.
SD D N A SA	17. Regular exercise cuts down the chances of broken bones.
SD D N A SA	18. I feel good about myself when I exercise to prevent osteoporosis.

For the following 6 questions, "taking in enough calcium" means taking enough calcium by eating calcium rich foods and/or taking calcium supplements.

SD D N A SA	19. Taking in enough calcium prevents problems from osteoporosis.
SD D N A SA	20. I have lots to gain from taking in enough calcium to prevent osteoporosis.
SD D N A SA	21. Taking in enough calcium prevents painful osteoporosis.
SD D N A SA	22. I would not worry as much about osteoporosis if I took in enough calcium.
SD D N A SA	23. Taking in enough calcium cuts down on my chances of broken bones.
SD D N A SA	24. I feel good about myself when I take in enough calcium to prevent osteoporosis.
SD D N A SA	25. I feel like I am not strong enough to exercise regularly.

SD D N A SA 26. I have no place where I can exercise.

SD D N A SA 27. My spouse or family discourages me from exercising.

SD D N A SA 28. Exercising regularly would mean starting a new habit which is hard for me to do.

SD D N A SA 29. Exercising regularly makes me uncomfortable.

SD D N A SA 30. Exercising regularly upsets my every day routine.

SD D N A SA 31. Calcium rich foods cost too much.

SD D N A SA 32. Calcium rich foods do not agree with me.

SD D N A SA 33. I do not like calcium rich foods.

SD = STRONGLY DISAGREE, **D** = DISAGREE, **N** = NEUTRAL
A = AGREE, **SA** = STRONGLY AGREE

SD D N A SA 34. Eating calcium rich foods means changing my diet which is hard to do.

SD D N A SA 35. In order to eat more calcium rich foods I have to give up other foods that I like.

SD D N A SA 36. Calcium rich foods have too much cholesterol

SD D N A SA 37. I eat a well-balanced diet.

SD D N A SA 38. I look for new information related to health.

SD D N A SA 39. Keeping healthy is very important for me.

SD D N A SA 40. I try to discover health problems early.

SD D N A SA 41. I have a regular health check-up even when I am not sick.

SD D N A SA 42. I follow recommendations to keep me healthy.

OSTEOPOROSIS SELF-EFFICACY SCALE

We are interested in learning how confident you feel about doing the following activities. Everyone has different experiences which will make each person more or less confident in doing the following things. Thus, there is no right or wrong answers. In this questionnaire, EXERCISE means activities such as walking, golfing, biking, aerobic dancing.

After reading each statement, circle if you STRONGLY DISAGREE, DISAGREE, are NEUTRAL, AGREE, or STRONGLY AGREE with the statement.

It is important that you answer according to your actual confidence and not according to how confident you think you should be. We need the answers that best explain your confidence.

If it were recommended that I do any of the following THIS WEEK, I am confident or certain that I could:

SD D N A SA 1. Begin a new or different exercise program

SD D N A SA 2. Change my exercise habits

SD D N A SA 3. Put forth the effort required to exercise

SD D N A SA 4. Do exercises even if they are difficult

SD D N A SA 5. Exercise for the appropriate length of time

SD D N A SA 6. Do the Type of exercises that I am supposed to do

If it were recommended that I do any of the following THIS WEEK, I am confident or certain that I could:

SD D N A SA 7. Increase my calcium intake

SD D N A SA 8. Change my diet to include more calcium rich foods

SD D N A SA 9. Eat calcium rich foods as often as I am supposed to do

SD D N A SA 10. Select appropriate foods to increase my calcium intake

SD D N A SA 11. Stick to a diet which gives an adequate amount of calcium

SD D N A SA 12. Obtain foods that give an adequate amount of calcium

OSTEOPOROSIS BEHAVIORS SURVEY

1. How many glasses (8 ounces) of milk do you drink during an average week?

1. NONE PER WEEK
2. ONE PER WEEK
3. TWO PER WEEK
4. THREE PER WEEK
5. FOUR PER WEEK
6. FIVE PER WEEK
7. SIX PER WEEK
8. ONE PER DAY
9. TWO PER DAY
10. THREE PER DAY
11. OTHER, PLEASE SPECIFY ________________________

2. How many eight-ounce servings of yogurt do you eat during an average week?

1. NONE PER WEEK
2. ONE PER WEEK
3. TWO PER WEEK
4. THREE PER WEEK
5. FOUR PER WEEK
6. FIVE PER WEEK
7. SIX PER WEEK
8. ONE PER DAY
9. TWO PER DAY
10. THREE PER DAY
11. OTHER, PLEASE SPECIFY ________________________

3. How many (1) ounce servings of cheese do you eat during an average week?

1. NONE PER WEEK
2. ONE PER WEEK
3. TWO PER WEEK
4. THREE PER WEEK
5. FOUR PER WEEK
6. FIVE PER WEEK
7. SIX PER WEEK
8. ONE PER DAY
9. TWO PER DAY
10. THREE PER DAY
11. OTHER, PLEASE SPECIFY ________________________

4. Do you take a calcium supplement?
   1. NO
   2. YES

   If yes, name of product_________________ Amount taken each day__________

5. How many times a week do you participate in weight bearing exercise such as a walking program, jogging and/or aerobic dancing?

1. LESS THAN 10 MINUTES PER WEEK
2. 10 TO 15 MINUTES, 1 TO 2 TIMES PER WEEK
3. 10 TO 15 MINUTES, 3 TO 4 TIMES PER WEEK
4. 10 TO 15 MINUTES, 5 TO 7 TIMES PER WEEK
5. 20 TO 30 MINUTES, 1 TO 2 TIMES PER WEEK
6. 20 TO 30 MINUTES, 3 TO 4 TIMES PER WEEK
7. 20 TO 30 MINUTES, 5 TO 7 TIMES PER WEEK
8. MORE THAN 30 MINUTES PER DAY

6. How many times a week do you participate in non weight bearing exercises such as swimming or biking?

1. LESS THAN 10 MINUTES PER WEEK
2. 10 TO 15 MINUTES, 1 TO 2 TIMES PER WEEK
3. 10 TO 15 MINUTES, 3 TO 4 TIMES PER WEEK
4. 10 TO 15 MINUTES, 5 TO 7 TIMES PER WEEK
5. 20 TO 30 MINUTES, 1 TO 2 TIMES PER WEEK
6. 20 TO 30 MINUTES, 3 TO 4 TIMES PER WEEK
7. 20 TO 30 MINUTES, 5 TO 7 TIMES PER WEEK
8. MORE THAN 30 MINUTES PER DAY

Please record how much physical activity you did in the last **SEVEN** DAYS. Please place your physical activity into one of the two categories: Moderate Physical Activity or Vigorous Physical Activity.

- Record only the time you were active. Do not count breaks or rest periods.
- You can record more than one activity. If you do, please write the minutes you were active for each activity separately.
- List the activity that you did when you were active.
- Please mark the box if you were not physically active in the past seven (7) days.

○ I was not physically active in the past seven (7) days.

Moderate Activity

Types of moderate activities include walking briskly, mowing the lawn with a non-motorized pushmower, dancing, swimming at a leisurely pace, partaking in water aerobics, or bicycling on level terrain for at least 30 minutes.

Vigorous Activity

Types of vigorous activities include jogging, high-impact aerobic dancing, swimming continuous laps at a moderate pace, bicycling uphill, high energy sports (e.g., basketball, soccer, running, singles tennis, fast dancing, or similar activities) for 20 or more minutes per occasion.

	Moderate Activity Type	**Minutes Moderate Activity**	**Vigorous Activity Type**	**Minutes Vigorous Activity**
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				

Compared to your physical activity over the past 3 months, was last week's physical activity more, less, or about the same?

○ More
○ Less
○ About the Same

DEMOGRAPHIC INFORMATION:

Please answer the following about yourself:

What is your gender?

- O MALE
- O FEMALE

What is your ethnicity/race?

- O White
- O African American
- O Hispanic American
- O Other

What is your age range?

- O 16-18
- O 19-21
- O 22-24
- O 25-27
- O 28-30
- O 31 or over

Has anyone in your family ever been diagnosed as having osteoporosis?

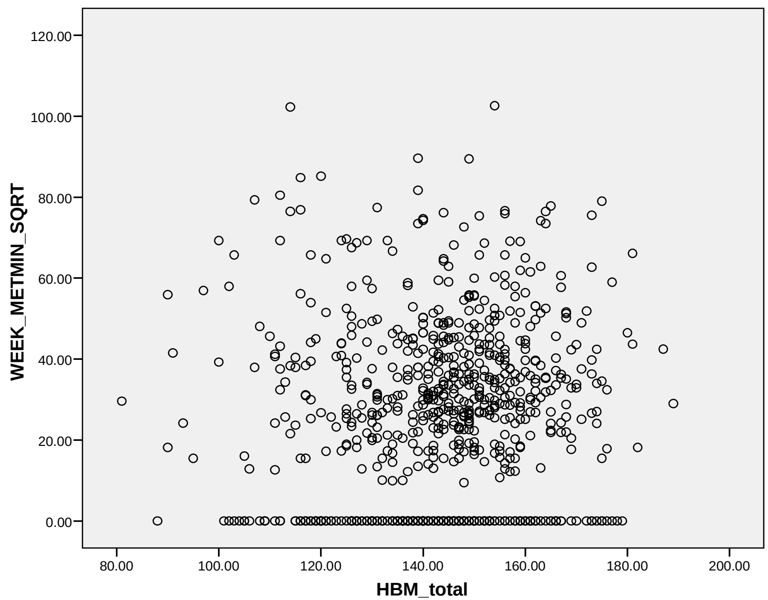
- O Yes
- O No

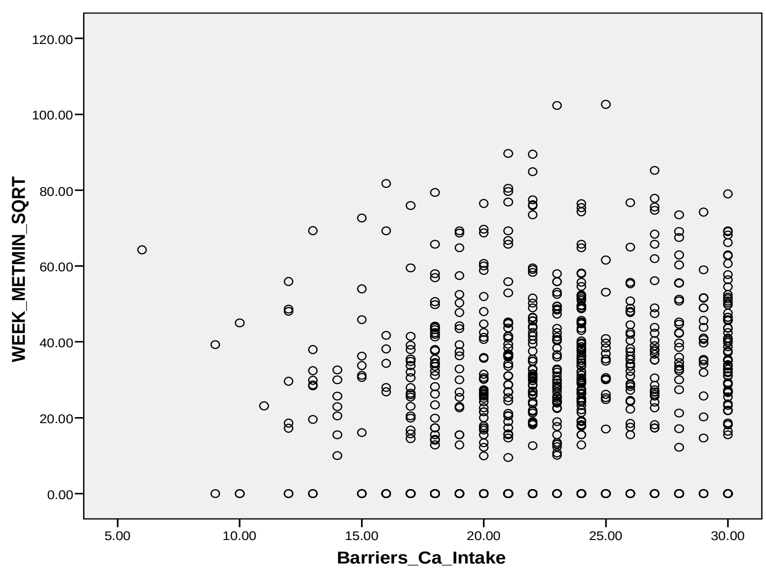
If yes, please state relation to you ___________________.

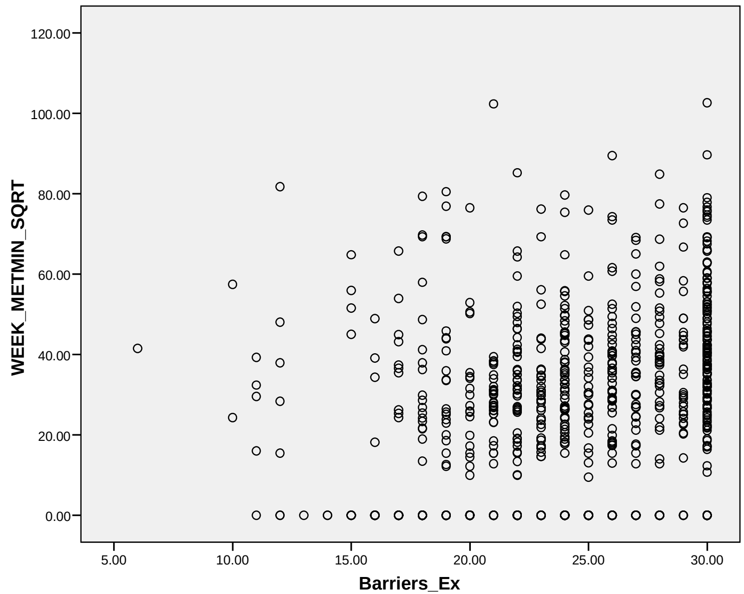
PLEASE CHECK TO SEE YOU HAVE ANSWERED ALL QUESTIONS.

APPENDIX E

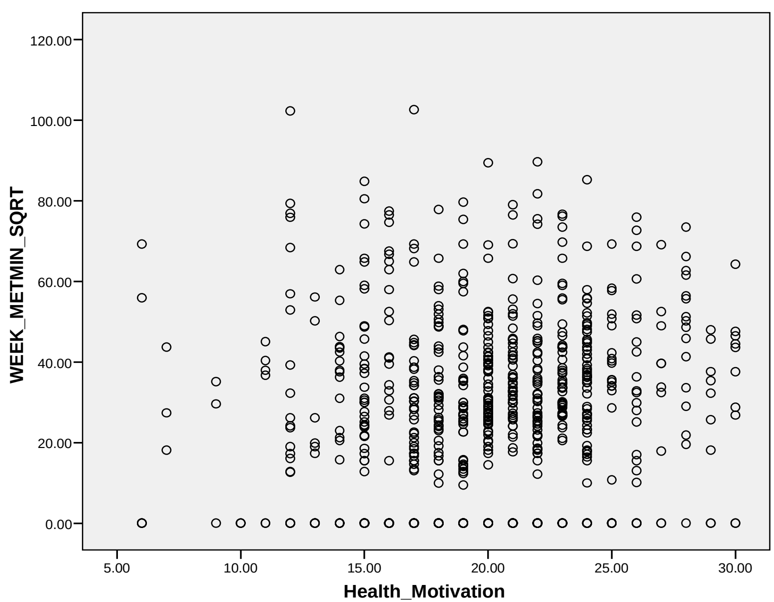
Scatterplots for Physical activity and Calcium intake



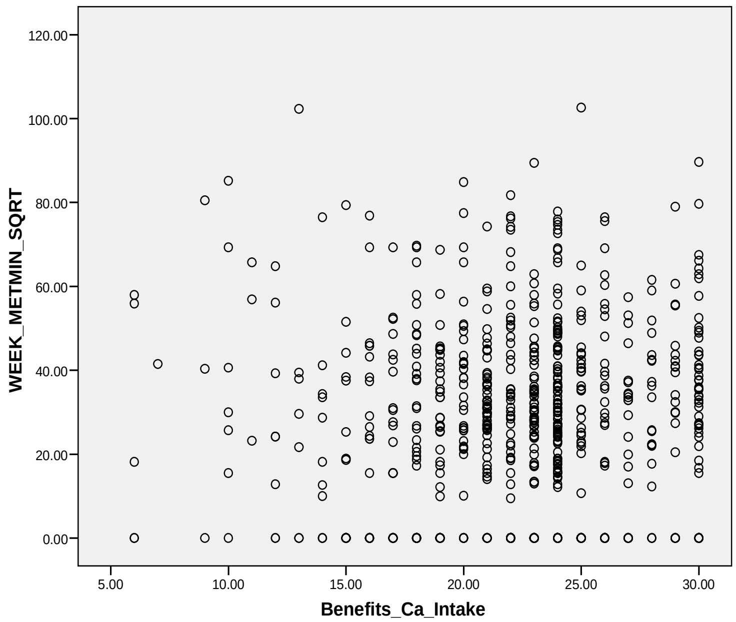


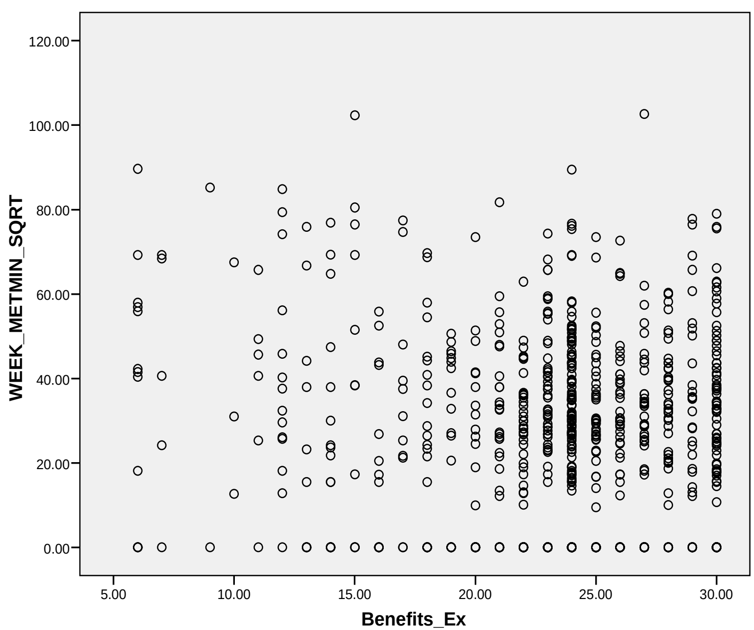


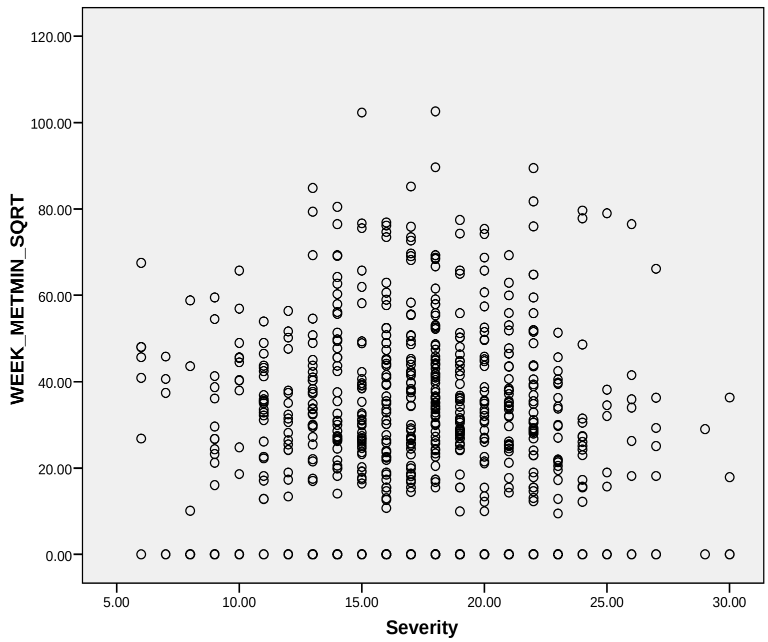
WEEK_METMIN_SQRT
Barriers_Ex
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00

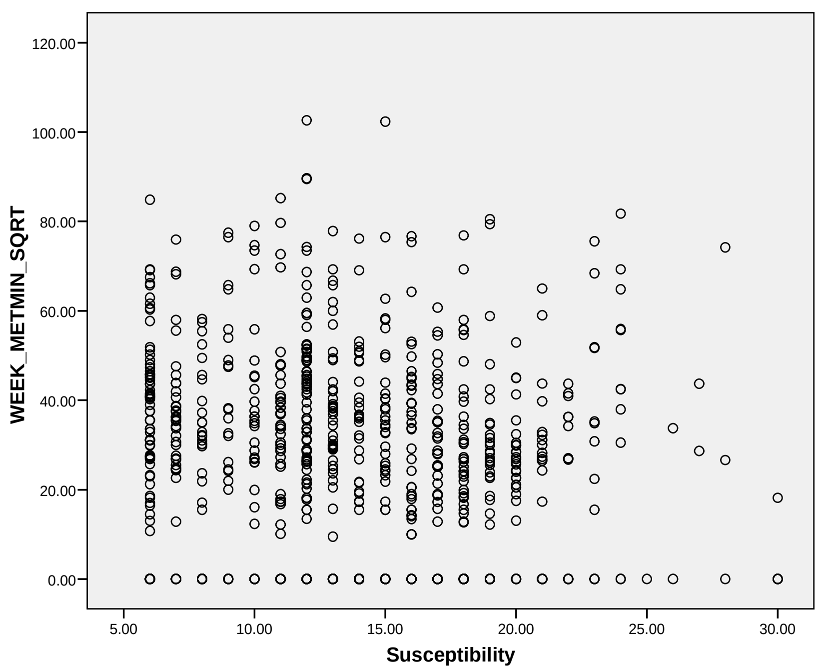


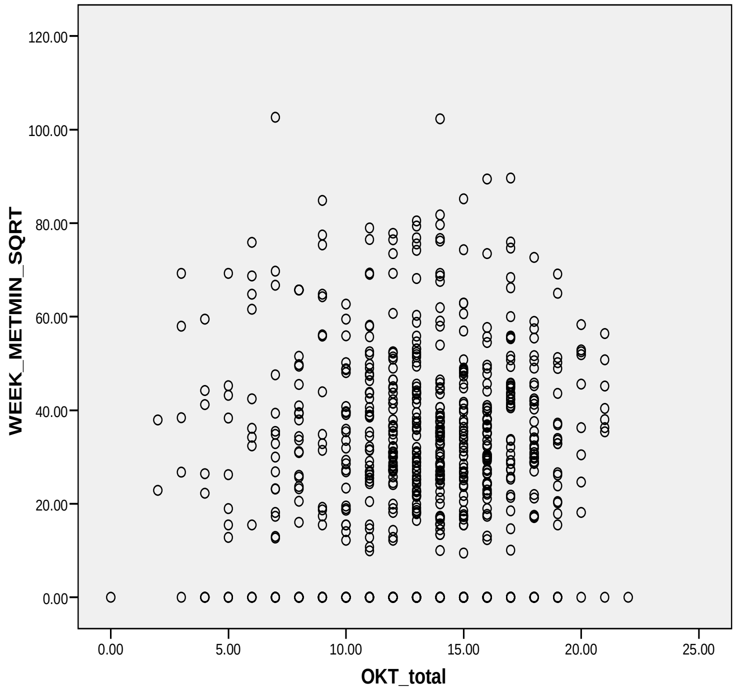
WEEK_METMIN_SQRT
Health_Motivation
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00

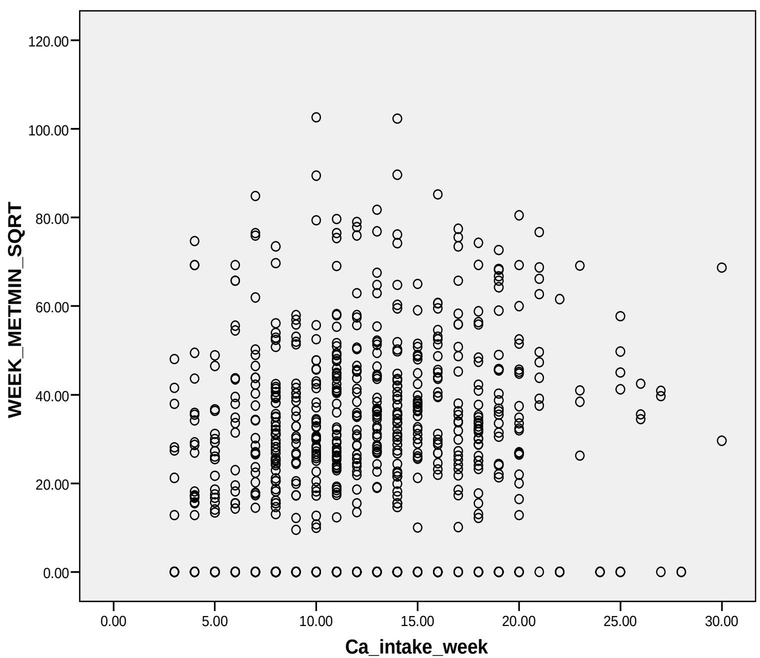

WEEK_METMIN_SQRT
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Benefits_Ca_Intake

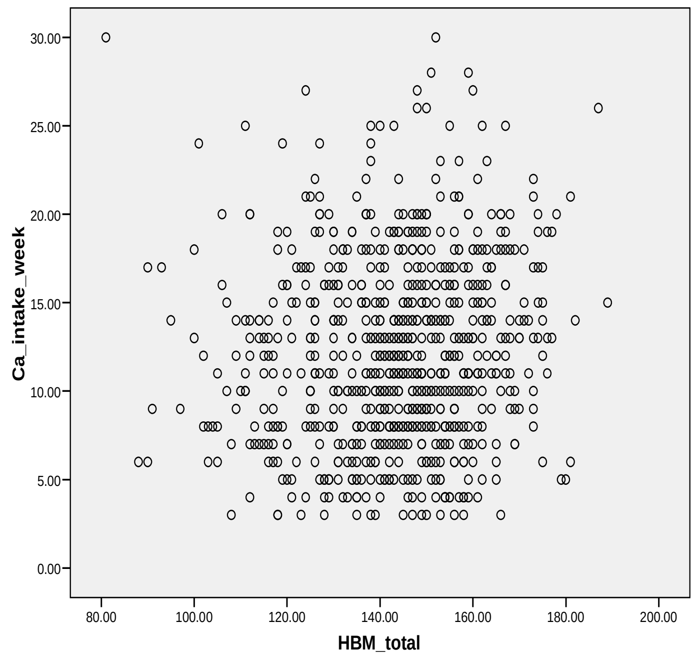

WEEK_METMIN_SQRT
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Benefits_Ex

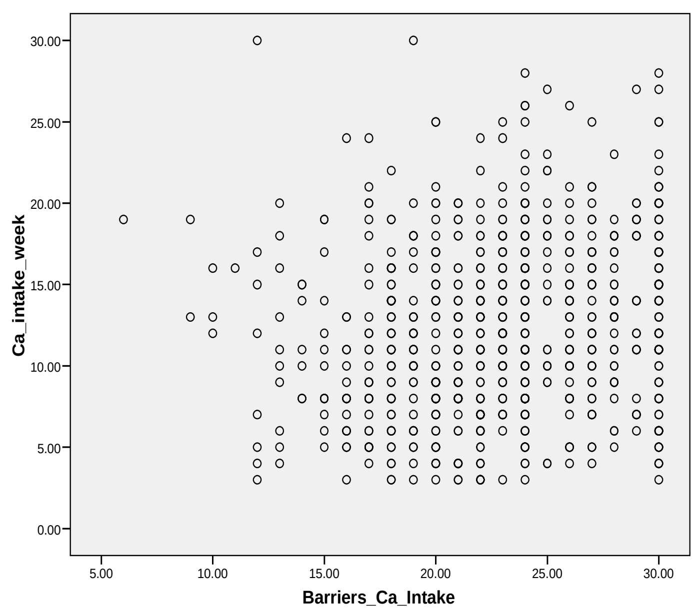

120.00
100.00
80.00
60.00
40.00
20.00
0.00
WEEK_METMIN_SQRT
5.00
10.00
15.00
20.00
25.00
30.00
Severity

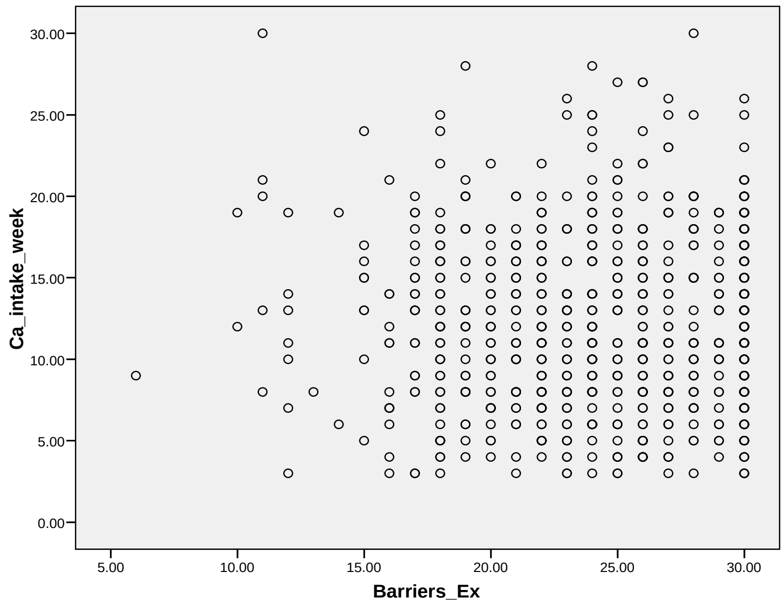

120.00
100.00
80.00
60.00
40.00
20.00
0.00
WEEK_METMIN_SQRT
5.00
10.00
15.00
20.00
25.00
30.00
Susceptibility

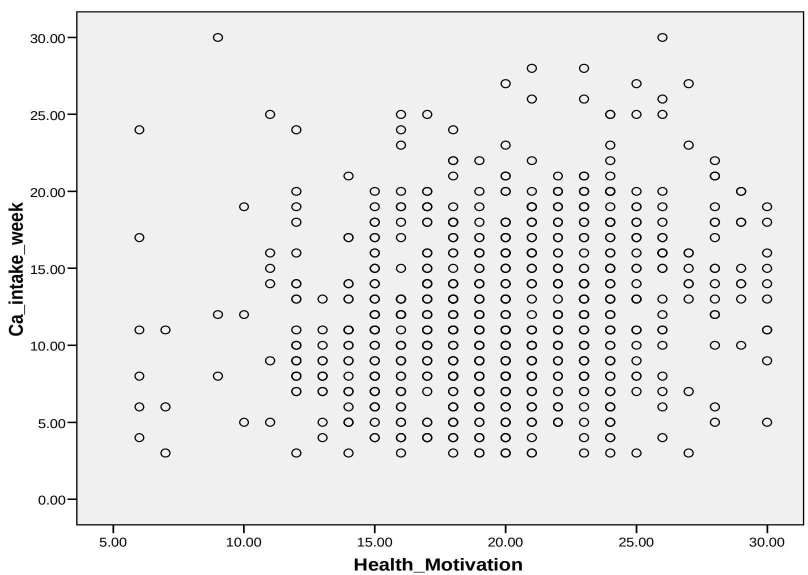

WEEK_METMIN_SQRT
OKT_total
0.00
20.00
40.00
60.00
80.00
100.00
120.00
5.00
10.00
15.00
25.00

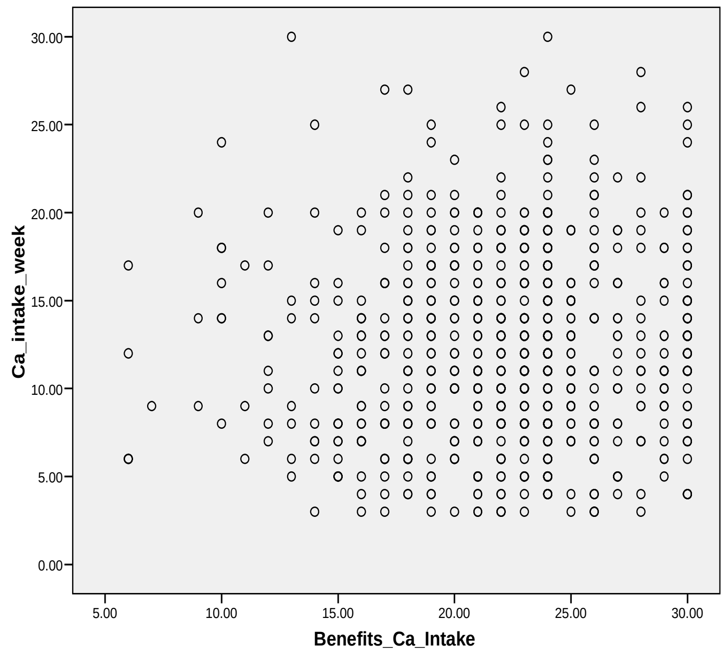

WEEK_METMIN_SQRT
Ca_intake_week
0.00
20.00
40.00
60.00
80.00
100.00
120.00
5.00
10.00
15.00
25.00
30.00

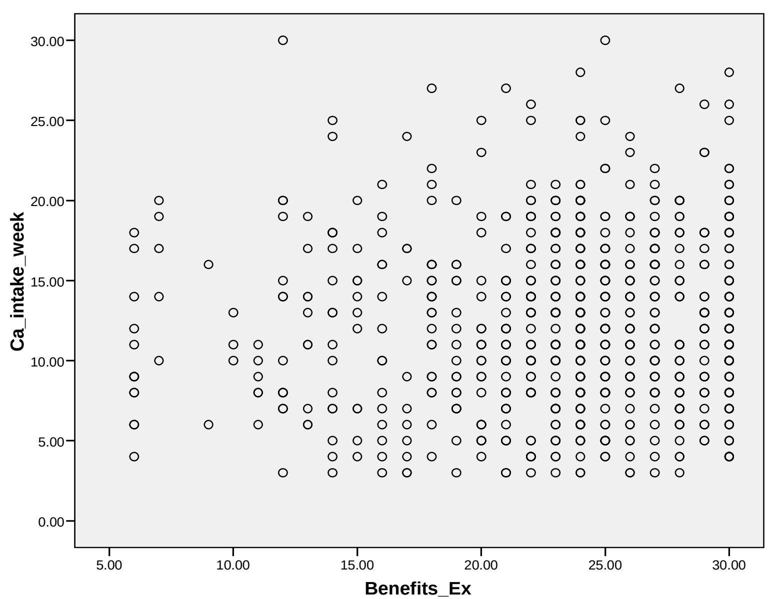

Ca_intake_week
HBM_total
30.00
25.00
20.00
15.00
10.00
5.00
0.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00

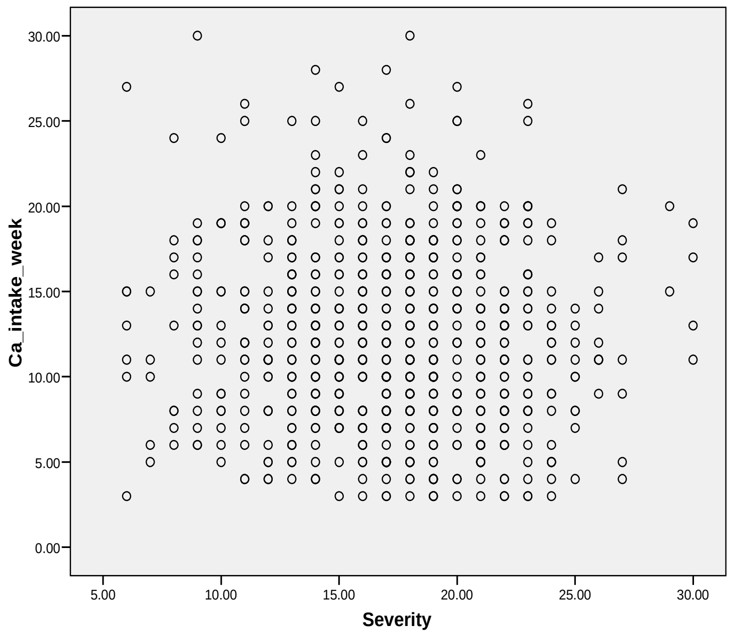

Ca_intake_week
Barriers_Ca_Intake
30.00
25.00
20.00
15.00
10.00
5.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00

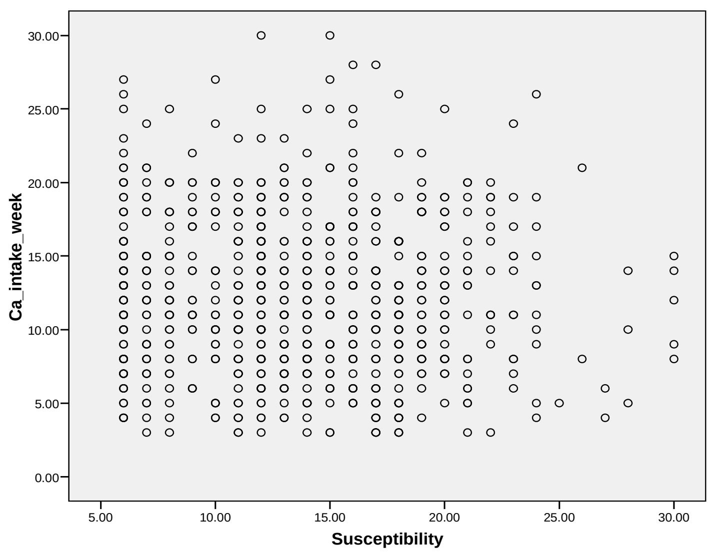

30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Barriers_Ex

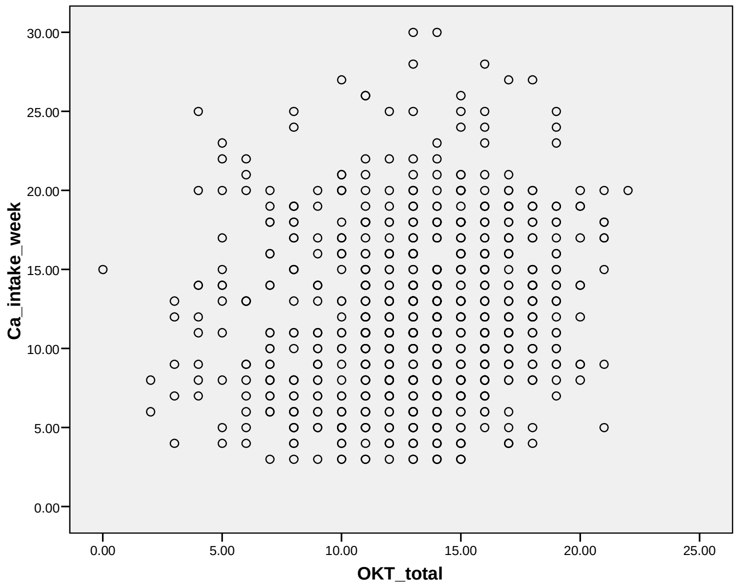

30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Health_Motivation


30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Benefits_Ca_Intake


30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Benefits_Ex


30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Severity


30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
5.00
10.00
15.00
20.00
25.00
30.00
Susceptibility


30.00
25.00
20.00
15.00
10.00
5.00
0.00
Ca_intake_week
0.00
5.00
10.00
15.00
20.00
25.00
OKT_total

APPENDIX F

UA IRB Approval

Office for Research

Institutional Review Board for the Protection of Human Subjects

THE UNIVERSITY OF ALABAMA
RESEARCH

February 13, 2009

Ellen Edmonds
Department of Health Science
College of Human Environmental Sciences
Box 870311

Re: IRB #: EX-09-CM-008, "Osteoporosis Knowledge, Beliefs and Behaviors of College Students: Utilization of the Health Belief Model"

Dear Ms. Edmonds:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your application has been given exempt approval according to 45 CFR part 46.101(b)(2) as outlined below:

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

This approval expires on 2/13/10. You will receive a notice of expiration 90 days in advance. If the study continues beyond that date, you must complete the appropriate portion of the Continuing Review and Closure Form. If you modify the application, please complete the Modification of an Approved Protocol Form. When the study closes, please complete the Continuing Review and Closure for closure.

Should you need to submit any further correspondence regarding this application, please include the assigned IRB application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM
Director of Research Compliance & Research Compliance Officer
Office of Research Compliance
The University of Alabama

152 Rose Administration Building
Box 870117
Tuscaloosa, Alabama 35487-0117
(205) 348-5152
FAX (205) 348-8882

Appendix G

UCA IRB Approval

Institutional
Review
Board

Memorandum

To: Ellen Edmonds

From: Tina Pilgreen
Research Compliance Coordinator

Date: September 18, 2008

Subject: Exemption Review of IRB # 08-137

Title: Knowledge and Beliefs about Osteoporosis in College Students

A member of the UCA Institutional Review Board (IRB) has reviewed your application requesting exemption from further IRB review.

The research, as presented in your application, qualifies for exemption from further IRB review.

Note: Any changes to the original application must be submitted to the Research Compliance Coordinator before implementation as they could change the exempt status of your project.

If you have any questions, please contact me at 450-3451 or tinap@uca.edu.