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Determinants Of Bone Mineral Density In African-American And Caucasian College-Aged Women

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DETERMINANTS OF BONE MINERAL DENSITY IN AFRICAN AMERICAN AND CAUCASIAN COLLEGE-AGED WOMEN

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ABSTRACT

Osteoporosis is a serious health issue affecting 10 million Americans, with an additional 44 million being at risk. Due to the morbidity and mortality associated with fractures caused by osteoporosis, it is an important public health concern. Some researchers suggest that African-American women fracture at a lower rate when compared to Caucasians with the same bone mineral density (BMD). However, when African-American women do fracture, they have higher mortality and morbidity rates. Data regarding risk factors and prevalence of low BMD among African American and Caucasian college-aged women are limited. **Purpose:** The primary purpose of this research was to explain the variance in bone mineral density (BMD) in African-American and Caucasian college-aged women. A secondary purpose was to evaluate the differences in osteoporosis knowledge among college-aged African-American and Caucasian women. **Methodology:** This study included 101 women ages 18 to 30 years. Fifty participants were African-American and 51 were Caucasian. Anthropometric measurements, osteoporosis knowledge, bone mineral density, body composition, physical activity and nutrient intake were assessed in the present study. **Results:** In this sample, 38.6% had low spinal BMD and 7.9% had low femoral bone mineral density. Femoral and spinal BMD were regressed on seven potential predictors: race, family history of osteoporosis, weight, current physical activity, osteoporosis knowledge, length of time on oral contraceptives, and calcium intake. Multiple regression analysis showed that BMI/weight and current physical activity were

the only two independent variables that significantly predicted spinal and femoral BMD. The final model explained 14.9% of the variance in spinal BMD and 13.1% of the variance in femoral BMD. Osteoporosis knowledge was not significantly different between African-Americans and Caucasians. **Conclusions:** Contrary to what was hypothesized, race was not a significant predictor of spinal or femoral BMD. Therefore, it is important for both African-American and Caucasian women alike to engage in osteoporosis-preventive behaviors. If women between the ages of 18 and 30 are made aware of their low-BMD status, they can begin bone-building activities before they reach peak bone mass. This provides an opportunity to decrease risk for osteoporosis and related fractures later in life.

DEDICATION

This dissertation is dedicated to my parents, Regina Johnson and the late Charles Edward Johnson. No one could ask for better parents or role models. Although my dad was not present in person to see me accomplish this, he will be forever present in my heart. I love and miss you dad.

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Chapter I

Introduction

Osteoporosis is defined as a skeletal disorder characterized by compromised bone strength, predisposing a person to an increased fracture risk (National Institutes of Health, 2001). The term "osteoporosis," which literally means "porous bone," was coined by French pathologist Jean Georges Chretien Frederic Martin Lobstein in the 1830s to describe patients' bones that had larger than normal holes (Patlak, 2001). Osteoporosis was not officially recognized as a disease by the World Health Organization (WHO) until 1994--over a century after it was first described (Anderson and Delmas, 2002).

It is estimated that 10 million Americans have osteoporosis, while 44 million adults over the age of 50 years are estimated to be at risk for this disease (Thomas, 2007). It is projected that by the year 2020, osteoporosis will affect approximately 14 million adults over the age of 50 (Lane, 2006). Women account for 80% of those affected by osteoporosis; and, men account for the remaining 20% (National Osteoporosis Foundation [NOF], 2008). As a result of the higher prevalence of osteoporosis in women, their risk of hip fractures is equal to their risk of breast, uterine, and ovarian cancers combined (Thomas, 2007).

Due to the morbidity and mortality associated with fractures caused by osteoporosis, it is an important public health concern (Thomas, 2007). The

annual incidence of osteoporotic fractures is estimated at over 1.5 million in the United States with 1 in 5 persons dying during the first year following a hip fracture (Lane, 2006). Some factors associated with increased mortality following a hip fracture include preexisting chronic conditions and low physical ability in patients prior to hip fracture (Meyer, Tverdal, Falch, and Peders, 2000). Hip fractures are considered the most serious kind of fracture due to the cost, mortality, and morbidity associated with them (Cummings and Melton, 2002). In 2005, hip fractures accounted for 72% of the estimated $17 billion spent on osteoporotic fractures in the United States (Burge et al., 2007). The medical cost of osteoporosis-related fractures is projected to rise nearly 50% by the year 2025 (Burge et al., 2007). Fifty to 70% of older patients are not able to return to their prefracture level of functioning; and, up to 79% of older patients are unable to ambulate following a hip fracture (Coleman et al., 2000).

When examining the mortality and morbidity statistics associated with osteoporotic fractures, studies show that certain ethnic groups are affected disproportionally. Barrett-Connor et al. (2005) suggest that Black women fracture at a lower rate when compared to Caucasians with the same bone mineral density; but, when they do fracture they have higher mortality and morbidity rates. These differences in outcome, in part, can be attributed to racial disparities in screening and treatment of Blacks at risk for osteoporosis. Neuner et al. (2007) found that Black female Medicare recipients aged 65-89 years, who resided in Florida, Illinois, or New York, were about 2/3 less likely than Whites to undergo BMD testing. Moreover, after surveying Black and White women aged 50 years and older who received their health care coverage through a large regional managed care organization in Alabama, Mudano et al. (2003)

found that Black women had roughly a two-third lower odds than White women of receiving BMD testing and all forms of prescription osteoporosis, even after having a previous fracture. Miller et al. (2005) found that the odds of at-risk Black women being referred for bone density testing were 61% lower than that of White women of comparable risk. Physicians were also less likely to recommend calcium and vitamin D supplementation to at-risk Blacks in comparison to White women of comparable risk (Miller et al., 2005).

The number of osteoporotic fractures is projected to increase an estimated 2.5 million by the year 2025 with African American women accounting for 3.2 % of the increase (Vanness and Tosteson, 2005). This is mainly due to the growing elderly population in the United States. By the year 2030 in the United States, ethnic minorities will comprise 25% of the 65 and older population (Bohannon, 1999). Annually, about 500,000 hospitalizations, 800,000 emergency room visits, and 180,000 nursing home placement can be attributed to osteoporotic fractures (US Department of Health and Human Services [USDHHS], 2004).

BMD and Fracture Risk

There is a strong relationship between BMD and fracture risk in postmenopausal women. In postmenopausal White women, there is a 1.5 to 2.6-fold increase in relative fracture risk for every one standard deviation decrease in BMD (Siris et al., 2001). However, this relationship is unclear in premenopausal women (Gourlay and Brown, 2004). Furthermore, there are limited data on the relationship between BMD and fracture risk in non-Caucasian women. Moreover, the data that exists are difficult to

interpret (Binkley, Schmeer, Wasnich, Lenchik, 2002). Some researchers recommend not using the word “osteoporosis” in conjunction with premenopausal women in cases where the diagnosis is based solely on BMD, when values are at the low end or just below normal BMD values, and when no fractures have occurred in the past (Cohen and Shane, 2008). The International Society for Clinical Densitometry (ISCD) goes even farther and states that the WHO classification for normal, osteopenia, and osteoporosis is not appropriate for healthy premenopausal women (Lewiecki, 2005). Below normal BMD values in young adults are typically not an important concern due to their low risk of falls and their greater muscle strength and agility (Gourlay and Brown, 2004). However, a history of premenopausal fractures increases risk of postmenopausal fractures (Hosmer, Genant, and Browner, 2002). Bone mineral density acquired by early adulthood can explain 60% of osteoporosis risk (Bachrach, Hastie, Wang, Narasimhan, and Marcus, 1999). Therefore, attainment of high peak bone mass can greatly reduce osteoporosis and associated fracture risk.

T-score and Z-score

The skeleton consists of cortical bone and trabecular bone. Cortical bone, which forms the outer part of long bones, is very dense and calcified, whereas trabecular bone, located at the ends of long bones and in the spine, is more spongy in appearance (K. Khan et al., 2001). Trabecular bone has a higher rate of bone turnover in comparison to cortical bone, which makes it more susceptible to bone loss (Hochberg et al., 2002). More than 50% of the bone in the lumbar spine and in the trochanter of the femur is trabecular bone, which makes these sites more susceptible to fracture (Meier,

et al., 2004). Increased tendency to falls is also a reason why postmenopausal women are at increased risk for hip fractures (Geusens et al., 2002).

The utilization of t-scores and z-scores to express bone mineral density (BMD) is typical. The t-score is based on comparison of an individual's bone density to the bone density of a 25- to 30-year-old of similar gender and race/ethnicity (Winters-Stone, 2005, p. 10). Calculation of an individual's t-score is performed by using the formula: (patient's BMD – young normal mean)/SD of young normal. The individual's BMD is compared with the mean value in a population of similar age, sex, and height when using the z-score (Richmond, 2003). Calculation of an individual's z-score is performed by using the formula: (patient's BMD – mean of similar population) / SD of similar population. Diagnostic criteria for osteoporosis, which is based on an individual's BMD t-scores, were established by the WHO (Lane, 2006). The WHO (1994) uses a threshold of 2.5 standard deviations below the mean of young adult women and a threshold of 1 to 2.5 standard deviations below the mean of young adult women as the criterion for a diagnosis of osteoporosis and osteopenia, respectively. These definitions for osteoporosis and osteopenia, however, are based on BMD measurements in menopausal White women. Furthermore, applying these criteria to premenopausal women with low BMD was not the original intention of these definitions (A. Khan, 2006). Questions have been raised as to whether or not separate race-specific norms should be used to define osteoporosis and osteopenia in non-White groups (Acheson, 2005). It is suggested that z-scores, instead of t-scores, be used when examining the BMD of premenopausal women, children, and men younger than 20 years (Lewiecki et al., 2004). Furthermore, the use of z-scores is suggested when determining the BMD of

African Americans on scanners that do not have an African-American reference database (Richmond, 2003). For the present study, t-scores were utilized for four reasons: 1) t-scores and z-scores are relatively equal for individuals between the ages of 19 and 30 years, 2) the densitometer utilized for this study contains an African-American database, 3) t-scores rather than z-scores are utilized by the WHO for diagnostic criteria, 4) and z-scores are not available on the densitometer used in this study for individuals younger than 18 years.

Bone densitometry, which is used to measure BMD, is one of the most frequently used techniques in the assessment and management of patients suspected to have osteoporosis (Ralston, 2005). Several techniques exist that can measure BMD. They include single-photon absorptiometry, dual-photon absorptiometry, dual-energy x-ray absorptiometry (DEXA), and quantitative computed tomography (Sievanen, Oja, and Vuori, 1992). DEXA, however, is considered the gold standard of methods used to diagnose osteoporosis (Lochmuller, Muller, Kuhn, Lill, and Eckstein, 2003). It delivers a dose of radiation that is about one tenth of that delivered by a standard chest x-ray (Vega, de Tejada, Hachero, Cano, and Rodriguez, 1996). Current DEXA technology uses a fan-beam x-ray source coupled with multi-element solid-state detectors (Salamone et al., 2000). This results in increased resolution and scan speed.

Risk Factors

Risk factors for osteoporosis can be classified as either primary or secondary. Primary risk factors for osteoporosis include estrogen deficiency, age, being female, genetic factors, personal history of fractures in the absence of trauma, thin/small frame,

diet low in calcium, vitamin D deficiency and reaching menopause either naturally or surgically before the age of 45 (Amonkar and Mody, 2002). In addition to those listed, the NOF (2008) also lists diseases and conditions such as anorexia nervosa, rheumatoid arthritis, and gastrointestinal diseases as well as being of Caucasian, Asian, or Hispanic/Latino race/ethnicities as risk factors for osteoporosis. Secondary risk factors include the use of certain drugs such as glucocorticoids and antiepileptics and lifestyle behaviors such as excessive alcohol consumption, smoking and physical inactivity (Amonkar and Mody, 2002). Just as risk factors can be considered primary or secondary, osteoporosis can be classified as either primary osteoporosis or secondary osteoporosis. Primary osteoporosis is defined as bone loss that occurs during the normal human aging process while secondary osteoporosis is defined as bone loss that results from specific, well-defined clinical disorders (Fitzpatrick, 2002).

The U.S. Preventive Services Task Force (as cited by USDHHS, 2004) recommends routine osteoporosis screening for all women aged 65 and older and starting at age 60 for women who are at high risk for osteoporosis as a result of having a body weight less than 70 kg or having a lack of hormone replacement therapy. The Task Force, however, does not make any BMD testing recommendations for premenopausal women nor are their screening recommendations race-specific. This poses a problem since it is possible for premenopausal women and non-White women to develop low BMD. The Institute for Clinical Systems Improvement, however, recommends BMD testing for premenopausal women who have had amenorrhea for more than 1 year (Mauck and Clarke, 2006).

Approximately 15% of premenopausal women have osteopenia (Kanis, Delmas, Burckhardt, Cooper, and Torgerson, 1997). Some factors that are linked to low bone mineral density in premenopausal women include conditions that require the use of glucocorticoids and anticonvulsants and the eating disorder, anorexia nervosa (Hansen and Vondracek, 2004). Other factors that are linked to low BMD in premenopausal women are delayed menarche and amenorrhea (Gourlay and Brown, 2004).

Prevention and Treatment

The NOF (2008) lists 5 steps for bone health and the prevention of osteoporosis: (1) get recommended amounts of calcium and vitamin D daily, (2) engage in regular weight-bearing exercises, (3) avoid smoking and excessive alcohol consumption, (4) discuss bone health with your healthcare provider, and (5) have a bone density test and take medication when appropriate. Several pharmacological and non-pharmacological interventions exist for the treatment of osteoporosis. The purpose of the pharmacological interventions is either to inhibit bone resorption and/or to decrease bone loss. Bisphosphonates, calcitonins, estrogens and the selective estrogen receptor modulators and calcium are the 5 major pharmacological categories of drugs used to treat osteoporosis (Stafford, Drieling, and Hersh, 2004). Bisphosphonates are the drug of choice with one study showing that they were prescribed 73% of the time during osteoporosis patients' visits (Stafford, Drieling, and Hersh, 2004). Non-pharmacological treatments include weight-bearing exercise, hip protectors, pain management, rehabilitation to improve mobility, ortheses, back supports and walking aids (Gaudio and Morabito, 2005; Lips and Ooms, 2000). Improvement of mobility is important because it

reduces fall-risk. A reduction in fall-risk is important because, a fall from standing height or less is the cause of approximately 90% of hip fractures in both men and women (Cummings and Melton, 2002).

Although bisphosphonates are the drug of choice for treating osteoporosis, data are limited regarding the use of these drugs in premenopausal women who do not have a secondary cause of bone loss, such as glucocorticoid therapy or an overactive thyroid gland (A. Khan, 2006). Glucocorticoid therapy causes an increase in bone turnover. Bisposphonates are beneficial in women who have undergone this type of therapy because they work by lowering bone turnover (A. Khan, 2006). These drugs, however, could suppress normal bone turnover rates in women who do not have a secondary cause of bone loss (A. Khan, 2006). Another reason why bisphosphates are not typically prescribed to premenopausal women with secondary causes of bone loss is because they have the ability to be discharged from the bones several years after being ingested (A. Khan, 2006). This gives them the potential of being released during pregnancy; and their effects on the bones of fetuses are unknown (A. Khan, 2006).

In order to understand how pharmacological treatments for low bone density work, the process of bone building and bone resorption must be understood. Bone contains three types of cells: osteoblasts, osteocytes, and osteoclasts (K. Khan, et al., 2001). Osteoblasts, which are under the control of endocrine, paracrine, and autocrine factors, are responsible for producing bone matrix. Osteocytes are mature bone cells that assist with communication between bone cells and aid in bones response to mechanical loading. Lastly, osteoclasts are responsible for removing old bone. One way in which antiresorptive pharmacological agents affect bone cells is by shortening

the lifespan of osteoclasts and increasing the lifespan of osteocytes and osteoblasts (Boonen, Haentjens, Vandenput, and Vanderschueren, 2004).

Purpose:

The primary purpose of this research is to explain the variance in BMD in African-American and Caucasian college-aged women. A secondary purpose was to evaluate the differences in osteoporosis knowledge among college-aged African-American and Caucasian women.

Research question:

What variables account for the variance in BMD among African-American and Caucasian college-aged women?

Operational Definitions:

Amenorrhea is defined as the absence or suppression of menstruation (Thomas, 1997).

Anticonvulsant is defined as an agent that prevents or relieves the sudden onset of involuntary muscular contractions and relaxations (Thomas, 1997).

Anorexia nervosa is defined as an eating disorder marked by excessive fasting (Thomas, 1997).

Bone matrix is a combination of extracellular proteins arranged to promote mineral deposition (Marzia et al., 2000).

Cortical bone is a very dense and calcified type of bone found on the outer parts of long bones, such as the femur (K. Khan et al., 2001).

Glucocorticoid is defined as a general classification of adrenal cortical hormones that are primarily active in protecting against stress and in affecting protein and carbohydrate metabolism (Thomas, 1997).

Menarche (menses) is defined as the initial menstrual period in a woman which usually occurs between the ages of 9 and 17 years (Thomas, 1997).

Osteoblasts are bone cells responsible for producing bone matrix (K. Khan, et al., 2001, ch. 1).

Osteoclasts are bone cells that are responsible for the removal of old bone (K. Khan et al., p. 7, 2001).

Osteocytes are mature bone cells that assist with communication between bone cells and aid in bones response to mechanical loading (K. Khan, et al., 2001, ch. 1).

Peak bone mass is defined as the maximum amount of bone acquired at the end of growth (Lafage-Proust, Combe, Barthe, and Aparicio, 1999).

Premature menopause refers to development of amenorrhea due to cessation of ovarian function before the age of 40 years (Goswami and Conway, 2005).

Premenopausal or premenopause refers to the period in women between the age of peak bone mass and menopause (Lewiecki, 2004).

Trabecular bone is located at the ends of long bones and in the spine, is spongy in appearance (K. Khan et al., 2001).

Null Hypotheses:

H_{O1}: African-American women's bone mineral density level will not be significantly different from Caucasian women's bone mineral density among low, normal, and high BMI groups.

H_{O2}: Women with high BMIs will not have significantly different bone mineral density than women with low BMIs regardless of ethnicity.

H_{O3}: Women who have inadequate intake of calcium will not have a significantly different BMD than women who have an adequate intake of calcium.

H_{O4}: BMD will not be significantly different in women who currently engage in regular physical activity in comparison to women who do not engage in regular physical activity regardless of ethnicity.

H_{O5}: Women who participated in high school sports will not have significantly different BMD values than women who have not engaged in physical activity in the past regardless of ethnicity.

H_{O6}: Length of time on oral contraceptives will not be significantly related BMD.

H_{O7}: BMD values will not be significantly different in women who are more knowledgeable of osteoporosis in comparison to those who are less knowledgeable.

H_{O8}: BMD values will not be significantly different between African American and Caucasian women.

Alternative Hypotheses:

H_{A1}: African-American women's bone mineral density level will be significantly different than Caucasian women's bone mineral density among low, normal, and high BMI groups.

H_{A2}: Women with high BMIs will have significantly different bone mineral density than women with low BMIs regardless of ethnicity.

H_{A3}: Women who have inadequate calcium intake will have a significantly different BMD than women who have an adequate intake of calcium.

H_{A4}: BMD will be significantly different in women who currently engage in regular physical activity in comparison to women who do not engage in regular physical activity regardless of ethnicity.

H_{A5}: Women who participated in high school sports will have significantly different BMD values than women who have not engaged in physical activity in the past regardless of ethnicity.

H_{A6}: Length of time on oral contraceptives will be significantly related to BMD.

H_{A7}: BMD values will be significantly different in women who are more knowledgeable of osteoporosis in comparison to those who are less knowledgeable.

H_{A8}: BMD values will be significantly different between African American and Caucasian women.

Delimitations:

1. Only African-Americans and Caucasians are included in this study.
2. Only women are included in this study.
3. Participants must be between the ages of 18 and 30, inclusive.

Limitations:

1. All participants will be volunteers. Volunteers are likely to represent a biased sample because of their interest and motivation to volunteer.
2. The sample of this study will not be a random sample.

3. The sample of this study will be selected from Northern Mississippi and therefore not a nationally representative sample.

Assumptions:

1. Participants can read and understand English.
2. Participants are the race that they report.
3. Participants answer questions honestly.

Significance of Study:

With an increasing aging population and longevity of minority groups, osteoporosis is increasing as a public health concern (Kidambi, Partington and Binkley, 2005). Some researchers suggest that African American women fracture at a lower rate when compared to Caucasians with the same bone mineral density but when they do fracture they have higher mortality and morbidity rates (Barrett-Connor et al., 2005). Data regarding risk factors and prevalence of low bone mineral density among African American college women are limited. Caucasian women are at the greatest risk for low BMD. However, African American women do have osteopenia and osteoporosis. The primary objective of this research is to explain the variance in BMD in African-American and Caucasian college-aged women. A secondary objective of this study is to evaluate knowledge about osteoporosis among college-aged African-American and Caucasian women.

Chapter II

Review of Literature

This chapter contains an extensive review of literature pertinent to the aims of this study. This chapter is divided into eight sections. The first section discusses peak bone mass and the importance of attaining this early in life. The second section explains risk factors of osteoporosis. The third section, which is arguably the most important section, discusses racial differences in BMD and osteoporosis risk. The fourth section discusses heredity and how it can play a part in determining osteoporosis risk. The fifth section discusses nutrient intake and its importance in BMD determination. The sixth section discusses contraceptive use and its effect on bone mineral density. The seventh section discusses body composition and body weight and their possible effect on BMD. The eighth section discusses the importance of type of physical activity for building or maintaining BMD. Lastly, the ninth section discusses osteoporosis knowledge.

Peak Bone Mass

Amount of peak bone mass is a major determinant of osteoporosis and fractures in the elderly (Wren, Kim, Janicka, Sanchez, and Gilsanz, 2007). According to Thomas (2007), the most important predictor of future fracture risk is peak bone mass. Bone mineral density acquired by early adulthood can explain 60% of osteoporosis risk (Bachrach et al., 1999). Peak bone mass is defined as the maximum amount of bone

acquired at the end of growth (Lafage-Proust et al., 1999). It is generally thought that women reach peak bone mass in their mid-to-late 20s (Picone, 2004). Other researchers, however, report BMD peaking at around age 35 years (Cohen and Roe, 2000).

Many factors play a role in the attainment of peak bone mass. These factors include genetics, nutrition, and exercise in addition to other factors such as tobacco and alcohol use (Heaney et al., 2000). Ettinger et al. (1997) reports that Black women and men attain 5-15% more peak bone mass than Whites. Heredity, nutrition, and exercise will be discussed in a later section.

Risk Factors

Primary risk factors for osteoporosis include estrogen deficiency, age, being female, genetic factors, thin/small frame, diet low in calcium, vitamin D deficiency, being of Caucasian, Asian, or Hispanic/Latino race/ethnicities and reaching menopause either naturally or surgically before the age of 45 (Amonkar and Mody, 2002; NOF, 2008). The risk of bone loss and osteoporosis increases with age due to increased bone resorption and decreased bone formation which is a result of the decrease in estrogen production (Leskela et al., 2003). Women who reach menopause prematurely are at greater risk for osteoporosis due to their extended time of estrogen deficiency (Kalantaridou et al., 2006). Estrogen deficiency induces bone loss by causing the upregulation of osteoclasts (Cencil et al., 2000).

Although most prevention and research protocols with osteoporosis are mainly designed with the underlying school of thought that African-American and Hispanic

women have a small chance of developing osteoporosis, these minority groups are disproportionately affected by some of the main risk factors associated with osteoporosis (Geller and Derman, 2001). Results from NHANES III show that African American women tend to have a lower intake of calcium when compared to White and Hispanic women (Arab, Carriquiry, Steck-Scott, and Gaudet, 2003).

Sex hormones play a role in the differences in BMD among men and women. Androgens, which are male sex hormones, are thought to increase bone formation (Orwoll, Belknap, and Klein, 2001). Due to these hormonal differences, women typically have a smaller/thinner frame than men. Consequently, as a result of their bone geometry, individuals with small frames are at risk for osteoporosis due to weaker bones (Lewiecki, 2004). Women are also at greater risk for osteoporosis than men because they begin with a lower amount of bone mass than men and because they lose bone mass at a greater rate than men (USDHHS, 2004).

Secondary risk factors include the use of certain drugs such as glucocorticoids and antiepileptics and lifestyle behaviors such as excessive alcohol consumption, smoking, anorexia nervosa, rheumatoid arthritis, and gastrointestinal diseases and physical inactivity (Amonkar and Mody, 2002; NOF, 2008). Glucocorticoids cause osteoporosis by influencing the production and action of hormones that regulate bone and calcium metabolism, which in turn causes bone resorption and impaired bone formation (Mazziotti, Angeli, Bilezikian, Canalis, and Giustina, 2006). Long-term treatment with antiepileptics can ultimately result in vitamin D deficiency, which increases risk of osteoporosis (Ma, Kong, Chan, Tong, and Chan, 2007).

Race

The NOF (2008) states that individuals who are Caucasian, Asian, or Hispanic/Latino are at increased risk for osteoporosis. When compared to Caucasians, as well as other ethnicities, African American women tend to have higher BMD values (USDHHS, 2004 and NIH, 2001). Barrett-Conner et al. (2005) described the prevalence of low BMD and the relationship between low BMD and 1-year fracture occurrence in Black, Asian, White, Hispanic, and Native American postmenopausal women 50 years or older. Results show that Black women had the highest mean t-score, whereas, Asian women had the lowest mean t-score. It was also found that White and Hispanic women had the greatest risk for fractures and that Asian women had the lowest risk for fractures, although Asian American women have lower BMD values (Barrett-Conner et al, 2005). Finkelstein et al. (2002) also found that African-American women between the ages of 42 to 52 years old had higher BMD values in the femoral neck and lumbar spine when compared to Caucasian, Chinese, and Japanese women.

Differences in BMD between races in young adults have been tested as well. Ettinger et al. (1997) tested whether or not differences in bone density between Black and White males and females between the ages of 25-36 years can be explained by differences in bone metabolism and lifestyle. Their results show that both male and female Blacks had significantly higher BMDs at all skeletal sites in comparison to White males and White females.

Though studies continuously show that African Americans have higher BMD than other ethnic groups, this does not mean that African Americans are without risk regarding osteoporosis. Currently, over 300,000 African-American women have

osteoporosis (Kessenich, 2000). Results from the National Osteoporosis Risk Assessment (NORA), a longitudinal observational study examining the incidence, risk factors, and fracture incidence of low BMD in postmenopausal women showed that 32% of African-American women had osteopenia and 4% had osteoporosis (Siris et al., 2001). Moreover, Kidambi, Partington and Binkley (2005) found that when examining the quantitative calcaneal ultrasound results of 150 Wisconsin, African-American women aged 45 years and older, 33% had low bone mass. Additionally, only 25% of the study sample surveyed believed that they were at moderate to high risk for osteoporosis.

Heredity

The NOF (2008) lists family history as a risk factor for osteoporosis. It is believed that a variety of genes that control bone building and bone loss are involved in the development of osteoporosis (Rizzoli, Bonjour, and Ferrari, 2001). The determinants of bone strength, including BMD, peak bone mass, bone geometry, and bone metabolism, are influenced by genetics (Bohannon, 1999). Up to 80% of the differences seen in peak BMD can be attributed to genetic factors (Koller et al., 2000). Hip fractures are twice as likely to occur in women with a maternal history of hip fracture in comparison to women without a maternal history of hip fracture (Lane, 2006).

Nutrient Intake

The bones and teeth house over 99% of total body calcium in humans (Cashman, 2002). According to the NOF (2008), a diet low in calcium is a risk factor for

osteoporosis. Although heredity can contribute up to 80% of the differences seen in peak BMD, up to 40% of the variability seen in peak bone mass can be attributed to environmental factors, including diet (Koller et al., 2000; Lewiecki, 2005). Some of the vitamins that are shown to have an effect, whether substantial or negligible, include calcium, vitamin D, iron, zinc, and magnesium. A deficiency in magnesium can affect bone density indirectly. Calcium metabolism is altered when there is a deficiency in magnesium (Ilich and Kerstetter, 2000). Dairy product intake is a measure of calcium intake due to the abundance of calcium in dairy products; especially milk (Heaney, 2000). Food frequency questionnaires are commonly used to measure dietary intake in research studies due to the low cost associated with their use (Sebring et al., 2007).

Although the recommended dietary reference intake (DRI) for calcium is 1300 mg for individuals ages 9 to 18 and 1000 mg for individuals ages 19 to 50, only 19% of females ages 9 to 18 and 40% of women ages 19 to 50 are currently meeting these requirements (Beaudoin and Blum, 2005). The percentages of females not meeting the DRI are even higher when examining minority populations. Lactose maldigestion's high prevalence among minority groups, especially non-Hispanic African Americans, is typically cited as the culprit for low intake among minority populations (Jackson and Savaiano, 2001). Lactose maldigestion occurs in 70% to 75% of Blacks (Buchowski, Semenya, and Johnson, 2002). Some evidence exists that there is an increased prevalence of osteoporosis among lactose maldigestors due to their avoidance of dairy products (Jackson and Savaiano, 2001).

The effect that calcium has on bone density and fracture risk has been debated. One study found that higher intakes of vitamin D and calcium reduced osteoporosis risk

but not 3-year fracture risk in Caucasian women (Nieves et al., 2008). Another study conducted in Sweden showed that calcium and vitamin D intake in women estimated at middle age and older age is not of major importance in the primary prevention of osteoporotic fractures (Michaelsson, Melhus, Belloco, and Wolk, 2003). Wallace and Ballard (2002) found that lifetime calcium consumption was not a significant predictor of BMD or bone mineral content (BMC) in premenopausal Caucasian women, although current calcium consumption contributed to the total variance in BMD. Prince et al. (2006), however, found that supplementation with 1200 mg of calcium carbonate tablets in elderly women reduced the risk of clinical fracture in those who adhered to the protocol. According to Heaney (2001), osteoporotic fracture risk can be reduced by 30% to 50% by increasing calcium intake in the over-65 population. Ramsdale et al. (as cited in Gourlay and Brown, 2004) found a significant correlation between calcium intake and BMD at the neck of the femur (r = .41), the Ward's triangle of the femur (r = .40) and the trochanter of the femur (r = .47) and at the spine (r = .27) in healthy premenopausal women aged 21 to 47 years. Harris et al. (2003) also found that calcium, magnesium, phosphorus, zinc and vitamin D had positive significant associations with BMD.

Contraceptives

Some evidence exists that the use of oral contraceptives by women decreases the risk of osteoporosis. A study of 710 Australian women ages 20 to 69 showed that premenopausal women who had been exposed to oral contraceptives had lumbar spine bone density values that were 3.3% higher than those not exposed to oral

contraceptives (Pasco et al., 2000). All studies have not shown an increase in bone density as a result of oral contraceptive use. Prior et al. (2001) looked at oral contraceptive use and BMD changes in 524 women ages 25 – 45 years. They observed lower BMD values in premenopausal women who used oral contraceptives when compared to premenopausal women who had never used them. Another study examining oral contraceptive use and BMD changes over a 36-month period in women aged 18 to 39 years concluded that oral contraceptive did not appear to have any impact on bone density during the study period (Reed et al., 2003).

One contraceptive of concern is depot medroxyprogesterone acetate (DMPA), also known as Depo-Provera, which is injected intramuscularly. This particular contraceptive is of concern due to its ultimate suppression of estrogen production from the ovaries (Albertazzi, Bottazzi, and Steel, 2006). Walsh, Eastell, and Peel (2008) found that that DMPA use was associated with a 5% bone density deficit at the hip and spine in Caucasian women who starting using it before the age of 20. This deficit, however, was not seen in women who began using Depo-Provera after the age of 34. Another study comparing BMD changes in first-time DMPA users to BMD changes in nonusers found that BMD of the hip and spine declined after each injection during the entire 24 month study period in comparison to a less than 1% decline in nonusers (Clark, Sowers, Nichols, and Levy, 2004). Since the adverse effects of DMPA on bone are most pronounced in those who have not attained peak bone mass, it is recommended that DMPA not be used in women prior to this attainment (Lewiecki, 2005).

Body Composition/Weight

The link between body composition and BMD is well established, especially in older adults. Coin et al. (2000) determined the relationship between nutritional status and bone mass with body composition. Subjects included 60 women, 30 of whom were underweight and 51 men, 30 of whom were underweight. The low weight women had a mean age of 81.3 years and the low weight men had a mean age of 80.8 years. When looking at bone mineral content (BMC) and bone mineral density (BMD) at the femoral level, both genders of underweight patients had lower values when compared to normal subjects. Bone turnover were within normal range for the underweight and normal weight individuals. In both men and women for the entire subject population, whole body BMD correlated with fat-free soft mass ($r = .34$ and $r = .31$, respectively). BMD correlated with appendicular skeletal muscle mass ($r = .35$) in men only. It was concluded that, in addition to other factors, malnutrition and osteoporosis is associated with low weight in the elderly.

Glauber et al. (1995) examined the relationship between bone density and weight, body mass index, height, adiposity, regional fat distribution, and frame. Subjects were 6,705 non-Black women with an average age of 71.2 years. Data on lifestyle and health-related behaviors were collected as well as weight, height, waist-to-hip ratio, knee height, and elbow width. Single- photon absorptiometry was used to measure BMD at the distal and proximal radius and the calcaneous during the first visit. Dual-energy x-ray absorptiometry was used to measure BMD of the lumbar spine and femoral neck. Bioelectrical impedance analysis was used to measure adiposity. Weight accounted for over 81% of the variability of adiposity on BMD at weight-bearing sites.

Thirty-two to 47 % of the effects of adiposity on BMD could be accounted for by weight at non-weight bearing sites. Proximal femoral BMD increased with increases in body weight. Weight, however, did not influence the relationship between BMD and age. It was concluded that due to its loading effects on the skeleton, weight as the major anthropomorphic determinant of bone density in late postmenopausal women.

Ettinger et al. (1997) tested whether or not differences in bone density between Black and White males and females could be explained by differences in bone metabolism and lifestyle. Subjects included 109 and 95 Black men and women, respectively, and 114 and 84 White men and women recruited from the Kaiser Permanente Medical Care Program as a part of the CARDIA study. DEXA of total body, hip, lumbar spine, lean body mass, fat mass, and ratio of trunk to leg fat was performed using a densitometer. Muscle strength of the quadriceps and hamstrings were assessed with a dynamometer. Bone markers and mineral metabolism markers creatinine, calcium, phosphorus, bone-specific alkaline phosphatase, intact parathyroid hormone, 25D, 1,25 D, and osteocalcin were attained through blood draws. Growth factors and level of sex and adrenal hormones were also measured. Physical activity, diet habits, and medical history including history of tobacco and alcohol use were assessed. Results show that physical activity was higher in Black men than White men but was higher in White women in comparison to Black women. Higher intakes of calcium and vitamin D were seen in White women in comparison to Black women. Smoking and weight were higher in black subjects in comparison to white subjects. Black men had lower abdominal fat than White men whereas Black women had higher abdominal fat than White women. Blacks had significantly higher BMDs at all skeletal

sites in comparison to white subjects. Calcium and vitamin intake were higher in White women than in Black women. No significant differences were seen among men. Black men and women had lower levels of 25D and higher 1,25D levels in comparison to their White counterparts. This study concluded that clinical and biochemical variables measured in young adulthood does not explain racial differences in BMD.

Other studies have focused on children and young adults to establish the relationship between BMD and body composition. Rollins, Imrhan, Czajka-Narins, and Nichols (2003) assessed lumbar spine and femoral neck BMD values in 61 Caucasian women aged 18 to 30 years. These women were all healthy and did not have any known risk factors that would place them at apparent risk for secondary osteoporosis. Participants were divided into a lower weight group (BMI of 16.0 to 19.9) and a normal weight group (BMI 23.0 to 25.9). Results showed that 9 of the 30 women in the lower weight group had spinal BMD values in the osteopenic range, according to the WHO criteria, in comparison to 2 of the 31 women in the normal weight group who had osteopenic spinal BMD values. Furthermore, none of the normal weight participants had femoral neck BMD values within the osteopenia range in comparison to 3 participants having femoral BMD values within the osteopenia rage.

Young et al. (2001) sought to determine the degree of association between longitudinal changes in bone mineral density and body composition in female twins. The subjects included 104 paired female twins and 78 unpaired female twins with their subjects being aged 8 to 25 years. Their subjects were registered with the Australian Twin Registry. Dual energy x-ray absorptiometry (DEXA) was used to measure total body fat, total body lean mass, and total body bone mineral content (BMC) as well as

bone mineral density (BMD) at the lumbar spine, femoral neck and total hip. Data on menarchial status and height measurements were also taken. Results showed that height increased and changes in lean mass were the greatest 1-year before menarche. Changes in fat mass, BMD at the hip and lumbar spine, and total BMC were at their largest around the age of menarche. Association results were reported in annual percent changes in lumbar spine and hip areal BMD and total BMC against annual changes in lean and fat mass and height rather than with correlation values. Changes in lean mass, fat mass and height were associated with changes in BMD at the lumbar spine, femoral neck, total hip, and total body BMC during the linear growth phase. For the post-linear growth phase, femoral BMD changes and total body BMC were associated with changes in lean mass and fat mass. It was concluded that lean mass plays a role in building bone during linear growth and that fat mass plays some part in maintaining bone density during post-linear growth.

Reid, Plank, and Evans (1992) evaluated the relationship between bone mineral density (BMD) and body composition in men and premenopausal women. Subjects included 68 healthy premenopausal women and 51 healthy men all of which were White. Dual-energy x-ray absorptiometry was used to measure total BMD. Height and weight measurements were also taken for each of the subjects. Multiple regression analysis and correlation coefficients were used to analyze the data. Results show that men were taller and had higher BMDs and lean mass in comparison to women. Fat mass increased with age in women but not in men. Weight, and lean mass were closely associated with BMD in both men and women ($r = .56$ compared to .69, and .51 compared to .55 respectively), whereas BMD was related to fat mass in women only ($r =$

.60). When BMD was expressed as a ratio to height, it was closely associated with fat mass in women (r = .57) and just attained significance in men (r = .28). When multiple regression was used to look closer at the relationship between fat and lean mass and BMD, lean and fat mass were associated with BMD in women only (R^2 = .48). The researchers concluded that although fat mass is related to bone mineral density in women, it is not related to bone mineral density in men.

Wang et al. (2005) attempted to validate the reported findings that amount of lean tissue and fat mass affects bone mass and to differentiate between the affect of each of these masses on bone mass. Subjects included 317 African American women, 154 Asians, 322 Caucasians, and 128 Latinas who were ages 20-25 years and who had no known diseases that would affect bone mass. Height, weight, and reproductive history were recorded. Dual-energy X-ray absorptiometry was used to measure lean tissue mass, fat mass, and bone density of the spine, left proximal femur, and whole body. Multiple linear regression, ANOVA, and Bonferroni's techniques were used to analyze the data. Results show that African Americans had the highest mean weight, fat mass and lean tissue whereas Asians had the lowest of all of these. African Americans had the highest bone density and Asians had the lowest at most sites. Fat mass had a significant positive correlation with femoral neck BMD (r = .23). Lean mass and weight had significant positive correlations ranging from 0.34 to 0.76 with femoral neck BMD, whole body BMD, whole body BMC, and whole body BMC/height. Except for bone mineral apparent density, lean mass had a significantly greater effect on bone density than fat mass for all bone density measures in multiple linear regression. It is

concluded that lean tissue mass has a greater effect on bone density than does fat mass in young women.

Physical Activity

Osteoporosis is one of the many chronic diseases that can result from a lack of physical activity. Therefore, engaging in physical activity can help prevent osteoporosis. Wolff's Law can explain the mechanism by which exercise improves bone density. Wolff's Law describes bones' ability to adapt to physical strains that are placed on them (K. Khan et al., 2001, ch.3, p. 27). Since some of the available pharmacological therapies are not typically recommended in premenopausal women with low BMD, prevention of osteoporosis through diet and exercise is preferable (Lewiecki, 2005). It is important to start these prevention methods early. Studies have shown that Caucasian female adults who participated in sports during their teenage years had a significant increase in femoral BMD compared to those who were sedentary as a teenager (Ford, Bass, Turner, Mauromustakos, and Graves, 2004; Lloyd et al., 2000).

When examining Wolff's Law, it is noted that the more strain that is put on the bones, the stronger they become. This is the reason why strength training is so effective in building BMD. In a meta-analysis of controlled trials looking at the effect of resistance training on BMD in women, it was concluded that resistance training has a positive effect on spinal BMD in pre- and postmenopausal women (Kelley, Kelley, and Tran, 2001). This same meta-analysis also found that resistance training had a positive effect on BMD in the femur and radius of postmenopausal women (Kelley, Kelley, and Tran, 2001).

Although the benefits of physical activity have been well researched, some ethnic groups are not taking advantage of these benefits. When observing physical activity in American society, minority women are among the least active subgroups (Geller and Derman, 2001). Furthermore, physical activity is lower in African-American women than all other ethnic groups except for Mexican-American women (Adams-Campbell et al., 2000). This lack of physical activity among this group places them at increased risk for osteoporosis.

Osteoporosis Knowledge

It is possible that osteoporosis prevalence is linked to a lack of knowledge regarding the disease and its risk factors (Wilson, 2007). Although one would think that knowledge of what is healthy and what is unhealthy will cause a behavior change, knowledge alone is often not enough to cause a behavior change (Wallace, 2002). Studies have shown that women are typically aware that lack of physical activity and low calcium intake are risk factors for osteoporosis (Kasper, Peterson, and Allegrante, 2001; Ford, Bass, and Keathley, 2007). However, women are more likely to be unaware that factors such as amenorrhea and menopause put them at increased risk for osteoporosis (Kasper, Peterson, and Allegrante, 2001). For this study, osteoporosis knowledge will be assessed using the Osteoporosis Knowledge Test (OKT) developed by Kim, Horan, Gendler, and Patel (1991).

Chapter III

Methodology

The primary purpose of this research is to explain the variance in BMD in African-American and Caucasian college-aged women. A secondary purpose was to evaluate the differences in osteoporosis knowledge among college-aged African-American and Caucasian women. This chapter includes a discussion of the subjects, a description of the surveys used, step-by-step data collection procedures, measurements of variables, and treatment of the data. This chapter is divided into the following sections: (1) subjects, (2) subject selection, (3) laboratory procedures, (4) equipment, and (5) statistical analysis.

Subjects

Participants were 18-30 year-old African American and Caucasian females identified in three groups: (a) *low weight*, (b) *normal weight*, and (c) *high weight*. Power analysis indicated that a total of 72 subjects were needed to attain a power of .80 with an estimated effect size of .30 at an α-level of .05.

Subject Selection

Participants were recruited by email, advertising in University classrooms and on bulletin boards around the University as well as in doctors' offices, in local churches, and in local newspapers. Participants were included if they were between the ages of

18 and 30, and did not have any conditions that would place them at apparent risk (celiac disease, corticosteroid use, and amenorrhea) for low bone mineral density. As documented in the initial phone screening, potential participants were questioned about apparent osteoporosis risk factors. The purpose of this questioning was to determine if any risk factors would be potential contributors to the current study. Upon initial phone contact with the principal investigator (PI), participants were screened over the phone as described in detail on the form "Initial phone contact with potential participant" (Appendix A). The initial phone screening process determined preliminary eligibility based on the inclusion/exclusion criteria described. Secondary eligibility was based on the results of the pre-DEXA pregnancy test required prior to an initiation of DEXA scan. Once a participant was deemed preliminarily eligible, the participant was scheduled to come in for the initial visit.

The respective procedures presented no more than minimal risk of harm to the involved participants and involved no procedures for which written consent is normally required outside of the research context. In addition, written informed consent was obtained at the initial visit prior to any research activities. This study was approved by the University of Mississippi's Institutional Review Board (IRB Protocol 07-076).

Laboratory Procedures

All participants were required to meet with the researcher on two occasions. The following procedures were followed with all participants during their initial visit:

1. Each participant met researcher in the lobby of the Turner Center and then was escorted to the Body Composition and Bone Mineral Density Laboratory.

2. Each participant was asked to read and sign the informed consent form provided.

3. Each participant was asked to complete a demographic questionnaire - approximately 10 minutes (Appendix D).

4. Each participant was instructed on how to and asked to complete the 7-day Physical Activity Recall instrument – approximately 10 minutes (Appendix C).

5. Each participant was instructed on how to complete a four-day food log that includes 2 weekdays and 2 weekend days – approximately 10 to 15 minutes (Appendix E).

6. Each participant was asked to complete the Osteoporosis Knowledge Test – approximately 10 minutes (Appendix B).

7. The researcher gave a sterile urine specimen container to each participant and then gave directions.

8. The researcher escorted the participant to the restroom and obtained the sample from the participant once completed.

9. The researcher and the participant returned to the Body Composition and Bone Mineral Density Laboratory where the researcher analyzed the sample (approximately 5 minutes total). If the pregnancy test was positive, the researcher did not perform a DEXA scan on the participant because of this positive reading. This is due to the risks associated with radiation exposure to an unborn fetus. In turn, the participant was ineligible to participate in the study based on the documented exclusion criteria. No potential participant in this study had a positive pregnancy test reading.

10. After the negative pregnancy test result, each participant was asked to remove all metal objects in preparation for the DEXA scan.
11. Height and weight was obtained using a Detecto scale (Webb City, MO) with the participant's shoes removed (approximately 2 minutes).
12. Each participant was asked to lie on the DEXA table where non-dominant femoral BMD, anterior posterior (AP) spinal BMD, and total body composition assessment was performed by a trained DEXA technician using the procedure outlined in the Hologic user's manual (approximately 15 minutes total). Leg dominance is established by coordinative preferences (i.e. kicking a ball) (Sone, Imai, Joo, Onodera, and Fukunaga, 2006) in current literature. The researcher asked each participant the following question: I*f you were to kick a ball, which leg/foot would you likely kick with?*
13. Each participant scheduled a day and time, which could not occur sooner than 5 days after the first meeting, to submit food records, to confirm foods that were written in their food record, and to obtain DEXA scan results.

The following procedures were followed with all participants during their second visit:

1. Each participant met the researcher in the lobby of the Turner Center and then was escorted to the Body Composition and Bone Mineral Density Laboratory.
2. Each participant was asked to confirm foods that were written in their food records (15-20 minutes).

3. Each participant had the results of their DEXA scans explained and was given a copy of the results (5 minutes).

4. Each participant was given the opportunity to ask questions.

Equipment

DEXA Machine

The Body Composition and Bone Mineral Density Laboratory at the University of Mississippi houses a Hologic Delphi-W (Hologic, Waltham, MA) DEXA machine. This machine is used to measure BMD and body composition. t-scores and z-scores are used to express BMD. The t-score is based on comparison of an individual's bone density to the bone density of a 25- to 30-year-old, typically the age of peak bone mass, of similar gender and race/ethnicity (Winters-Stone, 2005, p. 10). The individual's BMD is compared with the mean value in a population of similar age, sex, and height when using the z-score (Richmond, 2003).

Surveys

Osteoporosis knowledge was assessed using the Osteoporosis Knowledge Test (OKT) developed by Kim, Horan, Gendler, and Patel (1991). The 24-item, self-administered, multiple-choice questionnaire has two subscales: OKT calcium and OKT exercise whose reliability coefficients for internal consistency are 0.72 and 0.69 respectively.

Physical activity was assessed using a 7-day Physical Activity Recall (Dishman and Steinhardt, 1988). Physical activity ranged from 0 to 7. Participants will receive 1 point for each day of the week that they exercised a total of at least 30 minutes. If the

total is ≥ 5, then the participant will be considered to have met the physical activity requirement.

All researchers underwent a one-day training session to learn how to instruct participants on how to record their food intake. During their initial visit, each participant was given instructions on how to record their food intake over the next 4 days. Licensed technicians entered food records into the 4.01 software version of the Nutrition Data System for Research (NDS-R). The NDS-R, which calculates nutrient intake, is a dietary analysis program that was developed by the Nutrition Coordinating Center at the University of Minnesota in 1998.

Anthropometric Data

The height and weight of all participants were taken using a balance scale (Detecto, Webb City, MO) located in the Body Composition and Bone Mineral Density Laboratory. BMI, which is calculated using participant's weight in kilograms divided by height in meters squared, ranged from 16.6 to 36.6.

Statistical Analysis

This study included women between the ages of 18 and 30. Power analysis for multiple linear regression (Cohen and Cohen, 1983) indicated that a total of 72 subjects were needed to attain a power of .80 with an effect size of .30 at an α-level of .05. The rule of thumb, however, is 10 subjects per independent variable (Darlington, 1990). The following independent variables were included in the analysis to explain the variance in spinal BMD and femoral BMD: age, physical activity, calcium intake, oral contraceptive

use, family history of osteoporosis, BMI, and race. Based on the rule of thumb and if all 7 predictor variables are used, a total of 70 subjects are recommended.

Data were examined for missing data and outliers. Values for the variance inflation factor were examined for each independent variable to determine whether or not collinearity existed. The univariate associations between the dependent variables (lumbar spine BMD and femoral BMD) and the previously mentioned independent variables were examined. For spine and femoral skeletal sites, BMD values were compared among the two ethnic groups (African-American and Caucasian) by using *ANOVA*. To determine whether observed ethnic differences in BMD are due to ethnic variation in factors that affect BMD were compared again with lumbar spine BMD and femur BMD values using multivariate linear regression. Data were analyzed using SPSS version 17.0.

Chapter IV

Results

The primary purpose of this research project was to explain the variance in BMD in African-American and Caucasian college-aged women. A secondary purpose was to evaluate the differences in osteoporosis knowledge among college-aged African-American and Caucasian women. This chapter is presented in the following sections: (1) description of the sample, (2) survey responses, (3) nutrition, (4) Osteoporosis Knowledge Test responses, (5) univariate results, (6) multivariable results, and (7) summary of results and formal hypotheses.

Description of the Sample

A total of 107 women ages 18 – 30 years old, which live in a southern state, were enrolled in this study. Six participants were not used in the statistical analyses due to: dual hip surgeries (n = 2), multiple episodes of amenorrhea (n = 1), bone marrow transplant (n = 1), and non-completion of the study due to time constraints (n = 2). Therefore, 101 participants were included in the analyses. African-American women comprised 49.5% of the sample. Caucasian women comprised 50.5% of the sample. Table 4-1 summarizes the demographics of the study population. African-American and Caucasian women had similar demographics in terms of their mean age, anthropometric measures, and BMD scores. The mean age of African-American

women was 21.00 years (±1.75), whereas the mean age of Caucasian women was approximately 21.55 years (±2.62). There were, however, significant differences between African-American and Caucasian participants regarding total hours of exercise and calcium intake.

Table 4 – 1

Mean and Standard Deviation (SD) of Demographics/Characteristics Overall and by Race

Demographics	African American (n = 50)	SD	Caucasian (n = 51)	SD	Overall (N = 101)	SD
Age (Years)	21.00	±1.75	21.55	±2.62	21.30	±2.24
Body Mass Index	23.80	±4.87	22.96	±3.81	23.40	±4.37
Spinal BMD (t-score)	-0.57	±1.04	-0.40	±1.01	-0.49	±1.02
Femoral BMD (t-score)	0.30	±0.89	0.52	±1.05	0.41	±0.98
Hours of Exercise	3.36	±4.39	7.69	±7.53	5.54	±6.52*
Grams of Calcium	0.75	±0.29	0.98	±0.44	0.87	±0.39*
Length of Time on Oral Contraceptives (months)	19.04	±25.02	29.75	±30.35	24.50	±28.22

*$p < 0.05$

For the purposes of this study, participants were stratified into three weight categories: 1) low weight if BMI $\leq$ 20.4 kg/m^2, 2) normal weight if 20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2 and 3) high weight if BMI $\geq$ 24.5 kg/m^2. Participants were stratified in this way closely emulate the BMI cutoffs set by the World Health Organization [WHO]. The WHO's cutoffs are as follows: 1) underweight if BMI < 18.5 kg/m^2, 2) normal weight if 18.5 kg/m^2 $\leq$ BMI $\leq$ 24.9 kg/m^2, and 3) overweight if BMI $\geq$ 25 kg/m^2 (World Health Organization, 2000). The number of participants by race for each of the weight categories is provided in Table 4-2. Among African Americans, 42% were of a high-weight status (BMI $\geq$ 24.5 kg/m^2) whereas 26% were of low-weight status (BMI $\leq$ 20.4

kg/m^2). There was a 1:1 ratio of Caucasian women of a low-weight status (BMI $\leq$ 20.4 kg/m^2) compared to Caucasian women of a high-weight status (BMI $\geq$ 24.5 kg/m^2).

Table 4 – 2

Mean, Minimum and Maximum Values for Body Mass Index (BMI) Categories with SD Overall and by Race*

Weight Categories	N	Min.	Max.	Mean	SD
Low: BMI $\leq$ 20.4 kg/m^2	31	94.0	149.5	113.8	10.9
African-American	13	94.0	125.0	109.4	10.5
Caucasian	18	105.0	149.5	116.9	10.3
Normal: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	31	109.0	155.0	133.7	11.8
African-American	16	109.0	150.0	130.5	11.9
Caucasian	15	118.0	155.0	137.2	11.1
High: BMI $\geq$ 24.5 kg/m^2	39	133.0	222.0	164.7	20.2
African-American	21	144.0	222.0	169.0	22.0
Caucasian	18	133.0	201.0	159.6	17.2

*Standard Deviation

The mean spinal BMD for each race and weight category is provided in Table 4 – 3. The mean spinal BMD was higher in individuals belonging to the high-weight category (BMI $\geq$ 24.5 kg/m^2) in comparison to the low-weight category (BMI $\leq$ 20.4 kg/m^2). It is noteworthy that Caucasians in the low-weight group (BMI $\leq$ 20.4 kg/m^2) had a higher maximal spinal BMD than African Americans in that same weight category. Significance testing of these findings will be discussed in detail later in this chapter.

The mean femoral BMD for each race and weight category is provided in Table 4 – 4. Similar to the mean spinal BMD, the mean femoral BMD was higher in individuals belonging to the high-weight category (BMI $\geq$ 24.5 kg/m^2) in comparison to the low-weight category (BMI $\leq$ 20.4 kg/m^2). Also, similar to that seen with mean spinal BMD, Caucasians in the low-weight group and in the normal weight group (20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2) had higher maximal femoral BMDs than African Americans in each comparison weight category (2.30 versus 0.90, and 2.40 versus 2.30, respectively).

Table 4 – 3

Mean, Minimum and Maximum Spinal BMD Values with SD for Race and Weight Categories*

Weight Categories	N	Min.	Max.	Mean	SD
Low: BMI $\leq$ 20.4 kg/m^2	31	-2.70	1.60	-0.82	0.98
African-American	13	-2.60	0.70	-0.98	0.98
Caucasian	18	-2.70	1.60	-0.71	1.00
Normal: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	31	-2.10	1.20	-0.72	0.93
African-American	16	-2.10	1.20	-0.90	0.92
Caucasian	15	-2.10	0.90	0.61	0.86
High: BMI $\geq$ 24.5 kg/m^2	39	-1.80	2.40	-0.03	0.97
African-American	21	-1.70	2.40	-0.07	0.98
Caucasian	18	-1.80	1.80	0.88	1.10

*Standard Deviation

Table 4 – 4

Mean, Minimum and Maximum Femoral BMD Values with SD by Race and Weight Categories*

Weight Categories	N	Min.	Max.	Mean	SD
Low: BMI $\leq$ 20.4 kg/m^2	31	-1.70	2.30	0.00	0.94
African-American	13	-1.50	0.90	-0.12	0.80
Caucasian	18	-1.70	2.30	0.08	1.04
Normal: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	31	-1.20	2.40	0.47	0.86
African-American	16	-1.20	2.30	0.34	0.86
Caucasian	15	-0.70	2.40	0.61	0.86
High: BMI $\geq$ 24.5 kg/m^2	39	-1.00	2.50	0.67	1.01
African-American	21	-0.90	2.50	0.52	0.92
Caucasian	18	-1.00	2.10	0.88	1.10

*Standard Deviation

Spinal BMD categories for each weight category for entire sample are summarized in Table 4 - 5. Individuals were classified as having low spinal BMD if their t-score was ≤ -1.0. They were classified as having normal spinal BMD if their t-score was > -1.0. Among the 31 participants who were of a low-weight status (BMI $\leq$ 20.4 kg/m^2), nearly 55% also had low spinal BMD. It is also worth mentioning that 17.9% of those of a high-weight status (BMI $\geq$ 24.5 kg/m^2) also had low spinal BMD.

Table 4 – 5

Body Mass Index Categories by Spinal Bone Mineral Density Categories of All Participants (%)

Weight Categories	Spinal BMD Categories		
	Low BMD n (%)	Normal BMD n (%)	Total
Low weight: BMI $\leq$ 20.4 kg/m^2	17 (43.6%)	14 (22.6%)	31
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	15 (38.5%)	16 (25.8%)	31
High weight: BMI $\geq$ 24.5 kg/m^2	7(17.9%)	32 (51.6%)	39
Total	39	62	101

Femoral BMD and weight categories for the entire sample are summarized in Table 4 - 6. Individuals were classified as having low femoral BMD if their t-score was ≤ -1.0 and as having normal femoral BMD if their t-score was > -1.0. The study sample had a higher prevalence of low spinal BMD than low femoral BMD (38.6% versus 7.9%, respectively). Individuals who were of a low weight status (BMI $\leq$ 20.4 kg/m^2), were more than four times as likely to have low femoral BMD in comparison to those who were of a normal or high weight status (20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2 and BMI $\geq$ 24.5 kg/m^2). Refer to Figure 1 and Figure 2 in Appendix F for a graphical representation of how participants with low spinal and femoral BMD compare with participants with normal spinal and femoral BMD according to demographics/characteristics.

Caucasians' spinal BMD status and weight category are summarized in Table 4 – 7. It is noteworthy that 35.3% of Caucasian participants had low spinal BMD (t-score < -1.0). Half of the Caucasians with low spinal BMD were classified as having a low weight (BMI $\leq$ 20.4 kg/m^2) whereas 22.2% were classified as having a high weight (BMI $\geq$ 24.5 kg/m^2). The remaining 27.8% of those with low spinal BMD were classified as having a normal weight (20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2).

Table 4 – 6

Body Mass Index Categories by Femoral Bone Mineral Density Categories of All Participants (%)

Weight Categories	Femoral BMD Categories		
	Low BMD n (%)	Normal BMD n (%)	Total N
Low weight: BMI $\leq$ 20.4 kg/m^2	6 (75.0%)	25 (26.9%)	31
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	1 (12.5%)	30 (32.3%)	31
High weight: BMI $\geq$ 24.5 kg/m^2	1 (12.5%)	38 (40.9%)	39
Total	8	93	101

Table 4 – 7

Body Mass Index Categories by Spinal Bone Mineral Density Categories of Caucasians (%)

Weight Categories	Spinal BMD Categories		
	Low BMD n (%)	Normal BMD n (%)	Total
Low weight: BMI $\leq$ 20.4 kg/m^2	9 (50.0%)	9 (27.3 %)	18
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	5 (27.8%)	10 (30.3%)	15
High weight: BMI $\geq$ 24.5 kg/m^2	4 (22.2%)	14 (42.4%)	18
Total (N)	18	33	51

Caucasians' femoral BMD status and weight category are summarized in Table 4 – 8. Among the Caucasian participants, 7.8% had low femoral BMD values (t-score < -1.0) with 75% of those with low femoral BMD being found in the low weight group (BMI $\leq$ 20.4 kg/m^2). The remaining 25% were in the high weight group (BMI $\geq$ 24.5 kg/m^2).

African Americans' spinal BMD status and weight category are summarized in Table 4 – 9. It is noteworthy that 42% of African-American participants had low spinal BMD (t-score < -1.0). Among those with low spinal BMD, 38% were classified as low weight (BMI $\leq$ 20.4 kg/m^2) whereas 14.3% of a high weight (BMI $\geq$ 24.5 kg/m^2). The remaining 47% with low spinal BMD were classified as having a normal weight (20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2). The presence of low spinal BMD (t-score < -1.0) was more

prevalent in African-American participants, who had 21 individuals with low spinal BMD, in comparison to Caucasian participants, who had 18 individuals with low spinal BMD (42% versus 35.3%, respectively).

Table 4 – 8

Body Mass Index Categories by Femoral Bone Mineral Density Categories of Caucasians (%)

Weight Categories	**Femoral BMD Categories**		
	Low BMD n (%)	Normal BMD n (%)	Total
Low weight: BMI $\leq$ 20.4 kg/m^2	3 (75.0%)	15 (31.9%)	18
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	0 (0.00%)	15 (31.9%)	15
High weight: BMI $\geq$ 24.5 kg/m^2	1 (25.0%)	17 (36.2%)	18
Total (N)	4	47	51

African Americans' femoral BMD status and on weight category, is summarized in Table 4 – 10. Among the African-American participants, 8% had low femoral BMD (t-score < -1.0) values with 75% of those with low femoral BMD being found in the low weight group (BMI $\leq$ 20.4 kg/m^2). The remaining 25% were in the normal weight group (20.5 $\leq$ BMI kg/m^2 $\leq$ 24.4 kg/m^2). Caucasian and African-American participants were almost equally affected by low femoral BMD (t-score < -1.0) with 7.8% of Caucasians and 8% of African Americans having low BMD. Refer to Figure 3 and Figure 4 in Appendix F for a graphical representation of how African-Americans with low spinal and femoral BMD compare with Caucasian participants with low spinal and femoral BMD according to demographics/characteristics.

Table 4 – 9

Body Mass Index Categories by Spinal Bone Mineral Density Categories of African-Americans (%)

Weight Categories	Spinal BMD Categories		
	Low BMD n (%)	Normal n (%)	Total
Low weight: BMI $\leq$ 20.4 kg/m^2	8 (38.1%)	5 (17.2%)	13
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	10 (47.6%)	6 (20.7%)	16
High weight: BMI $\geq$ 24.5 kg/m^2	3 (14.3%)	18 (62.1%)	21
Total (N)	21	29	50

Table 4 – 10

Body Mass Index Categories by Femoral Bone Mineral Density Categories of African-Americans (%)

Weight Categories	Femoral BMD Categories		
	Low BMD n (%)	Normal n (%)	Total
Low weight: BMI $\leq$ 20.4 kg/m^2	3 (75.0%)	10 (21.7%)	13
Normal weight: 20.5 kg/m^2 $\leq$ BMI $\leq$ 24.4 kg/m^2	1 (25.0%)	15 (32.6%)	16
High weight: BMI $\geq$ 24.5 kg/m^2	0 (0.0%)	21 (45.7%)	21
Total (N)	4	46	50

Survey Responses

The following questions are summarized in Table 4 – 11 according to race. Family history of osteoporosis was more likely to occur in Caucasians in comparison to African Americans (31.4% versus 2%, respectively). Caucasians were also more likely than African Americans to have a family history of fracture (17.6% versus 6%, respectively). African Americans were less likely to have been breastfed as a child in comparison to Caucasians (22% versus 68.6%, respectively). African Americans were also less likely to be a current smoker in comparison to Caucasians (2% versus 9.8%, respectively).

Additionally, African- American participants were more likely to have used Depo-Provera in comparison to Caucasians (18% versus 2%, respectively). Lastly, Caucasians were more likely to meet exercise requirements in comparison to African Americans (29.4% versus 14%, respectively).

Table 4 – 11

Percentages of Participants' Correct Responses to Survey Items According to Race

Items	African Americans n = 50	Caucasians n = 51
Family history of osteoporosis	2.0%	31.4%
No family history of osteoporosis	80.0%	51.0%
Unaware of family history of osteoporosis	18.0%	17.6%
Has family history of fracture	6.0%	17.6%
No family history of fracture	82.0%	72.5%
Does not know family history of fracture	12.0%	9.8%
Breastfed as child	22.0%	68.6%
Not breastfed as child	62.0%	25.5%
Unaware of being breastfed as child	16.0%	5.9%
No milk consumption as a child	6.0%	9.8%
About 1 serving of milk per day as a child	18.0%	29.4%
About 2 servings of milk per day as a child	44.0%	27.5%
About 3 servings of milk per day as a child	22.0%	27.5%
About 4 or more servings of milk per day as a child	10.0%	5.9%
Smokes	2.0%	9.8%
Does not smoke	98.0%	90.2%
Oral contraceptive use	62.0%	76.5%
Depo-Provera use	18.0%	2.0%
High school sports participation	*64.6%	90.2%
Met exercise requirements	14.0%	29.4%

*n=48

Family history of osteoporosis was determined by self-reported information obtained from two questions: "Was your biological mother or grandmother ever told by a doctor that they had osteoporosis, sometimes called thin or brittle bones?" and "Did

your biological mother or grandmother ever fracture her hip?" Participants chose from the options of "Yes," "No," or "I don't know." It was reported by 16.8% of the participants that their biological mother or grandmother was diagnosed with osteoporosis; whereas 65.3% reported that their biological mother or grandmother had not been diagnosed with osteoporosis; and 17.8% reported not knowing whether or not their biological mother or grandmother had been diagnosed with osteoporosis. Among the 16.8% who reported that their biological mother or grandmother had been diagnosed with osteoporosis, three participants reported that their biological mother or grandmother had suffered a hip fracture.

Absence or presence of consumption of breast milk as a child was determined through the question: "When you were a baby, were you breastfed?" The response options were "Yes," "No," and "I don't know." It was reported by 45.5% of the participants that they were breastfed as a child whereas 43.6% reported not being breastfed as a child; and 10.9% reported not knowing whether or not they were breastfed as a child. Data were obtained regarding childhood milk consumption through the question, "During your childhood, approximately how many servings of milk did you drink each day?" The answer choices were "None," "1 serving," "2 servings," "3 servings," and "4 or more servings." It was reported by 7.9% that they consumed no milk during their childhood; 23.8% reported having 1 serving of milk per day during childhood; 35.6% reported having 2 servings of milk per day; 24.8% reported 3 servings of milk per day; and 7.9% reported having 4 or more servings per day.

Current smoking habits were identified by the question, "Do you smoke?" and the answer choices were "Yes" and "No." Six individuals reported being current smokers

whereas 94.1% reported being non-smokers. This means that only six participants reported being a current smoker. Of the six who reported being a current smoker, one was African-American and the remaining five were Caucasian.

Information regarding contraceptive use was obtained by the question, “Have you ever taken birth control pills for any reason?” The answer choices were “Yes” and “No.” Oral contraceptive use was reported by 69.3% of the participants whereas 30.7% reported no oral contraceptive. Length of time on oral contraceptives was obtained from each participant by asking, “How long all together have you taken birth control pills?” Information regarding Depo-Provera use was obtained through the question, “Have you ever had the Depo-Provera shot?” and the answer choices were “Yes” and “No.” Depo-Provera use was reported by 9.9% of the participants.

High school sports participation was assessed by the question, “Did you participate in sports in high school?” with the answer choices being “Yes” and “No.” Among the 99 participants who responded to the question, 22.2% reported not participating in high school sports while 77.8% reported participating in high school sports.

Physical activity was assessed using a 7-day Physical Activity Recall (Dishman and Steinhardt, 1988). This instrument records moderate and vigorous physical activity. For the purpose of this study, the time spent engaging in moderate and vigorous physical activities were combined. Participants were classified as meeting exercise requirements if they engaged in at least 30 minutes of exercise, regardless of intensity, on not less than five days of the week. This is a primary guideline set forth by the American College of Sports Medicine and the American Heart Association for adults

aged 18 to 65 years (Haskell et al., 2007). Only 21.8% of the participants met these requirements. Caucasian participants were more likely to engage in the recommended amount of exercise than African-American participants (29.4% versus 14%, respectively). There was also a significant difference ($p = 0.001$) between Caucasian and African-American participants regarding total hours of exercise with Caucasians spending more time engaged in physical activity than African-Americans. Caucasians reported spending an average of 7.69 hours per week engaged in physical activity in comparison to an average of 3.36 hours per week reported by African-Americans.

Nutrition

Nutrient intake was determined from each participant's 4-day dietary record. Each participant's record was entered into NDS-R. NDS-R is a dietary analysis program developed by the Nutrition Coordinating Center at the University of Minnesota in 1998. Three individuals who did not provide a complete 4-day recall were not included in the analyses involving nutrient data. Table 4 – 12 shows the percentage of participants meeting the RDA for calcium, vitamin D, iron, zinc, and magnesium. The main nutrient of interest for the present study is calcium. The RDA of calcium for women up until the age of 18 years is 1300 mg/day. After the age of 18 years, the RDA is 1000 mg/day (NOF, 2008). There was a significant difference ($p = 0.002$) in calcium intake between African-American and Caucasian participants. Caucasian women were more likely than African-American women to meet the RDA for calcium (37.3% versus 16% respectively). Caucasians were also more likely than African Americans to meet the RDA for magnesium (27.5% versus 6% respectively).

Table 4 – 12

Percentage of African-Americans, Caucasians, and Total Sample Meeting Recommended Dietary Allowance for Calcium, Vitamin D, Iron, Zinc, and Magnesium

Nutrients	African American (n = 50)	Caucasian (n = 51)	Total (N = 101)
Calcium	16.0%	37.3%	26.7%
Vitamin D	46.0%	56.9%	51.5%
Iron	32.0%	39.2%	35.6%
Zinc	72.0%	66.7%	69.3%
Magnesium	6.0%	27.5%	16.8%

Osteoporosis Knowledge Test Responses

Osteoporosis knowledge was assessed using the Osteoporosis Knowledge Test (OKT) developed by Kim, Horan, Gendler, and Patel (1991). The items included in the OKT and the percentage of correct answers for African Americans and Caucasians are reported in Table 4 – 13. Refer to Appendix C for complete instrument. It is noteworthy that more than 70% of Caucasian participants and more than 60% of African-American participants did not realize that being a White woman with fair skin increases osteoporosis risk. It is also noteworthy that 90% of African Americans and 87% of Caucasians surveyed did not know the recommended milligrams of calcium intake for adults. Seventy percent of African Americans and 69% of Caucasians did not know that bone size affects osteoporosis risk. Having ovaries surgically removed was not correctly identified as a risk factor for osteoporosis by 82% of the African- American participants and 63% of Caucasians. More than 50% of African- American and

Table 4 – 13

Percentage of Correct Responses on Osteoporosis Knowledge Test for Each Race and Overall

Items	African American (n=50)	Caucasian (n=51)	Overall Total (N=101)
1.Eating a diet LOW in milk products	84.0%	98.0%	91.1%
2. Being menopausal; "change of life"	48.0%	92.2%	70.3%
3. Having big bones	30.0%	31.4%	30.7%
4. Eating a diet high in dark green leafy vegetables	52.0%	70.6%	61.4%
5. Having a mother or grandmother who has osteoporosis	84.0%	98.0%	91.1%
6. Being a white woman with fair skin	38.0%	27.5%	32.7%
7. Having ovaries surgically removed	18.0%	37.3%	27.7%
8. Taking cortisone (steroids e.g. Prednisone) for a long time	54.0%	51.0%	52.5%
9. Exercising on a regular basis	88.0%	100.0%	94.1%
10. ... exercises is the best way to reduce a person's chance of getting osteoporosis?	44.0%	33.3%	38.6%
11. ... exercises is the best way to reduce a person's chance of getting osteoporosis?	48.0%	43.1%	45.5%
12. How many days a week do you think a person should exercise to strengthen the bones?	76.0%	84.3%	80.2%
13. What is the LEAST AMOUNT OF TIME a person should exercise on each occasion to strengthen the bones?	78.0%	84.3%	81.2%
14. Exercise makes bones strong, but it must be hard enough to make breathing:	52.0%	52.9%	52.5%
15. ... exercises is the best way to reduce a person's chance of getting osteoporosis?	92.0%	84.3%	88.1%
16. ... exercises is the best way to reduce a person's chance of getting osteoporosis?	88.0%	84.3%	86.1%
17. Which of these is a good source of calcium?	90.0%	100.0%	95.0%
18. Which of these is a good source of calcium?	22.0%	25.5%	23.8%
19. Which of these is a good source of calcium?	78.0%	66.7%	72.3%
20. Which of these is a good source of calcium?	84.0%	100.0%	92.1%
21. Which of these is a good source of calcium?	52.0%	76.5%	64.4%
22. Which of the following is the recommended amount of calcium intake for an adult?	10.0%	13.7%	11.9%
23. How much milk must an adult drink to meet the recommended amount of calcium?	50.0%	56.9%	53.5%
24. Which of the following is the best reason for taking a calcium supplement?	76.0%	82.4%	79.2%

Caucasian participants (56% & 67%, respectively) did not know that brisk walking and bicycling (52% & 57%, respectively) were better modes of exercise for preventing osteoporosis than kitchen chores, yoga, swimming, and house cleaning. Lastly, 78% of African Americans and 75% of Caucasians did not know that canned sardines were a better source of calcium than watermelon and corn. Refer to Figure 5 in Appendix F for

a graphical representation of where African-American and Caucasian participants differed in correct responses on the Osteoporosis Knowledge Test.

Univariate Findings

ANOVAs, t-tests, and correlations were performed to examine the relationship of each outcome variable, femoral and spinal BMD, with all of the predictor variables. The alpha level was set at 0.05 a priori.

Independent t-tests were conducted to test mean difference in BMD for each predictor. The alpha level was set at 0.05 a priori. The results of these tests for spinal BMD are shown in Table 4 – 14. Based on the results from the t-test as seen in Table 4 – 14, there was no statistically significant difference between mean spinal BMD for African Americans and Caucasians ($p = 0.42$). There were no significant differences in mean spinal BMD ($p > 0.05$) based on any of the remaining predictors listed in Table 4 – 14 (oral contraceptive use, calcium intake, present physical activity, high school sports participation, osteoporosis knowledge and age).

The results of the t-tests for femoral BMD are shown in Table 4 – 15. Based on the results from Table 4 – 15, there was no statistically significant difference between mean femoral BMD for African Americans compared to that of Caucasians. There were no significant differences in mean femoral BMD ($p > 0.05$) based on any of the remaining predictors listed in Table 4 – 15.

Mean difference in spinal BMD between African-Americans and Caucasians were computed and tested for each BMI category using t-tests as indicated in Table 4 – 16. Based on the 95% confidence intervals (include zero) and the p-values ($p>0.05$)

there was not a statistically significant difference (p = 0.47) in African Americans' mean spinal BMD and Caucasians' spinal BMD for those in the low BMI category (BMI $\leq$ 20.4 kg/m^2). There also was no statistically significant differences (p = 0.28) in mean spinal BMD between African Americans and Caucasians in the normal BMI category. Furthermore, there was not a statistically significant difference (p = 0.82) in African Americans' mean spinal BMD and Caucasians' spinal BMD for those in the high BMI category (BMI $\geq$ 24.5 kg/m^2).

Table 4 – 14

Results of t-tests for Spinal Bone Mineral Density (BMD) Differences for Race, Oral Contraceptive Use, RDA of Calcium, Physical Activity High School Sports Participation, Osteoporosis Knowledge, and Age for Entire Sample

Categorical Variables	n	Mean BMD	Mean Difference	95% Confidence Interval	t-test
Race			0.16	-0.24, 0.57	0.81, *p* = 0.42
African American	50	-0.57			
Caucasian	51	-0.40			
Oral Contraceptive Use			-0.28	-0.71, 0.16	-1.26, *p* = 0.21
Yes	70	-0.57			
No	31	-0.29			
RDA of Calcium			0.09	-0.37, 0.54	0.37, *p* = 0.71
Meets	27	-0.55			
Does not meet	74	-0.46			
Physical Activity			-0.09	-0.58, 0.41	-0.35, *p* = 0.73
Meets requirement	22	-0.42			
Does not meet	79	-0.50			
High School Sports Participation			-0.14	-0.64, 0.35	-0.58, *p* = 0.56
Yes	77	-0.47			
No	22	-0.61			
Osteoporosis Knowledge			0.11	-0.36, 0.59	0.47, *p* = 0.64
Less than 70% Correct	77	-0.46			
≥70% Correct	24	-0.57			
Age			0.34	-0.41, 1.09	0.91, *p* = 0.37
18 to 24	93	-0.46			
25 to 30	8	-0.80			

Table 4 – 15

Results of t-tests for Femoral Bone Mineral Density (BMD) Differences According to Race, Oral Contraceptive Use, RDA of Calcium, Physical Activity High School Sports Participation, Osteoporosis Knowledge, and Age for Entire Sample

Categorical Variables	n	Mean BMD	Mean Difference	95% Confidence Interval	t-test
Race			0.22	-0.17, 0.60	1.13, *p*=0.26
African American	50	0.30			
Caucasian	51	0.52			
Oral Contraceptive Use			-0.33	-0.75, 0.08	-1.56, *p* = 0.12
Yes	70	0.31			
No	31	0.64			
RDA of Calcium			-0.15	-0.59, 0.28	-0.70, *p* = 0.48
Meets	27	0.52			
Does not meet	74	0.37			
Physical Activity			-0.05	-0.52, 0.42	-0.22, *p*= 0.83
Meets requirement	22	0.45			
Does not meet	79	0.40			
High School Sports Participation					
Yes			-0.45	-0.91, 0.02	-1.90, *p* = 0.06
No	77	0.52			
	22	0.07			
Osteoporosis Knowledge			-0.05	-0.50, 0.41	-0.21, *p* = 0.83
Less than 70% Correct	77	0.40			
≥70% Correct	24	0.45			
Age			0.32	-0.39, 1.04	0.89, *p* = 0.37
18 to 24	93	0.43			
25 to 30	8	0.11			

Mean difference in femoral BMD between races was computed for each BMI category using t-tests. Results are shown in Table 4 – 17. As indicated in Table 4 – 17, there was not a statistically significant difference (p = 0.57) in African Americans' mean spinal BMD and Caucasians' spinal BMD for those in the low BMI category (BMI $\leq$ 20.4 kg/m^2). There also was no significant difference (p = 0.39) in mean spinal BMD between African Americans and Caucasians in the normal BMI category. Furthermore, there was not a statistically significant difference (p = 0.28) in African Americans' mean

spinal BMD and Caucasians' spinal BMD for those in the high BMI category (BMI $\geq$ 24.5 kg/m^2).

Table 4 – 16

Mean Difference in Spinal Bone Mineral Density (BMD) Between African Americans and Caucasians for Low, Normal, and High Body Mass Index Categories

BMI Categories	Race	n	Mean BMD	Mean Difference	95% Confidence Interval	p
Low: (BMI $\leq$ 20.4 kg/m^2)				0.27	-0.47, 1.00	p = 0.47
	African American	13	-0.98			
	Caucasian	18	-0.71			
Normal : (20.5 kg/m^2 $\geq$ BMI $\geq$ 24.45 kg/m^2)				0.33	-0.32, 1.05	p = 0.28
	African American	16	-0.89			
	Caucasian	15	-0.53			
High: (BMI $\geq$ 24.5 kg/m^2)				0.07	-0.57, 0.71	p = 0.82
	African American	21	-0.07			
	Caucasian	18	0.01			

Table 4 – 17

Mean Difference in Femoral Bone Mineral Density (BMD) Between African Americans and Caucasians for Low, Normal, and High Body Mass Index Categories

BMI Categories	Race	n	Mean BMD	Mean Difference	95% Confidence Interval	p
Low: (BMI $\leq$ 20.4 kg/m^2)				0.20	-0.51, 0.91	p = 0.57
	African-American	13	-0.12			
	Caucasian	18	0.08			
Normal : (20.5 kg/m^2 $\geq$ BMI $\geq$ 24.45 kg/m^2)				0.27	-0.36, 0.90	p = 0.39
	African-American	16	0.34			
	Caucasian	15	0.61			
High: (BMI $\geq$ 24.5 kg/m^2)				0.35	-0.30, 1.01	p = 0.28
	African American	21	0.52			
	Caucasian	18	0.88			

ANOVAs were performed to test whether the means of femoral BMD and spinal BMD differed according to race and BMI category. The results are shown in Tables 4 – 18 and 4 – 19. The results showed that both spinal and femoral BMD means were significantly different for BMI categories ($p = 0.001$ and $p = 0.01$, respectively). Spinal and femoral BMD means were not significantly different for race category or the interaction between race and BMI category ($p > 0.05$).

Table 4 – 18

ANOVA Results for Comparison of Spinal Bone Mineral Density According to Race and Body Mass Index (BMI) Category

	F	p
RACE	1.45	0.23
BMI CATEGORY	7.14	0.001
RACE * BMI CATEGORY	0.21	0.81

Table 4 – 19

ANOVA Results for Comparison of Femoral Bone Mineral Density According to Race and Body Mass Index (BMI) Category

	F	*p*
RACE	2.07	0.15
BMI CATEGORY	4.96	0.01
RACE * BMI CATEGORY	0.06	0.94

Since, femoral and spinal BMD means were significantly different based on BMI category, Bonferroni post-hoc tests were conducted to examine which BMI categories had significantly different spinal and femoral BMD means. Bonferroni post-hoc results for femoral BMD are shown in Table 4 – 20. According to the results, the mean femoral BMD of participants with a low BMI category was significantly different from the femoral BMD of participants with a high BMI ($p = 0.01$).

Table 4 – 20

Bonferroni Comparison of Body Mass Index Categories (BMI) for Femoral Bone Mineral Density

Comparisons	Mean BMD Difference	Std. Error	95% Confidence Interval	*p*
Low BMI vs. Normal BMI	-0.47	0.24	-1.05, 0.12	0.16
Low BMI vs. High BMI	-0.69	0.23	-1.24, -0.13	0.01
Normal BMI vs. High BMI	-0.22	0.23	-0.34, 0.77	1.00

Bonferroni post-hoc results for spinal BMD are shown in Table 4 – 21. These results for spinal BMD showed that the mean spinal BMD of participants with a low BMI was significantly different from the mean spinal BMD of participants with a high BMI (p = 0.001). It also showed that the mean spinal BMD of individuals with normal BMIs were significantly different from the mean spinal BMD of individuals with high BMIs (p = 0.01).

Table 4 – 21

Bonferroni Comparison of Body Mass Index Categories (BMI) for Spinal Bone Mineral Density

Comparisons	Mean BMD Difference	Std. Error	95% Confidence Interval	*p*
Low BMI vs. Normal BMI	-0.11	0.25	-0.71, 0.50	1.00
Low BMI vs. High BMI	-0.79	0.23	-1.36, -0.22	0.003
Normal BMI vs. High BMI	0.68	0.23	0.13, 1.25	0.01

ANOVAs were performed to test whether the femoral BMD and spinal BMD means differ according to family history of osteoporosis categories. Results are shown in Table 4 – 22. Spinal and femoral BMD means were not significantly different for participants based on their family history of osteoporosis.

Table 4 – 22

ANOVA of Family History of Osteoporosis on Spinal and Femoral BMD

	F	*p*
Family History of Osteoporosis (Spinal)	0.31	0.73
Family History of Osteoporosis (Femoral)	1.11	0.33

Next, pairwise correlations were conducted on the continuous predictor variables: BMI, length of time on oral contraceptives, age, and average calcium intake, with spinal BMD and femoral BMD. The results are shown in Table 4 – 23. These results show that BMI category (BMI) and physical activity were significantly correlated with spinal BMD and femoral BMD. Length of time on oral contraceptives, age, and average calcium intake were not significantly correlated with spinal BMD and femoral BMD.

Table 4 – 23

Pairwise Correlations Between Spinal and Femoral Bone Mineral Density, Body Mass Index, Length of Time on Oral Contraceptives, Age, Physical Activity, and Average Calcium Intake

	Spinal BMD T-score	Femoral BMD T-score	Body Mass Index	Length of Time on Oral Contraceptives	Age	Physical Activity	Average Calcium Intake
Spinal BMD T-score	–						
Femoral BMD T-score	0.72** (p=0.001)	-					
Body Mass Index	0.31** (p=0.001)	0.25* (p=0.01)	-				
Length of Time on Oral Contraceptives	-0.08 (p=0.42)	-0.09 (p=0.35)	-0.01 (p=0.96)	-			
Age	-0.05 (p=0.60)	-.09 (p=0.37)	0.15 (p=0.12)	0.40** (p=.001)	-		
Physical Activity	0.23* (p=0.02)	0.26** (p=.01)	0.002 (p=0.99)	0.07 (p=0.50)	0.039 (p=0.70)	-	
Average Calcium Intake	0.02 (p=0.87)	0.17 (p=0.10)	-0.11 (p=0.27)	0.22* (p=0.03)	0.26** (p=0.01)	0.22* (p=0.03)	–

A secondary purpose of this study was to evaluate the difference in osteoporosis knowledge among college-aged African-American women and Caucasian women. Results of t-test are shown in Table 4 – 24. According to t-test results, osteoporosis knowledge between African-American and Caucasian women was significantly different. Caucasian women were more knowledgeable of osteoporosis than African-American women.

Table 4 – 24

Osteoporosis Knowledge Between African-American and Caucasian Women

	n	Mean Score	Mean Difference	95% Confidence Interval	p
Race			1.58	0.23, 2.93	0.02
African American	50	15.94			
Caucasian	51	14.36			

Multivariable Findings

Multiple linear regression was performed to determine which predictor variables were significant in predicting femoral and spinal BMD. The multiple regression normality assumption was tested using the Shapiro-Wilk test. The Shapiro-Wilk statistic was non-significant ($p = 0.53$) which indicates that the normality assumption was not violated. The residual plots were examined for linearity and homogeneity of variance. The plots demonstrated a linear relationship; therefore the linearity assumption was not violated. The standardized residuals were examined to search for outliers. None of the standardized residuals were greater than three standard deviations from the mean; therefore, no outliers were present. Based on these results, it was determined that the use of multiple linear regression was appropriate.

Multiple regression was conducted to determine which predictor variables predict spinal BMD and which of the independent variables predict femoral BMD. Multiple regression results indicate that BMI and total hours of exercise are significant predictors of femoral BMD as well as spinal BMD. The results from the regression analysis for spinal BMD are presented in Table 4 – 25. Accordingly, the model for predicting spinal BMD is as follows: $Y = -2.388 + 0.073$ (BMI) $+ 0.071$ (hours of exercise).

The final regression model is significant in predicting 14.9% (R^2=0.149) of the variance in spinal BMD (p = 0.017). Race, family history of osteoporosis, oral contraceptive use, calcium intake, and age were not significant predictors of spinal BMD. The model summary and the ANOVA summary table are shown below in Table 4 – 26 and Table 4 – 27, respectively.

Table 4 – 25

Multiple Regression Results for Spinal Bone Mineral Density

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-2.193	0.532		-4.126	0.000		
	Body Mass Index	0.073	0.022	0.312	3.268	0.001	1.000	1.000
2	(Constant)	-2.388	0.525		-4.549	0.000		
	Body Mass Index	0.073	0.022	0.312	3.344	0.001	1.000	1.000
	Total Hrs. Exercise	0.071	0.029	0.227	2.435	0.017	1.000	1.000

Table 4 – 26

Model Summary for Spinal Bone Mineral Density

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.312[a]	0.097	0.088	0.9755
2	0.386[b]	0.149	0.131	0.9521

a. Predictors: (Constant), Body Mass Index

b. Predictors: (Constant), Body Mass Index, Total Hrs. Exercise

Table 4 – 27

ANOVA Summary Table for Spinal Bone Mineral Density

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.162	1	10.162	10.679	0.001[a]
	Residual	94.206	99	0.952		
	Total	104.368	100			
2	Regression	15.535	2	7.768	8.569	0.000[b]
	Residual	88.833	98	0.906		
	Total	104.368	100			

a. Predictors: (Constant), Body Mass Index

b. Predictors: (Constant), Body Mass Index, Total Hrs. Exercise

c. Dependent Variable: Lumbar Spine T-score

Table 4 – 28

Multiple Regression Results for Femoral Bone Mineral Density

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	0.191	0.124		1.541	0.126		
	Total Hrs. Exercise	0.079	0.029	0.262	2.705	0.008	1.000	1.000
2	(Constant)	-1.111	0.507		-2.190	0.031		
	Total Hrs. Exercise	0.078	0.028	0.262	2.780	0.007	1.000	1.000
	Body Mass Index	0.056	0.021	0.249	2.642	0.010	1.000	1.000

The results from the regression analysis for femoral BMD are presented in Table 4 – 28. Accordingly, the model for predicting femoral BMD is as follows: Y = -1.111 + 0.078 (hours of exercise) + 0.056 (BMI). The final regression model is significant in predicting 13.1% (R^2=0.131) of the variance in femoral BMD (p = 0.010). As with spinal BMD, race, family history of osteoporosis, oral contraceptive use, calcium intake, and age were not significant predictors of femoral BMD. The model summary and the ANOVA summary table are shown below in Table 4 – 29 and Table 4 – 30.

Table 4 – 29

Model Summary for Femoral Bone Mineral Density

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.262[a]	0.069	0.059	0.9476
2	0.362[b]	0.131	0.113	0.9202

a. Predictors: (Constant), Total Hrs. Exercise

b. Predictors: (Constant), Total Hrs. Exercise, Body Mass Index

Table 4 – 30

ANOVA Summary Table for Femoral Bone Mineral Density

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.568	1	6.568	7.314	0.008[a]
	Residual	88.894	99	0.898		
	Total	95.462	100			
2	Regression	12.478	2	6.239	7.368	0.001[b]
	Residual	82.984	98	0.847		
	Total	95.462	100			

a. Predictors: (Constant), Total Hrs. Exercise

b. Predictors: (Constant), Total Hrs. Exercise, Body Mass Index

c. Dependent Variable: Hip T-Score

Summary of Results and Hypotheses

The results of the null hypotheses tested are discussed in the following paragraphs. H_{O1} stated that African-American women's bone mineral density level would not be significantly different from Caucasian women's bone mineral density among low, normal, and high weight categories groups. ANOVA results showed that there was no significant difference in the mean spinal and femoral BMD (p = 0.23 and

p = 0.15, respectively) between African-American and Caucasian women. Furthermore, there was no significant difference in the mean spinal and femoral BMD of African-American and Caucasian women based on the interaction between race and weight category (p = 0.81 and p = 0.94, respectively). Therefore there was no significant difference between the mean spinal and femoral BMDs of African-American and Caucasian women in the low-weight category; there was no significant difference between the mean spinal and femoral BMDs of African-American and Caucasian women in the normal-weight category; and there was no significant difference between the mean spinal and femoral BMDs of African-American and Caucasian women in the high-weight category. Therefore, H_{O1} failed to be rejected.

H_{O2} stated that women with high BMIs (high weight) would not have significantly different bone mineral density than women with low BMIs (low weight) regardless of race. ANOVA results showed that both spinal and femoral BMDs were significantly different (p = 0.001 and p = 0.01, respectively) across BMIs. Bonferroni post-hoc results for femoral BMD showed that the femoral BMD of participants with a low BMI was significantly different from the femoral BMD of participants with a high BMI (p = 0.01). Bonferroni post-hoc results for spinal BMD showed that the spinal BMD of participants with a low BMI was significantly different from the spinal BMD of participants with a high BMI (p = 0.003). It also showed that the lumbar spine BMD of individuals with a normal BMI was significantly different from spinal BMD of individuals with a high BMI (p = 0.01). Therefore, H_{O2} was rejected.

H_{O3} stated that women who have inadequate intake of calcium would not have a significantly different BMD than women who have an adequate intake of calcium. The

results of t-test analyses also showed that the mean spinal and femoral BMDs of those who had an adequate intake of calcium were not significantly different from those who had an inadequate intake of calcium ($p = 0.71$ and $p = 0.48$, respectively). Therefore, H_{O3} failed to be rejected.

H_{O4} stated that BMD would not be significantly different in women who currently engage in regular physical activity in comparison to women who do not engage in regular physical activity regardless of ethnicity. Results of t-test analyses also showed that those who currently engaged in an adequate amount of physical activity did not have significantly different spinal or femoral BMDs from those who did not currently engage in adequate amounts of physical activity ($p = 0.73$ and $p = 0.83$, respectively). Therefore, H_{O4} failed to be rejected.

H_{O5} stated that women who participated in high school sports would not have significantly different BMD values from women who did not participate in sports during high school regardless of ethnicity. Results of t-test analyses showed that those who participated in high school sports did not have significantly different spinal or femoral BMDs from those who did not participate in sports during high school ($p = 0.56$ and $p = 0.60$, respectively). Therefore, H_{O5} failed to be rejected.

H_{O6} stated that length of time on oral contraceptives would not be significantly related BMD. Pairwise correlations showed that length of time on oral contraceptive was not significantly related to spinal BMD ($p = 0.42$) or femoral BMD ($p = 0.35$). Analyses by t-test also showed that those who took oral contraceptives did not have significantly different spinal or femoral BMD ($p = 0.21$ and $p = 0.12$, respectively) from those who did not take oral contraceptives. Therefore, H_{O6} failed to be rejected.

H_{O7} stated that BMD values would not be significantly different in women who are more knowledgeable of osteoporosis in comparison to those who are less knowledgeable. Results of t-test analyses showed that those who were more knowledgeable about osteoporosis did not have significantly different spinal or femoral BMDs from those who were less knowledgeable about osteoporosis ($p = 0.64$ and $p = 0.83$, respectively). Therefore, H_{O7} failed to be rejected.

H_{O8} stated that BMD values would not be significantly different between African American and Caucasian women. Analyses from t-test also showed that African-Americans' mean spinal and femoral BMD was not significantly different from Caucasians' mean spinal and femoral BMD ($p = 0.42$ and $p = 0.26$, respectively). Therefore, H_{O8} failed to be rejected.

The secondary purpose of this study is to examine differences in osteoporosis knowledge between African-American and Caucasian participants. According to t-test results, there is a significant difference in osteoporosis knowledge between African-American and Caucasian participants ($p = 0.02$). Caucasians are more knowledgeable about osteoporosis than African-Americans.

The research question for this study was: What variables account for the variance in BMD among African-American and Caucasian college-aged women? Results of multiple linear regression showed that after including the predictor variables age, physical activity, race, calcium intake, contraceptive use, family history of osteoporosis, and BMI in the regression equation, only body mass index and total exercise significantly predicted spinal BMD ($p = 0.001$ and $p = 0.017$, respectively). Body mass index and total exercise also significantly predicted femoral BMD ($p = 0.010$

and p = 0.007, respectively). The final regression models were significant in predicting 13.1% (R^2=0.131) of the variance in femoral BMD (p = 0.010) and 14.9% (R^2=0.149) of the variance in spinal BMD (p = 0.017).

Chapter V

Discussion

The primary purpose of this research was to explain the variance in BMD in African-American and Caucasian college-aged women. A secondary purpose was to evaluate the differences in osteoporosis knowledge among college-aged African-American and Caucasian women. This chapter is divided into the following sections: (1) discussion of results, (2) additional findings, (3) recommendations, and (4) future research.

According to K. Khan et al. (2004), approximately 15% of premenopausal women have low bone mineral density. In this study of premenopausal women, 38.6% had low spinal BMD; and 7.9% had low femoral BMD. Although some premenopausal women have low bone mineral density, the U.S. Preventive Services Task Force (as cited by USDHHS, 2004) does not recommend routine bone density testing for women until the age of 65. The Task Force also recommends testing starting at the age of 60 for women who are at high risk for osteoporosis having a body weight less than 70 kg or having a lack of hormone replacement therapy.

Given that it is possible for premenopausal women to have low bone mineral density, the researcher sought to identify factors that are responsible for determining BMD in African-American and Caucasian premenopausal women. The predictor variables included in the model were age, physical activity, race, calcium intake, contraceptive use, family history of osteoporosis and BMI. These variables are risk

factors for low bone mineral density. The outcome variables, non-dominant femoral BMD and spinal BMD, were measured using a Hologic Delphi-W DEXA machine.

Discussion of Results

Finding no racial differences across BMI groups was an unprecedented finding because numerous studies show that African-American women consistently have higher BMDs when compared to their Caucasian counterparts ((Barrett-Connor et al., 2005; USDHHS, 2004; Finkelstein, 2002; NIH, 2001; Ettinger et al., 1997). Due to previous research findings, one would expect that African-American women would consistently have higher BMDs than Caucasian women across each BMI category. This, however, is not what the present study found. It is possible that the higher prevalence of past and present use of Depo-Provera among African-American participants eliminated the racial differences that would typically be seen in this age group. In the present study, 18% of African-Americans reported past or current Depo-Provera use in comparison to 2% of Caucasian participants. Depo-Provera, a contraceptive which is injected intramuscularly, can cause a decline in femoral and spinal BMD (Walsh et al., 2008; Clark et al., 2004).

A number of studies show that weight status affects BMD (Coin et al., 2000; Rollins, Imrhan, Czajka-Narins, and Nichols, 2003; Young et al., 2001; and Wang et al., 2005). In the present study 43.6% of individuals who were classified as having a low BMI also had low spinal BMD; and 75% of those who had a low BMI also had low femoral BMD. As a matter of fact, being thin and/or having a small frame is listed as one of the risk factors for low bone mass (Amonkar and Mody, 2002; NOF, 2008),

meaning that a larger frame or higher weight would be associated with a higher bone density.

The present study found no significant difference between the BMDs of women who had an inadequate intake of calcium and those who had an adequate intake of calcium is a very interesting finding. This is interesting because, historically, low calcium intake has been listed as a risk factor for osteoporosis (NOF, 2008). Additionally, studies show that calcium intake plays a significant role in determining bone density (Harris et al., 2003; Gourlay and Brown, 2004; Heaney, 2001; and Prince et al., 2006). Other studies, however, show that calcium intake is not important in determining BMD (Michaelsson, Melhus, Belloco, and Wolk, 2003; and Wallace and Ballard, 2002). It is possible that no significant differences were seen between the spinal and femoral BMDs of women who had an adequate intake of calcium versus women who had an inadequate intake of calcium because this study only examined current calcium intake and not calcium intake over the life span.

Bainbridge, Sowers, Lin, and Harlow (2004) examined risk factors for low BMD in Caucasian women ages 22 to 44. They found that current physical activity is not related to BMD. When participants in the present study were categorized into two groups--those who met the physical activity requirements and those who did not--t-test results show no significant difference in spinal or femoral BMDs between the two groups. However, when spinal and femoral BMD were regressed on hours of current physical activity, it was a significant predictor of both spinal and femoral BMD. This finding is consistent with Ford et al. (2004), whose study included 157 women, aged 18 to 39.

They found that current physical activity was significantly associated with spinal BMD ($p = 0.004$).

The American College of Sports Medicine and The American Heart Association recommends at least 30 minutes of exercise on not less than five days of the week for adults aged 18 to 65 years (Haskell et al., 2007). Only 21.8% of the participants in this study met these requirements. Furthermore, 33.7% of this sample reported no physical activity. The latter finding is consistent with the findings of Wallace (2002), who found no physical activity reported in 30% of the subjects in a similar age group to that of the present study. Total hours of exercise were significantly different between Caucasians and African-Americans. Caucasians reported spending an average of 7.69 hours per week engaged in physical activity in comparison to an average of 3.36 hours per week reported by African-Americans. Caucasians were also more likely to meet exercise requirements in comparison to African-Americans (29.4% versus 14%). The lack of physical activity is a possible reason why low spinal BMD was so prevalent in this sample.

Asking participants about their high school sports participation was used to determine physical activity during teenage years. The typical age of a high school student is 15 to 18 years. Physical activity during the teenage years is deemed important due to the fact that the typical female accumulates 40 to 60 percent of their bone mass during these years (Lloyd et al., 2000). Therefore, physical activity during this crucial time can have an effect on BMD. Studies have found high school sports participation to be a factor affecting BMD among this age group (Ford et al., 2004; Bainbridge et al., 2004). For example, Ford et al. (2004) found that women between the

ages of 18 and 39, who did not participate in high school sports, were seven times more likely to have low BMD in comparison to those who were involved in sports during high school. High school sports participation was assessed by the question, “Did you participate in sports in high school?” with the answer choices being “Yes” and “No.” It is possible that the present study did not find significant differences in BMD between those who participated in high school sports and those who did not as did previous because of racial differences in the samples. Both Ford et al. (2004) and Bainbridge et al. (2004) had samples that were predominantly Caucasian, whereas the present study had an even distribution of African-American and Caucasian women.

Data, in regards to the affect that oral contraceptive use has on BMD, is equivocal. There are some studies that show that oral contraceptive use has a beneficial effect on BMD in a similar age group to the present study (Pasco et al., 2000; Kleerekoper, Brienza, Schultz, and Johnson, 1991); while other studies show that oral contraceptive use has a negative effect on BMD (Prior et al., 2001; Shoepe and Snow, 2005; Egan, Reilly, Giacomoni, Redmond, and Turner, 2006). Additionally, studies show that oral contraceptives either have no effect on BMD or that the results of the effect of oral contraceptives on BMD are inconclusive (Reed et al., 2003; Cobb et al., 2007). The average length of time on oral contraceptives for participants in this study was 2.5 years (SD ±2.35 years). It is possible that an effect on BMD from oral contraceptive use was not seen in this study due to participants not being on oral contraceptives long enough to see an effect. It is believed that a number of years of oral contraceptive use in premenopausal women are needed before seeing a significant effect on BMD (Kuohung, Borgatta, and Stubblefield, 2000). Kleerekoper et al. (1991)

found that the greatest protection against low BMD was seen in pre- and postmenopausal women who had taken oral contraceptives for 10 or more years.

A little over half of the participants (56.4%) answered approximately 60% of osteoporosis knowledge questions correctly. These results are similar to that of Anderson, Auld, and Schilitz (1996) who assessed the osteoporosis knowledge of women in a similar age group (aged 18 to 35 years). In the present study, over 90% of the participants knew that having a diet low in dairy products and not engaging in regular physical activity put them at increased risk for osteoporosis. These findings are similar to that of other studies in a similar age group to the present study (Ford, Bass, and Keathley, 2007; Kasper, Peterson, and Allegrante, 2001). Unfortunately, knowledge alone is often not enough to cause a behavior change (Wallace, 2002). Furthermore, studies show that osteoporosis prevention behaviors in women are not influenced by their osteoporosis knowledge (Terrio and Auld, 2002; Kasper, Peterson, and Allegrante, 2001). This can possibly explain why no significant difference in BMD as a result of more osteoporosis knowledge versus lack of knowledge was observed in the present study. Although participants were knowledgeable about osteoporosis that did not translate to them engaging is osteoporosis-preventative behaviors.

Other Findings

Only 5.9% of this sample reported being a current smoker. Furthermore, Caucasian women were more likely to be a current smoker in comparison to African American women (9.8% versus 2%). The percentage of current smokers in the present study was low compared to 22.5% smoking rate among women in Mississippi ages 18

years and older and the 28.8% smoking rate among individuals in Mississippi between the ages of 18 and 35 (MMWR, 2006). Therefore, our sample may have been drawn from a healthier population.

Family history of osteoporosis was determined by self-reported information obtained from two questions: "Was your biological mother or grandmother ever told by a doctor that they had osteoporosis, sometimes called thin or brittle bones?" and "Did your biological mother or grandmother ever fracture her hip?" Participants chose from the options of "Yes," "No," or "I don't know." It was reported by one African-American participant that her biological mother or grandmother was diagnosed with osteoporosis; whereas 17 (31.4%) Caucasian participants reported that their biological mother or grandmother had been diagnosed with osteoporosis. Although only one African-American participant reported having a family history of osteoporosis, three African-American participants reported having a family history of fracture. There are three possible reasons as to why the number of African-Americans reporting a family history of hip fractures is higher than the number of African-Americans reporting a family history of osteoporosis. One reason could be because all fractures are not necessarily osteoporotic fractures; so the hip fractures that occurred could have been due to factors other than osteoporosis. Secondly, it is possible that the family member who suffered the fracture was unaware of her osteoporotic-status. Thirdly, 18% of African-American participants reported not knowing their family history of osteoporosis. Therefore, it is possible that the participant did not know the osteoporotic-status of the family member who suffered the hip fracture.

Absence or presence of consumption of breast milk as a child was determined through the question: "When you were a baby, were you breastfed?" The response options were "Yes," "No," and "I don't know." It was reported by 45.5% of the participants that they were breastfed as a child whereas 43.6% reported not being breastfed as a child; and 10.9% reported not knowing whether or not they were breastfed as a child. Of the 45.5% who reported being breastfed as a child, only 11 were African-American whereas 35 were Caucasian. It is possible that the absence of being breastfed as an infant contributed to the presence of low BMD in this sample. Jones, Riley, and Dwyer (2000) found that BMD was higher in 8-year-old children who were breastfed longer than 3 months in comparison to the formula-fed children.

Data were obtained regarding childhood milk consumption through the question, "During your childhood, approximately how many servings of milk did you drink each day?" The answer choices were "None," "1 serving," "2 servings," "3 servings," and "4 or more servings." It was reported by 7.9% that they consumed no milk during their childhood; and 7.9% reported having 4 or more servings per day. For the purposes of this study, one serving of milk is equivalent to one cup; therefore, those who reported having four or more servings of milk per day were in actuality reporting that they consumed four or more cups of milk per day. There are 283.8 mg (1200mg/L) of calcium per cup of milk (Zhao, Martin, and Weaver, 2005). If milk was their only source of calcium during childhood, this means that only 8 participants consumed the recommended amounts of calcium during childhood. This finding is important because Kalkwarf, Khoury, and Lanphear (2003) found that women between the ages of 20 and

49 years who had a low intake of milk during childhood and adolescence also have a lower bone mass in adulthood.

Recommendations

It is clear from the number of participants in the study who are affected by low BMD that programs need to be established to encourage young women to engage in behaviors that will maximize their bone densities. According to A. Khan (2006), premenopausal women should be encouraged to modify their lifestyles to improve their BMD. It has been shown that physical activity, particularly weight-bearing exercises, help to improve BMD. In this study, however, only 21.8% of the participants got the recommended amount of physical activity. Furthermore, in this study Caucasians were more likely than African-Americans to meet the exercise requirements. Since physical activity was significant in predicting bone mineral density in this study, programs that specifically target increasing physical activity among young women should be established. Additionally, programs that target increasing the amount of physical activity among African-Americans should be established.

Although Caucasian women were more knowledgeable than African-American women regarding osteoporosis, overall, osteoporosis knowledge was lacking in this sample. A little over half of the participants (56.4%) answered approximately 60% of osteoporosis knowledge questions correctly. Although most participants were aware that lack of dairy products and lack of exercise put them at risk of osteoporosis, they were less aware of the specific types of foods that provide calcium and the specific types of exercises that improve bone health. Therefore, programs need to be put in

place to not only increase knowledge about osteoporosis, but also to encourage implementation of bone building behaviors.

Future Research

In this study, BMI was a significant predictor of both spinal and femoral BMD. Furthermore, participants in the low BMI category had significantly different mean femoral BMDs than individuals in the high BMI category; and participants in the low and normal BMI categories had significantly different mean spinal BMDs than individuals in the high BMI category. Studies, however, have shown that the proportion of lean mass to fat mass has an effect on BMD (Wang et al., 2005; Young et al., 2001). One of the limitations of the present study is not distinguishing between fat mass and lean mass, although these measurements were taken. BMI was used rather than fat and lean mass to give physicians and the general public a more convenient way of determining risk for low BMD. Therefore, future research should look more in-depth at the fat mass and lean mass of the individuals in this study to determine their contribution to the differences in BMD.

After including variables that affect bone mineral, only two, weight and physical activity, of the seven predictors were significant in predicting spinal and femoral BMD. Furthermore, these two significant predictors only accounted for 14.9% and 13.1% of the variance in spinal and femoral BMD, respectively. It is possible that genetics accounts for, in part, the remaining unexplained variance. According to Koller et al. (2000), up to 80% of the differences seen in peak BMD can be attributed to genetic factors.

Hormones, such as estrogen, possibly played a part in the remaining unexplained variance. Early menarche has been shown to result in higher BMD in premenopausal women just as late menarche has been shown to result in lower BMD and increased risk of fracture in postmenopausal women (Chevalley, Bonjour, Ferrari, and Rizzoli, 2008). These findings are due to the differences in duration of exposure to estrogen (Chevalley, Bonjour, Ferrari, and Rizzoli, 2008). Data regarding age at menarche was collected for the current study but was not included as one of the predictor variables for the regression model. Including an additional variable would have required at least an additional 10 participants. Therefore, this variable was not included due to budgetary restraints. A future study can examine the age at menarche for participants in the current sample to determine what affect, if any, this variable had on BMD values.

Another avenue for future research could include the replication of the current study in an older age group. Racial differences were not observed in this study. It is possible that racial differences in bone mineral density occur at a later age than that used in the current study. This seems plausible seeing that women in the current age group have not reached peak BMD.

The restrictions in this sample cannot be discounted as attributing to the lack of a substantial amount of variance in BMD being found. Since this sample was restricted regarding age and factors that place women at apparent risk for low BMD, the amount of variability was reduced. Therefore, it is difficult for the current study to account for a substantial amount of variance due to the research design limiting the variability of the sample.

Conclusions:

Contrary to what was hypothesized, race was not a significant predictor of spinal or femoral BMD. Therefore, it is important for both African-American and Caucasian women alike to engage in osteoporosis-preventive behaviors. If women between the ages of 18 and 30 are made aware of their low-BMD status, they can begin bone-building activities before they reach peak bone mass. This provides an opportunity to decrease risk for osteoporosis and related fractures later in life. Women between the ages of 18 and 30 can also be encouraged to maintain a healthy body weight and be more physically active to potentially increase their spinal and femoral BMD.

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Appendices

Appendix A
Initial Phone Contact with Potential Subject

INITIAL PHONE CONTACT WITH POTENTIAL SUBJECT

STUDY: A Comparison of Bone Mineral Density in African American and Caucasian College Women
INVESTIGATORS: ANDREA JOHNSON, MS & M. ALLISON FORD, PH.D

Part 1: Subject Information ***(Part of PI's confidential records – do not make hard copies of part 1)***

Name of investigator or study personnel: _____

Date of phone call: _____/_____/_____ Time of phone call: _____:_____

How did the subject hear about the study (circle)?

1. Flyer
2. Class visit
3. Other – Please specify _____

Verbal Informed Consent Process

1. Verbal informed consent process completed (i.e. phone script on p. 2) (circle): YES - NO

2. Verbal consent obtained (circle): YES - NO Time: _____:____

3. If answer to question 2 is NO, discontinue phone conversation with subject, otherwise proceed with question no. 4

4. If answer to question 2 is YES, then record following information from the subject:

    a. Subject's First Name: _____

    b. Age: _____

    c. Race:_____

    d. Assign subject ID _____

Part 2: Phone Script

Thank you for calling to find out more about our research study. My name is *{staff name}*, and I am a researcher at the University of Mississippi. The main purpose of this research study is to investigate bone mineral density among African American and Caucasian college age females. A secondary purpose of this study is to test osteoporosis knowledge among African American and Caucasian college age women. The following information will be destroyed if you choose not to participate. At any point during this conversation if you answer "NO" to a question and would like to discontinue, no more questions will be asked and you will be deemed ineligible to participate.

If you decide to participate in the study, we will ask you to come in for 2 visits (~ 1 hour each). During your 1st visit, you will complete an osteoporosis risk factor assessment, a 7-day physical activity recall instrument, and an osteoporosis knowledge questionnaire. You also will be instructed on how to record your food intake for 2 weekdays and 2 weekend days. On your 2nd visit, you will receive a DEXA scan (similar to an x-ray) to measure bone mineral density. You will also provide me with your 4-day food record and verify the information contained in your food record. Do you think you might be interested in participating in that study?

{If answer is "NO", discontinue conversation}: Thank you very much for calling.

{If answer is "yes", proceed}: O.K.

Before enrolling people in this study, we need to determine if you are eligible. And so what I would like to do now is ask you a few questions about your current and past health condition. Also, I would like to let you know that the information that I receive from you by phone and reveals your name or identity will be strictly confidential and will be kept securely. The purpose of these questions is only to determine whether you are eligible for our study. Remember that your participation is voluntary.

Do I have your permission to ask you these questions and record your answers?

{If answer is "NO", discontinue conversation}: Thank you very much for calling.
{Record answer and time in part 1 / no.2}

{If answer is "YES", proceed}: O.K.
{Record answer and time in part 1 / no.2 and proceed with part 1 / no. 4 and part 3)

Part 3: Eligibility Criteria / Phone screening conducted if answer to question no. 2 in part 1 is YES

- Date of phone screening: _____/_____/_____
- What is your height_____inches
- What is your weight_____lbs

BMI TO BE CALCULATED HERE FOR EXCLUSION CRITERIA:

Formula: weight (lb) / [height (in)]^2 x 703

Calculation: [weight (lb) / height (in) / height (in)] x 703

Calculate BMI by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703.

Example: Weight = 150 lbs, Height = 5'5" (65")
Calculation: [150 ÷ $(65)^2$] x 703 = 24.96

BMI:_____

NOTE: Must be less than 18.5 or between 25 and 30 in order to continue if not--→Thank you for showing interest in our research study. At this time, you are not eligible for our study.**

- Ask the participant the following questions:
    - If any participant answers YES to any of these questions (UNLESS NOTED ON THE QUESTION), they will not be eligible for this study.

o Have you ever been diagnosed with Cushings Disease? YES - NO

o Have you ever been diagnosed with Celiac Disease? YES - NO

o Have you ever or do you currently smoke cigarettes? YES - NO

- If yes-> How many cigarettes per day do you smoke _____
  (NOTE: There a typically 20 cigs per pack)
  (NOTE WE WILL NOT EXCLUDE ALL SMOKERS JUST THOSE WHO SMOKE MORE THAN A HALF PACK OF CIGARETTES PER DAY)

o Is your age between 18 and 30 years YES - NO
NOTE: PARTICIPANT MUST answer YES

o Have you ever been diagnosed with anorexia or bulimia YES - NO

o Have you ever taken synthetic glucocorticoids-also called steroids including cortisone, prednisone? YES - NO

- If yes-> have you taken these for longer Than 6 weeks YES - NO

o Have you ever taken any of the following medications?

Anti-convulsants YES - NO

Thyroid hormone YES - NO

Antacids that contain aluminum YES - NO

Methotrexate -- used to treat a variety of cancers, immune disorders, and resistant arthritic conditions YES - NO

Cyclosporine A -- used in organ transplantation and for the

treatment of some diseases of the immune system	YES	-	NO
Gonadotropin Releasing Hormone (GnRH) Analogues – used in the long-term treatment of Endometriosis	YES	-	NO
Heparin -- used to prevent blood clotting	YES	-	NO
Cholestyramine -- used to control blood cholesterol levels	YES	-	NO
Depo-Provera	YES	-	NO

- Do you have any questions for me? YES - NO
  If yes, summarize subject's concerns/questions:

  _____

  _____

- Subject's questions and concerns were answered (circle): YES - NO

- Based on phone screening, is subject eligible to participate in the study? YES - NO
  If YES, proceed with part 4. If NO, please destroy all subject information.

- As determined through this phone screening, you are eligible to participate, would you be interested in participating: YES - NO

- Now that we have determined you are eligible to participate, I would like to record your contact information to contact you for testing purposes and scheduling:

Subject's Phone Number: _____
Alternate Phone Number: _____
Subject's Email Address: _____

**********END OF Part 3: Eligibility criteria / Phone screening**********

Part 4: Subject Availability for Testing

Time	MON	TUES	WED	THURS	FRI
Morning					
Afternoon					

Other Information provided to subject:

- For testing, please wear
    - Pants
    - Comfortable clothing that does not contain metal objects such as buttons and zippers or under wire bras.
- You will be asked to consent to a urine pregnancy test (under 55 and/or have had a hysterectomy)
- Directions if needed
- Schedule time or will be contacted to schedule a time

Additional notes: _____

Appendix B
Osteoporosis Knowledge Test

ID NO: _____

OSTEOPOROSIS KNOWLEDGE TEST

Osteoporosis (os-te-o-po-ro-sis) is a condition in which the bones become very brittle and weak so that they break easily.

Below is a list of things which may or may not affect a person's chance of getting osteoporosis. After you read each statement, think about if the person is:

MORE LIKELY TO GET OSTEOPOROSIS, *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

LL = LESS LIKELY

NT = NEUTRAL

DK = DON'T KNOW

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

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For the next group of questions, choose one answer from the 4 choices. Be sure to choose only one answer. If you think there are 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
B. Yoga
C. Housecleaning
D. Don't Know

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
C. Cabbage
D. Don't Know

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

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Appendix C
7-Day Physical Activity Recall

Please record how much exercise you did in the last **SEVEN** days. Please place your exercise into one of the two categories: exercise that is **NOT EXAUSTING** or exercise that makes your **HEART BEAT RAPIDLY**.

Please do **not** record any **LIGHT** exercise (such as bowling, golfing with a motorized cart, or walking from your car to your house).

- Record only the time you actually exercised. Do not count breaks and rest periods.
- List the activity that you did when you exercised.
- Please ☑ the BOX if you did *NOT* exercise during the last seven days.

☐ I did *NOT* exercise in the last seven (7) days.

Exercise that is ***NOT EXAUSTING***	Exercise where your ***HEART BEATS RAPIDLY***
examples include: brisk walking, lifting weights, calisthenics, sports, doubles tennis, volleyball, water jogging, water aerobics	examples include: running, swimming, cycling, aerobics, strenuous sports such as singles racquetball or tennis, soccer, basketball

	Total Minutes	LIST ACTIVITY
Sun		
Mon		
Tues		
Wed		
Thurs		
Fri		
Sat		

Total Minutes	LIST ACTIVITY

Appendix D
Demographics Questionnaire

Please answer to the best of your knowledge.

1. Was your biological mother or grandmother ever told by a doctor they had osteoporosis, sometimes called thin or brittle bones?

    a. Yes
    b. No
    c. I don't know

    1a. Has a doctor ever told **you** that you have osteoporosis, sometimes called thin or brittle bones?

        a. Yes
        b. No

    1b. If your doctor has told you that you have osteoporosis, have you ever taken any medication other than calcium supplements for this disease?

        a. Yes
        b. No
        c. I don't know

2. Did your biological mother or grandmother ever fracture her hip?

    a. Yes
    b. No
    c. I don't know

3. When you were a baby, were you breastfed?

    a. Yes
    b. No
    c. I don't know

4. Have you ever been on a high protein diet (Atkins, South Beach, etc)?

    a. Yes
    b. No (if No, skip to #6)

5. How long have you been on this diet (or how long were you on this diet)?

    a. more than 1 year
    b. 10-12 months
    c. 7-9 months
    d. 4-6 months
    e. 1-3 months

6. During your childhood, approximately how many servings of milk did you drink each day?

   a. None (0 servings)
   b. 1 serving each day
   c. 2 servings each day
   d. 3 servings each day
   e. 4 or more servings each day

7. In general, do you take the stairs or the elevator?

   a. Stairs
   b. Elevator

The next questions ask about your background.

8. When is your birthday? (MM/DD/YY)

9. Which of the following best describes your ethnic group?

   a. 1 = Non-Hispanic White
   b. 2 = Non-Hispanic African American
   c. 3 = Asian American or Asian
   d. 4 = American Indian or Alaska Native
   e. 5 = Native Hawaiian/Pacific Islander
   f. 6 = Hispanic—country of origin_____
   g. 7 = Other

10. Does anyone who lives with you smoke cigarettes in the home?

   a. Yes
   b. No (if No, skip to #12)

11. Total number of persons who smoke cigarettes in the home.

   a. 0
   b. 1
   c. 2
   d. 3
   e. 4+

12. Do you smoke?

   a. Yes
   b. No (if No, skip to #14)

13. If you have ever smoked cigarettes, how long did you smoke?

    a. I have never smoked cigarettes
    b. less than 1 year
    c. less than 3 years
    d. less than 5 years
    e. less than 10 years
    f. greater than 10 years

14. How many alcoholic beverages do you generally consume in a setting?

    a. 0
    b. 1
    c. 2
    d. 3
    e. 4+

15. Have you had a period in the last 12 months?

    a. Yes
    b. No

16. Have you ever been amenorrheic (lost your menstrual cycle for any reason, other than pregnancy for longer than 3 months)?

    a. Yes
    b. No

17. Have you ever taken or used estrogen or female hormones in any form (i.e. pills, vaginal cream, suppositories, injections or skin patches?

    a. Yes
    b. No

18. How old were you when you first took or used the estrogen or female hormones? _____years

19. Have you ever taken birth control pills for any reason?

    a. Yes
    b. No

20. How long altogether have you or did you take birth control pills? _____

21. Have you ever had the Depo-Provera shot?

    a. Yes
    b. No (if No, skip to #24)

22. If you are currently taking, how long have you been taking the Depo-Provera shot?_____

23. If you are currently not taking the Depo-Provera shot, but have in the past, how long did you consistently take it? _____

24. How many live births have you had?

a. I have never had a live birth (if never, skip to #29)
b. 1 live birth
c. 2 live births
d. 3 live births
e. 4 live births
f. 5 live births
g. 6 live births
h. More than 6 live births

25. If you have had a live birth, how many did you have before age 30 and after age 30?

_____ before age 30
_____ after age 30

26. Approximately how much weight did you gain with each live birth pregnancy?

1st pregnancy _____lbs

2nd pregnancy _____lbs

3rd pregnancy _____lbs

4th pregnancy _____lbs

5th pregnancy _____lbs

6th pregnancy _____lbs

27. Did you breastfeed any of your children? Yes No

28. If yes, how many of your children have you breastfed? _____

29. Education: _____years (total # years in college)

30. College Major: _____

Appendix E
Food Record Form

Diet Record

Type of oil you use at home?
Type of margarine you use at home?
What type of milk do you typically drink? (Skim, 1%, 2%, Whole)
Type of Bread?

Day____of ____days
Participant ID____ _____

Date of Intake:_____

DOB: _____ Gender: M F

When was the last time you had anything to eat or drink?_____

Time AM PM	Food or Beverage *Please list each food eaten on a separate line.*	Portion Eaten?	When eaten? B L D S1 S2 S3 S4	Where was food consumed? Home Fast Food Work Other	How prepared? Cooking method Seasonings Additions Anything unique?	ICE
Time AM PM						Y N
Time AM PM						Y N
Time AM PM						Y N
Time AM						Y

The University of Mississippi

NUTRIENT INTAKE LABORATORY
DEPARTMENT OF FAMILY AND CONSUMER SCIENCES
OUTPUT: NUTRIENT INTAKE ASSESSMENT
PROJECT: Johnson Dissertation (2008)

Participant ID:
Personal Nutrient Profile 3 day average

Nutrient	Day 1	Day 2	Day 3	3-day average	Recommended Intake
Energy					
Protein					
Calcium					
Vitamin D					
Iron					
Zinc					
Magnesium					

Personal Lab Profile (none required)

Lab	Actual	Recommended

Reviewed: _____
Teresa Carithers, PhD, RD, LD
Director, UMNIA Lab

Appendix F
Figures

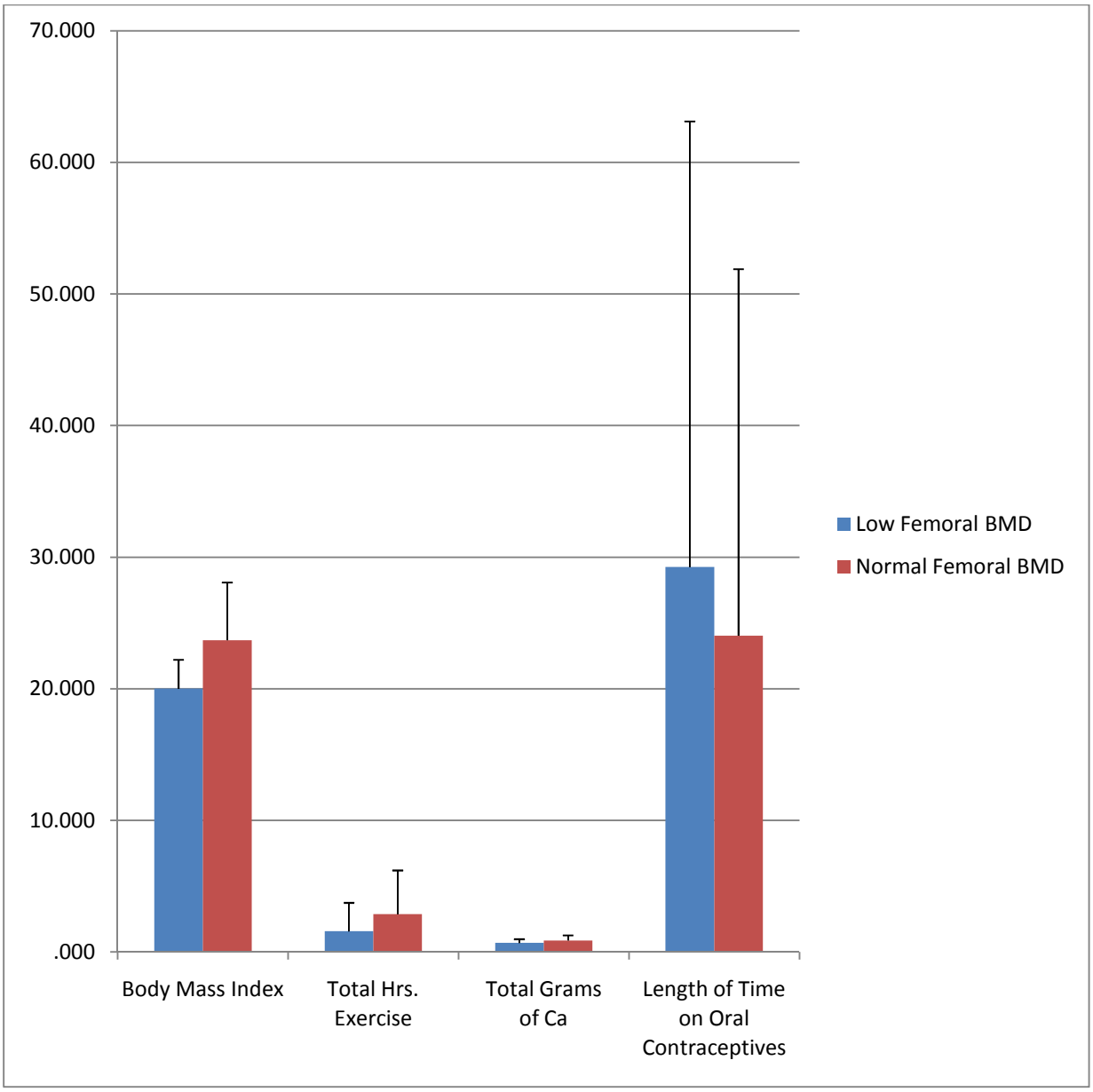

Figure 1: Comparison of Low and Normal Femoral Bone Mineral Density on Mean Body Mass Index, Total Hours of Exercise, Total Grams of Calcium, and Length of Time on Oral Contraceptives

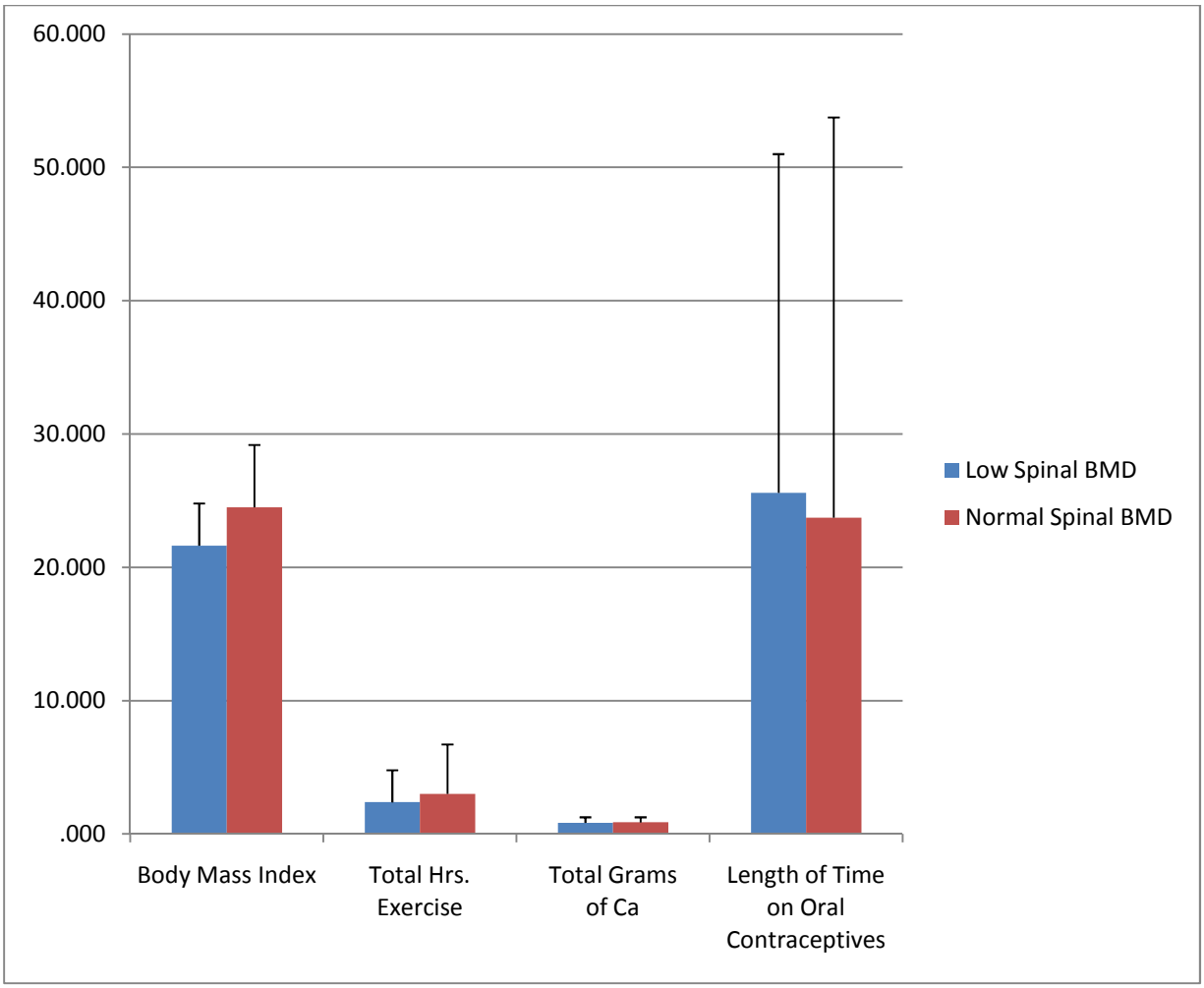

Figure 2: Comparison of Low and Normal Spinal Bone Mineral Density on Mean Body Mass Index, Total Hours of Exercise, Total Grams of Calcium, and Length of Time on Oral Contraceptives

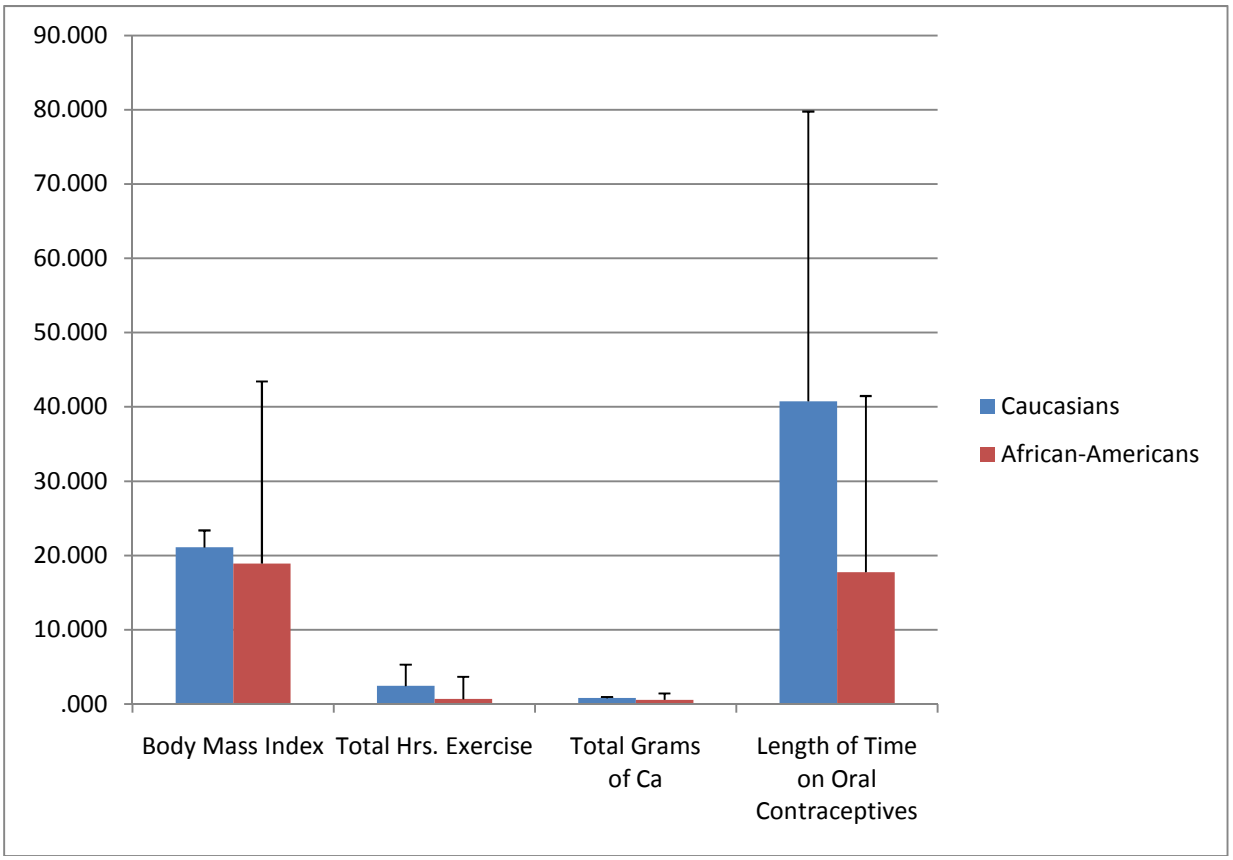

Figure 3: Comparison of Caucasians and African – Americans with Low Femoral Bone Mineral Density on Mean Body Mass Index, Total Hours of Exercise, Total Grams of Calcium, and Length of Time on Oral Contraceptives

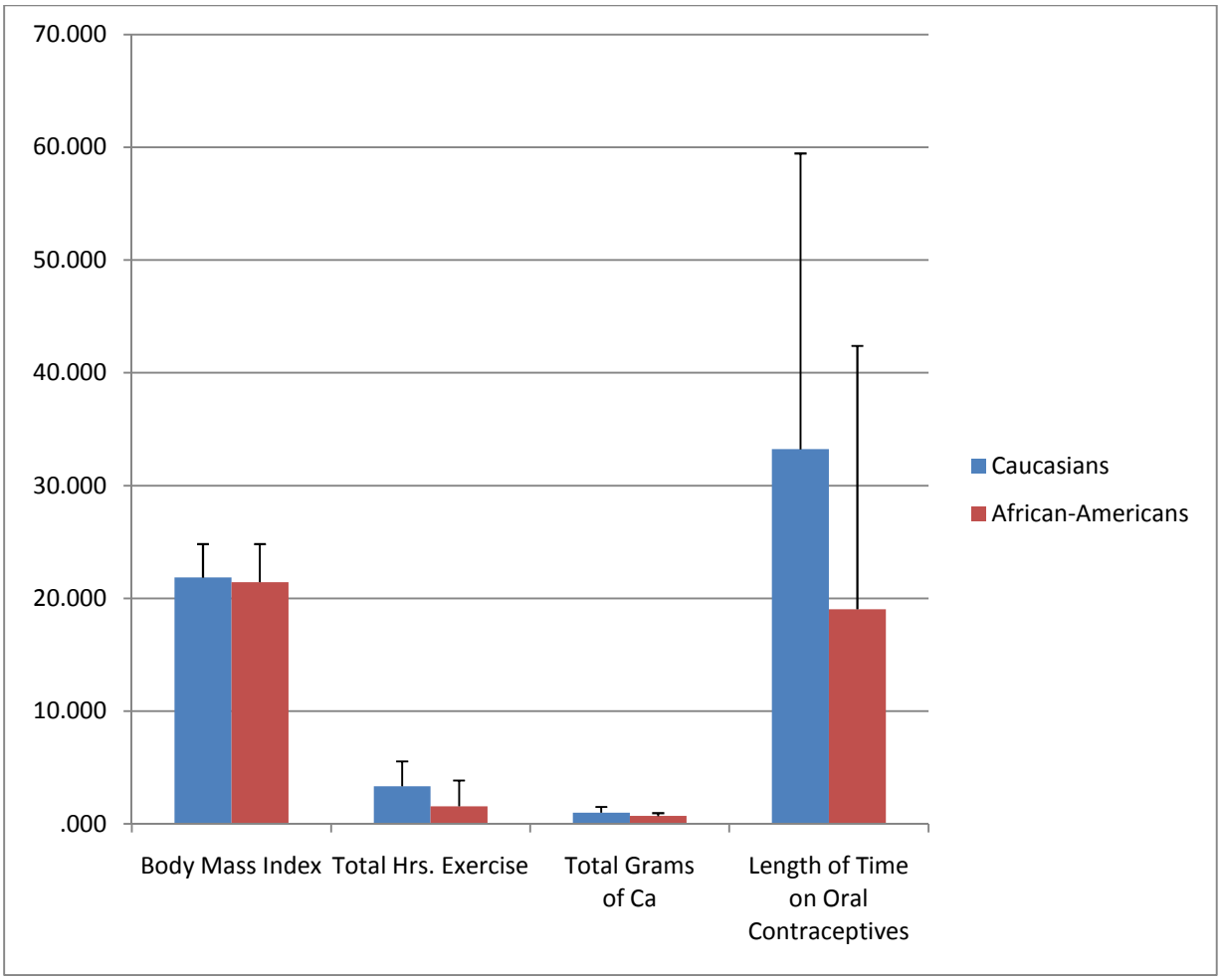

Figure 4: Comparison of Caucasians and African – Americans with Low Spinal Bone Mineral Density on Mean Body Mass Index, Total Hours of Exercise, Total Grams of Calcium, and Length of Time on Oral Contraceptives

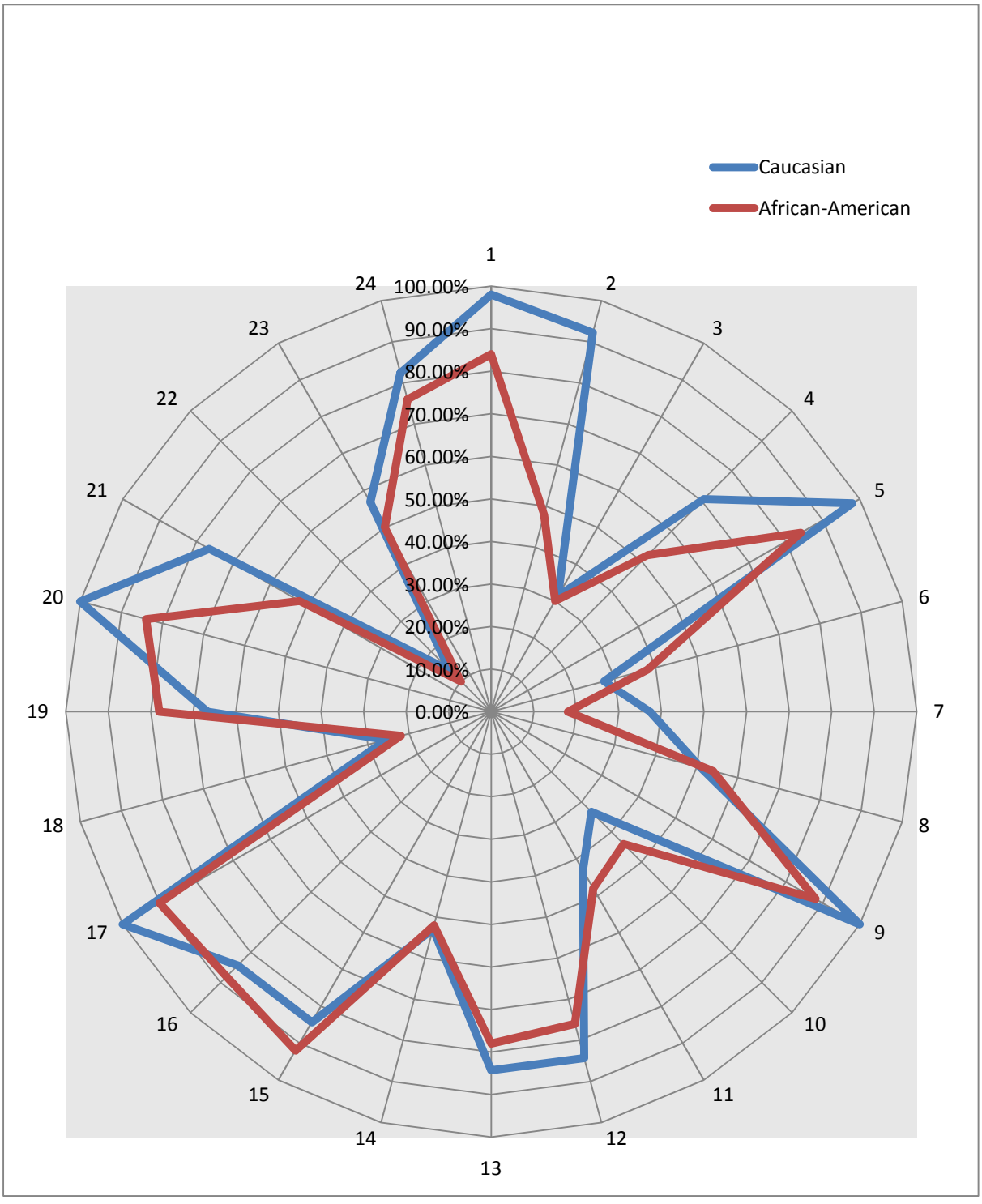

Figure 5: Comparison of Percentages of Correct Answers Between African-Americans and Caucasians on Osteoporosis Knowledge Test. Note: Numbers around the graph corresponds to each question on the Osteoporosis Knowledge Test.

VITA

Andrea K. Johnson, of Oakland, MS, is the daughter of Regina and the late Charles E. Johnson. She attended Coffeeville High School and graduated as class valedictorian in 1997. After high school, Andrea attended Jackson State University. While at Jackson State University, she was a student in the W.E.B. DuBois Honor's College. She graduated magna cum laude from Jackson State University in 2001 with a Bachelor of Science degree in Biology/Pre-Medicine. Andrea began the Master of Science program in Exercise Science at The University of Mississippi in January of 2004. While completing her Master's, she worked as a graduate assistant in Cardiac Rehab at Baptist Memorial Hospital. She completed her Master of Science degree in Exercise Science in 2005. Andrea began the Ph.D. in Health and Kinesiology at The University of Mississippi in August 2005. She served as a graduate assistant in the Health, Exercise Science, and Recreation Management Department and as a graduate student representative on The University of Mississippi's Institutional Review Board. During her doctoral studies, Andrea was awarded the J. Robert Blackburn Graduate Award, which is given to an outstanding graduate student as chosen by the Exercise Science faculty. Andrea joined the University of Mississippi's faculty as an Instructor of Exercise Science and Health Promotion in 2008. She completed her doctorate in Health and Kinesiology with an emphasis in Exercise Science in December of 2010. Her research interests include bone mineral density and women's health.