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The effect of stress on bone mineral density in college aged females

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The Effect of Stress on Bone Mineral Density in College Aged Females

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Abstract

The relationship between psychological variables and bone mineral density (BMD) has been increasingly studied in the past few years, with research suggesting that decreased mood may play a role in decreased BMD. The purpose of this study was to determine if stress in college aged females on the James Madison University campus was related to decreased BMD. This study included 46 females between the ages of 18-24, who were currently enrolled in the Fall of 2015. All participants completed a medical questionnaire, 24-hour dietary recall, the Perceived Stress Scale (PSS), and the Depression, Anxiety, and Stress Scale (DASS). Participants' BMD in the femoral neck and lumbar spine were measured using Dual X-Ray Absorptiometry (DXA). Descriptives, bivariate correlations, and partial correlations were used for statistical analysis. There were no significant results between stress, as measured by the PSS and DASS, and low BMD in either the hip or spine. Significance was found between the number of days of cardiovascular activity performed each week and femur T and BMD scores ($p=0.036$, 0.027). A trend was seen between days of cardiovascular activity and femur Z score ($p=0.0051$). While no significant findings supported a relationship between stress and BMD, more research is required to examine further a possible association.

Chapter I. Introduction

Stress is one of the most prevalent psychological conditions facing college students, as well as millions of adults around the world (American College Health Association [ACHA], 2013; American Psychological Association [APA], 2015). Chronic stress can have very serious health consequences including decreases in bone mineral density (BMD), possibly leading to osteopenia or osteoporosis (National Institutes of Mental Health [NIMH], 2015). Several studies have cited a relationship between stress and low BMD in older women. After reviewing these studies, it does not seem unreasonable to hypothesize that the increased intensity of the stress response that is occurring in college students, specifically that which is affecting college females, could be related to early onset of low bone mineral density. This study is significant because it is one of the first studies that has ever been conducted on the relationship between stress and BMD in college aged females. The present study investigated a possible relationship between stress and BMD, where high levels of stress may predict lower BMD.

Chapter II. Literature Review

Osteoporosis and BMD

The internationally accepted definition of osteoporosis, as given by the World Health Organization (WHO), is a disease characterized by low bone mass and degeneration of bone tissue, which increases bone fragility and consequently increases risk of fracture (1994). A decrease in bone mass, frequently referred to as low bone mineral density (BMD), is generally seen in older adults. There are frequent high rates of low BMD in women aged 50 and older, where twice as many women as men have low BMD (Looker, Borrud, Hughes, Fan, Shepherd, & Melton, 2012; NIH Osteoporosis and Related Bone Diseases National Resource Center [NIH], 2012; Schousboe, Shepherd, Bilezikian, & Baim, 2013). It is estimated, by the year 2050, there will be 6.2 million hip fractures worldwide due to osteoporosis (Bharathi & Baby, 2011). Research on osteoporosis and low BMD previously focused on aged adults because over half of the population, aged 50 and older, have low BMD (Looker, et al., 2012).

Women and Low BMD

Among women, osteoporosis is more common than heart attacks and breast cancer (Ford, Bass, Turner, Mauromoustakos, & Graves, 2004). Therefore, it is imperative that women are aware of their risk for low BMD, starting at an early age. Women need to be mindful of this so they know what they can do in order to slow the decline of bone mass. Women are more likely to have low BMD than men because women normally have smaller, thinner bones, and reach a lower peak bone mass than men (National Osteoporosis Foundation [NOF], 2015). Also the bone-protecting hormone, estrogen, decreases during a woman's life causing bone loss (NOF, 2015; Elgán, Dykes, & Smsioe, 2002). Caucasian and postmenopausal women are most at risk for low BMD and osteoporosis (NOF, 2015). In a study done on BMD on Indian women,

findings revealed that premenopausal women had a greater number of cases of osteopenia, but not osteoporosis, than any other age (Bharathi & Baby, 2011). According to the NOF (2015), between the ages of 20-80, Caucasian women lose one-third of the bone mass in their hip. If we know Caucasian women start losing BMD in their hip as early as age 20, then more research is needed to explain why young, college aged women would start to see a decline in bone health at this age. The risk of osteoporosis in post-menopausal women is associated with peak bone mass at a much younger age (NOF, 2015; Holm, Dan, Wilbur, Li, & Walker, 2002). If peak bone mass in young women is lower than normal, the chance of having osteoporosis, post-menopause, is high. Older women are at a greater risk of having osteoporosis, however young women, starting in their twenties or even before, are at risk for having low BMD. Low BMD in women is the result of low calcium or vitamin D intake, sedentary lifestyle or low physical activity levels, cigarette use, high alcohol intake, as well as psychological disorders such as anorexia nervosa and bulimia (Holm, et al., 2002; NOF, 2015). Body Mass Index (BMI) is directly related to BMD, women who were underweight, had lower BMD scores than women who were in the normal weight range (Bharathi & Baby, 2011). As previously mentioned, a low peak bone mass in women directly contributes to having low BMD throughout life. While preexisting conditions and some medications contribute to low peak bone mass, it is not clear why young women have low peak bone mass (NOF, 2015). The term for when women who have osteoporosis for unknown reasons is idiopathic osteoporosis (NOF, 2015). The fact that there are unknown reasons for low BMD in young women indicates that there is a need for more research in this particular area.

College Age Women and Low BMD

Osteoporosis has been described, by some, as a pediatric disease that doesn't become a problem until old age (Ford et al., 2004). This statement is of immeasurable importance because in order to prevent low bone density from becoming an issue later in life, more information is needed on how to slow the decrease of BMD, as well as identifying the cause. It is important to study lifestyle and physiological factors in addition to genetic links to low BMD because college aged women's (18-24) lifestyle choices may affect their peak bone mass (Elgán, Dykes, & Smsioe, 2002). One important protective factor for young women, starting in adolescence, is participation in physical activity. Those who do not participate in physical activity are at an increased risk for low BMD (Ford et al., 2004; Mudd, Fornetti, & Pivarnik, 2007). One study stated that women who did not participate in high school sports were seven times more likely to have low BMD than those who participated (Ford et al., 2004). On the other hand, a risk factor for low BMD is over stressing the bones, or over exercising (Mudd, Fornetti, & Pivarnik, 2007). This is often seen in female college athletes, who are participating in extreme vigorous physical activity and are at risk for all of the factors of the female athlete triad: amenorrhea, eating disorders, and low BMD (Mudd, Fornetti, & Pivarnik, 2007). Studies reveal that females participating in varsity running, and swimming/diving have significantly lower BMD values than varsity athletes in other sports (Mudd, Fornetti, & Pivarnik, 2007). Another severe risk factor for low BMD as a college female is having an eating disorder such as anorexia nervosa (Fernández-Soto, González-Jiménez, Chamorro-Fernández, & Leyva-Martínez, 2013). In a study conducted by Fernandez-Soto et al., (2013) as many as 90% of females with anorexia nervosa had abnormally low BMD in at least either the femoral neck of lumbar spine. There is limited research on other factors that might explain why women of college age are beginning to see a

decline in bone density. Physiologic, genetic, and lifestyle behaviors have been analyzed in the relationship between college females and low BMD, but research on the impact of psychological factors has been inconclusive.

Stress Defined

Stress affects individuals everywhere but it seems apparent that those with the highest stress are women, younger individuals, and persons with higher levels of education (Cohen, S., Janicki-Deverts, D., 2012). Stress is defined as, "the body's response to any demand for change" and can be either positive or negative (American Institute of Stress [AIS], 2015; NIMH, 2015, para. 1). Most people tend to associate stress with "distress" or negative stress, and therefore many sources describe stress as "a condition or feeling experiences when a person perceives that demands exceed the personal and social resources the individual is able to mobilize," (AIS, 2015, para. 3). The stress response is controlled by the stress hormone cortisol, which is a glucocorticoid hormone and is responsible for restoring homeostasis in the body after exposure to stress (Randall, 2011). Chronic stress can affect the body in negative ways by over stimulating the normal stress response signals over a prolonged period (Alvord, Davidson, Kelly, McGuiness, & Tovian, 2015; NIMH, 2015). Specific effects of chronic stress include lowered immunity, and disruptions in the normal function of the digestive, cardiovascular, excretory, reproductive, and central nervous systems (APA, 2015; Cohen, S., Janicki-Deverts, D., 2012; NIMH, 2015). Everyone experiences stress differently, however factors such as school, work, family issues, etc., seem to trigger the stress response consistently in some people, leading to chronic stress. Chronic stress has the ability to lead to major health problems such as heart disease, diabetes, depression, anxiety, and other illnesses as a result of the harmful effects of

prolonged levels of high cortisol in the body (AIS, 2015; Cohen, S., Janicki-Deverts, D., 2012; NIMH, 2015; Randall, 2011).

College Aged Women and How They Are Affected by Stress

Research suggests that women may be more susceptible to stress, due in part to the chemical and hormonal changes that are associated with premenstrual, post-partum, and menopausal phases (Cleveland Clinic, 2013; Lee, Wuertz, Rogers, & Chen, Y., 2013). Another reason why women may be more stressed than men is because women are socialized to be the caretakers of others and are more vulnerable to chronic stress (Cleveland Clinic, 2013; Lee et al., 2013). Women are more likely to report having a great deal of stress and half of all women report an increase in their stress over the past five years (APA, 2015). Women are also more likely to report physical and emotional symptoms of stress, which include: headache, feelings of indigestion, and feeling that they are about to cry (APA, 2015; Cleveland Clinic, 2013). A major problem associated with increased stress in women exists where only 35% say that they are successfully able to manage their stress, which leads to an overwhelming majority of women experiencing chronic stress without the ability to properly manage it (APA, 2015). College aged females have a particular problem with managing stress. According to the American College Health Association [ACHA] (2013) 89% of female college students felt overwhelmed, and 84% felt exhausted in the 12 months prior to the survey. College is a time of constant high stress due to schoolwork, grades, and social situations. This chronic stress can lead to sleep deprivation and several other health problems (Lee et al., 2013). One troubling statistic suggested that over 56% female college students reported feeling “more than average” to “tremendous” stress in the past 12 months (ACHA, 2013). In fact, the number one stressor reported by female college students, was academics, where 48% found academics to be “traumatic” or “very difficult to handle”

(ACHA, 2013). After academics, finances, intimate relationships, and family problems were found to be "very difficult to handle" (ACHA, 2013). The problems associated with chronic stress among college aged females can take a serious toll on health and wellness at a fairly young age, which can set them up for severe medical problems later in life.

College Behaviors Related to BMD

As previously stated, the current body of research includes many correlations between eating habits, physical activity, cigarette/alcohol use, etc. and low BMD. One area of recent interest is the association between low BMD and psychological variables such as stress and depression. Variables such as stress, depression, and other psychological factors have mainly been tested in older populations because this group contains lower BMD scores (NOF, 2015). However, little research exists on the association between the previously mentioned factors and low BMD in younger adults, specifically college students. Female college students experience high levels of stress, which suggests that they are an important population to study low BMD related to chronic stress. Also, college students frequently engage in other unhealthy behaviors previously linked with aggravating the stress response (Randall, 2011). For instance, when college students are under stress, they do not take the time to get proper sleep. Instead, many students increase the amount of alcohol consumed, drastically increasing cortisol levels (Randall, 2011). The stress hormone, cortisol is a chemical that in high doses displays inhibition of the activity of bone forming cells called osteoblasts, therefore decreasing overall BMD (Kurmanji, Sulaiman, Kah, & Chandrasekaran, 2010). Oftentimes, college students drink once a stressful event has passed, however alcohol consumption also contributes to an increased release of cortisol. (Randall, 2011). This is possibly an even greater amounts of cortisol is released after extreme intoxication than during a stressful situation (Randall, 2011). By substituting caffeine

for sleep and engaging in high levels of alcohol consumption, college students are increasing the intensity of the stress response at an alarming level. Thus increasing both short term and long-term severe health problems. One such health problem that must be acknowledged, and further studied, is that of early onset of low bone mineral density.

Chapter III. Methods

Participants

The Institutional Review Board (IRB) approved this study, effective August 2015 to July 2016, and assigned the protocol number 16-0042. The sample of this study contained 47 female students from James Madison University between the ages of 18-24. Participants were non-smokers who reported not being pregnant or planning on becoming pregnant. They were recruited through campus email, flyers, and by word of mouth. Participants were contacted by email to schedule an appointment for testing. Upon arrival to the laboratory, participants were briefed on the informed consent form and were asked to sign the form after all questions were answered. If interested in the study, participants signed the informed consent form and both the researchers and participants kept a copy of this form (Appendix B). Participants signed a release form stating there was no chance they could be pregnant. Dual X-ray Absorptiometry (DXA) scans produce low doses of radiation, which may be extremely harmful to a developing fetus and potentially result in early termination of a pregnancy. After agreeing that there was no chance of pregnancy, they were included in the study. If they refused to sign the form or stated there was a potential for pregnancy, they were thanked for their time and not included in the study. Participants that signed the consent form completed a general health questionnaire and a 24-hour recall (Wiley, Hoboken NJ) for nutrient intake. The 24-hour recall was performed using the three-pass method. Researchers asked each participant to review their food and drink intake three times. Each "pass" through the dietary record allowed for the minutiae of how food was prepared, any added condiments, ingredients, etc., to be obtained in order to ensure that no detail was excluded. Participants then completed the Perceived Stress Scale (PSS) and the Depression, Anxiety, and Stress Scale (DASS) in order to assess the level of perceived stress, as well as

physical stress symptoms a participant may have experienced (Appendices C & D). Once all the scales and questionnaires were completed, the researchers obtained participants' height and weight. Height was measured without shoes to the nearest 0.5 in. on a stadiometer, and weight was measured without shoes using a calibrated balance scale (Detecto, Webb City, MI) estimated to the nearest 0.5 lb. The measurements of height and weight were used to calculate Body Mass Index (kg/m^2).

BMD Measurement

The DXA scan was obtained (General Electric Lunar, Madison, WI) with participants in supine position. This scan was used to determine the bone mineral density in the femoral neck of the left leg and the lumbar spine. Participants were offered a copy of the DXA scan results. Participants were encouraged to take the results to their family physician to discuss possible problems.

Stress Scales

In order to measure perceived daily stress the participants completed the Perceived Stress Scale (PSS). This study used the ten-item version of the scale in English, developed by Cohen et al. (Cohen, Kamarck, & Mermelstien, 1983). The ten items on the survey measured to what level an individual perceives an event or situation in life as stressful based on personal and contextual factors (Cohen et al., 1983). The alpha coefficient of the PSS was estimated to be about 0.85, which shows strong internal consistency (Cohen, Sherrod, & Clark, 1986).

The Depression, Anxiety, and Stress Scale (DASS) was used in this study to measure the stress variable, by utilizing the specific DASS-stress questions. The DASS-Stress is characterized by "persistent tension, irritability, and low threshold for becoming upset or frustrated" (Brown, Korotitsch, Chorpita, & Barlow, 1997, p.80). The DASS-Stress is also used

to evaluate some symptoms that correspond to generalized anxiety disorder (Brown et al., 1997). All three variables analyzed by the DASS have very strong internal validity scores. The Cronbach's alpha score for the DASS-Stress was determined to be about 0.93, showing strong reliability (Brown et al., 1997).

Statistical Analysis

After all results were complied, the researchers used IBM SPSS statistics 23.0 program (Adirondack, NY) to analyze the data. Descriptive statistics were averaged for all participants. The responses on the DASS, PSS, general health questionnaire, and 24-hour recall (iProfile 3.0) for nutrition intake were all analyzed. Potential correlations between known covariates affecting BMD were used in the partial correlation analysis. The correlations between background variables and BMD and between stress and BMD were assessed using bivariate correlations. Alpha was set at 0.05.

Chapter IV. Results

Characteristics of research population

This study included 47 college age females from James Madison University. One participant was excluded from the final sample size after learning that she was a semi-regular smoker, leaving 46 participants for data analysis. The mean age of the participants was 20.24 years ± 1.03 (Table 1). Ninety-three percent (N=43) of participants identified as Caucasian, four percent (N=2) identified as African American, and two percent (N=1) chose not to identify (Table 2). Average body mass index (BMI) among the participants was 23.03 kg/m^2 ± 3.05 (Table 1).

Relationships between Covariates and BMD

A significant relationship was found between days of cardiovascular activity and femur t score (p=0.036), and femur BMD score (p=0.027), (Table 3, & Figures 2, &3). Results also suggest a trend between days of cardiovascular activity and femur z score (p=0.051), (Table 3, & Figure 1). No significant relationships were found between caloric intake, vitamin D intake, calcium intake, taking birth control, or bone promoting supplement sand either spine or femoral BMD (Table 3). The average number of calories consumed among all participants was 1974.7 kcal ± 462.0, average vitamin D intake was 2.1 μg ± 2.6, and average calcium intake was 801.9 mg ± 462.0 per day. The number of participants that took birth control and a bone-promoting supplement were 18 (39.1%) and 26 (56.5%), respectively.

Stress Scales and BMD

Participants' mean levels of stress on the DASS Stress scale were 1.30 + 0.84, and the mean level of stress on the PSS was 1.85 + 0.82. These levels fall within the normal range and indicate no significant psychological stress, on average, among this age group (Table 4). Average spine and femur Z, T, and BMD scores fell within normal range (Table 5), indicating low BMD is not prevalent in this age group. Correlations were calculated between PSS scores and spine and femur Z, T, and BMD scores, as well as DASS stress and spine and femur Z, T, and BMD scores. No significant results were found between stress and any of these BMD measurements (Table 3).

Chapter V. Discussion and Conclusions

The purpose of this study was to examine the relationship between stress and BMD in college females between the ages of 18-24. No significant correlations were found between stress and BMD. However, significant findings were present between the number of days of cardiovascular activity performed per week and femur t and femur BMD scores, as well as a positive trend between the number of days of cardiovascular activity performed per week and femur z score (Table 3, & Figures 1,2,& 3). Previous research determined an association between stress and BMD, but typically in much older populations of females. One study revealed an association between high levels of stress and significantly lower bone density in the right and left hip (Erez, Weller, Vaisman, & Kreitler, 2012). This study however, examined post-menopausal women, who, according to several studies, are much more susceptible to low BMD (NOF, 2015; Elgán, Dykes, & Smsioe, 2002; Holm et al., 2002). Several other studies found significant results between these two variables, indicating that psychological variables do play an important role in maintaining healthy bone density. However, this study did not find significant results between stress scores on the PSS or DASS stress scales and low BMD. This is likely due to a small sample size, making it very difficult to find an association between these variables.

This study found a positive correlation between femur BMD, and number of days of cardiovascular activity that college females participated in per week. This was an expected result because similar studies have revealed that physical activity has a positive effect on BMD, indicating that a protective factor exists between regular exercise and low rates of hip fracture (Ford et al., 2004; Mudd, Fornetti, & Pivarnik, 2007). This was the only protective factor with a significant correlation found in the present study, even though many other protective factors have been identified in various other studies. Some of the other previously identified protective factors

for BMD include adequate caloric, calcium, and vitamin D intake, as well as hormonal contraceptives and multivitamin use (Holm, et al., 2002; NOF, 2015; WHO, 2007).

Adequate intake of calories and other nutrients protect against low BMD by preventing BMI from getting too low, such as in the case of anorexia nervosa, which has been associated with drastic negative effects on bone density (Holm, et al., 2002; NOF, 2015). In addition, bone health is greatly promoted by calcium and vitamin D (NOF, 2015). The human skeleton contains 99% of all calcium in the body, and getting the recommended dose of calcium is vital in order to achieve peak bone mass and maintain bone health throughout life (NOF, 2015). Vitamin D is necessary for calcium absorption, muscle functioning, and overall bone health (NOF, 2015). This study, however, did not show significant results between BMD and caloric, calcium, or vitamin D intake, likely due to the fact that the sample size was of inadequate size to show significance.

The use of hormonal contraceptives and supplements such as a multivitamin, also promote bone health. Hormonal contraceptives often contain estrogen, which plays an important role in developing and sustaining healthy bones, indicating that these contraceptives may promote bone health (WHO, 2007). Multivitamins, which typically contain many bone promoting factors such as calcium, vitamin D, iron, magnesium, etc. which, as previously mentioned, have a great effect on the maintenance of healthy bones (NOF, 2015). While previous research has revealed positive correlations between these factors and increased BMD, the current study found no such association due to the fact that the minerals contained in the multivitamin/supplement, as well as exact hormonal contraceptives were not included in the dietary records of the participants. Participants of the current study were not asked in advance to bring in the labels of these items, so there was uncertainty as to the amounts of minerals included

in such supplements. This meant that calcium, vitamin D, and other mineral intake were limited to what participants received in their daily diet; this was a limitation of the study.

Practical Applications

This was one of the first studies, which sought to study the relationship between BMD and stress in females age 18-24. Therefore, future studies looking into a possible relationship between BMD and stress in young women should use a large, diverse sample size so the results may conclusively show whether or not an association exists. If a relationship is found, this may allow more preventative measures to be taken in young women to prevent the early loss of bone density due to psychological issues. This is of great importance due to the steadily increasing number of young people, especially females, who experience stress in the United States.

Conclusion

In conclusion, no significant results were found between stress scores on the PSS and DASS scales and BMD in the current study on college aged women. This is indication that more research is needed to further investigate factors affecting BMD in women ages 18-24.

Appendix A: Tables and Figures

Table 1. Descriptive statistics of the sample of 46 James Madison University female students who participated in the current study.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age	46	4.0	18.0	22.0	20.239	1.0368
BMI	46	12.10	17.10	29.20	23.0285	3.05657
Ht.In	46	12.00	59.00	71.00	66.0326	2.64712
Wt.lbs	46	102.0	100.0	202.0	143.022	21.0958

Table 2. Frequency of race among the sample of 46 JMU female students who participated in the current study.

Race	**N**	**Percentage**
Caucasian	43	93.5%
African American	2	4.3%
Did Not Identify	1	2.2%

Table 3. Correlation table depicting results from the statistical analysis of BMD measurements, stress measures, and covariates of the sample of 46 James Madison University female students who participated in the current study.

		Spine.Z	Spine.T	Femur.Z	Femur.T	Spine.BMD	Femur.BMD
DASS.stress	Pearson Correlation	-.104	-.108	-.043	-.049	-.112	-.064
	Sig. (2-tailed)	.500	.480	.779	.746	.463	.672
	N	44	45	45	46	45	46
PSS	Pearson Correlation	-.098	-.112	-.115	-.153	-.120	-.187
	Sig. (2-tailed)	.527	.463	.452	.311	.432	.214
	N	44	45	45	46	45	46
Sup Promote	Pearson Correlation	-.198	-.175	-.089	-.066	-.163	-.064
	Sig. (2-tailed)	.199	.250	.562	.662	.283	.674
	N	44	45	45	46	45	46
Birth Control	Pearson Correlation	.192	.165	.235	.204	.164	.202
	Sig. (2-tailed)	.212	.280	.120	.173	.281	.179
	N	44	45	45	46	45	46
No of days cardio	Pearson Correlation	.117	.138	.293	.310	.143	.326
	Sig. (2-tailed)	.451	.368	.051	.036*	.349	.027*
	N	44	45	45	46	45	46

Ca.mg	Pearson Correlation	.074	.089	.156	.169	.096	.193
	Sig. (2-tailed)	.632	.563	.305	.262	.532	.199
	N	44	45	45	46	45	46
Kcal	Pearson Correlation	.160	.163	.104	.093	.168	.124
	Sig. (2-tailed)	.300	.286	.498	.539	.269	.413
	N	44	45	45	46	45	46
VitD.ug	Pearson Correlation	.160	.152	.152	.161	.155	.153
	Sig. (2-tailed)	.298	.319	.318	.284	.309	.309
	N	44	45	45	46	45	46

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 1. Number of Days of Cardiovascular Activity on Femur Z score of the sample of 46 James Madison University female students who participated in the current study.

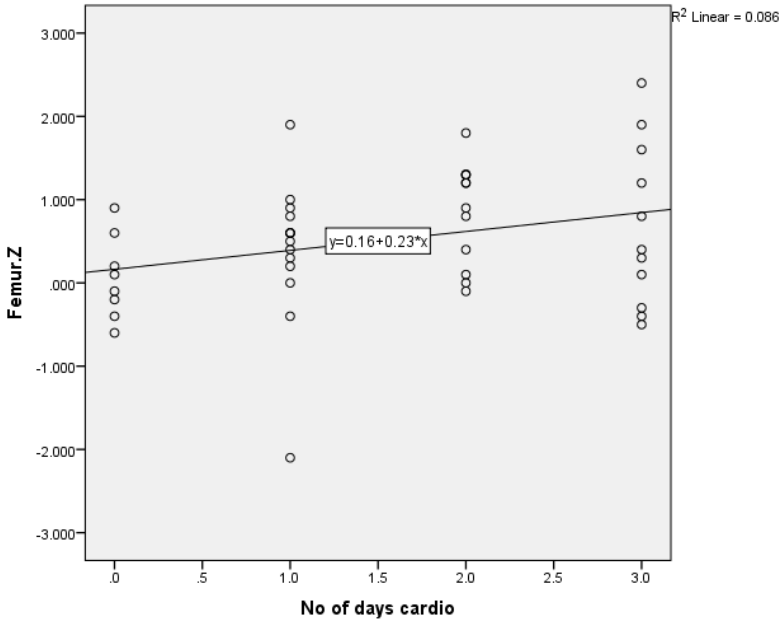

Figure 2. Number of Days of Cardiovascular Activity on Femur T score of the sample of 46 James Madison University female students who participated in the current study.

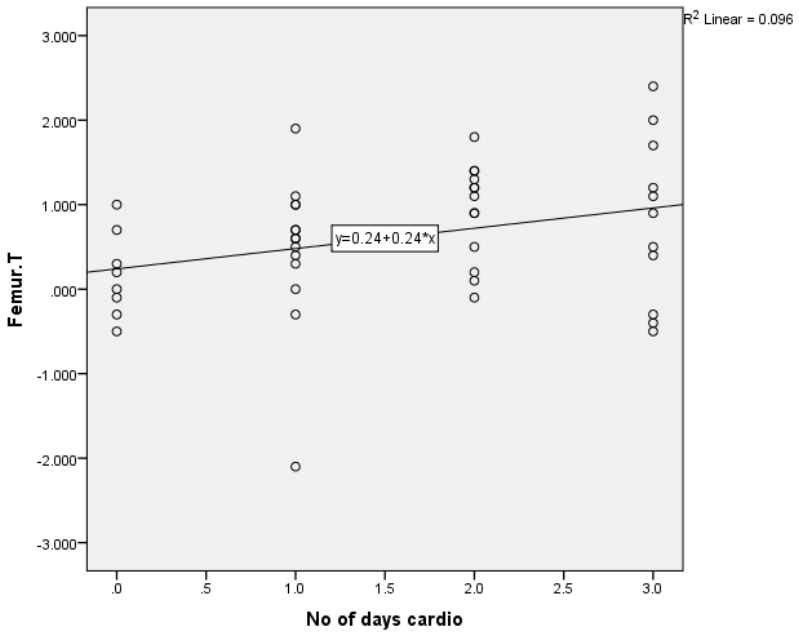

Figure 3. Number of Days of Cardiovascular Activity on Femur BMD score of the sample of 46 James Madison University female students who participated in the current study.

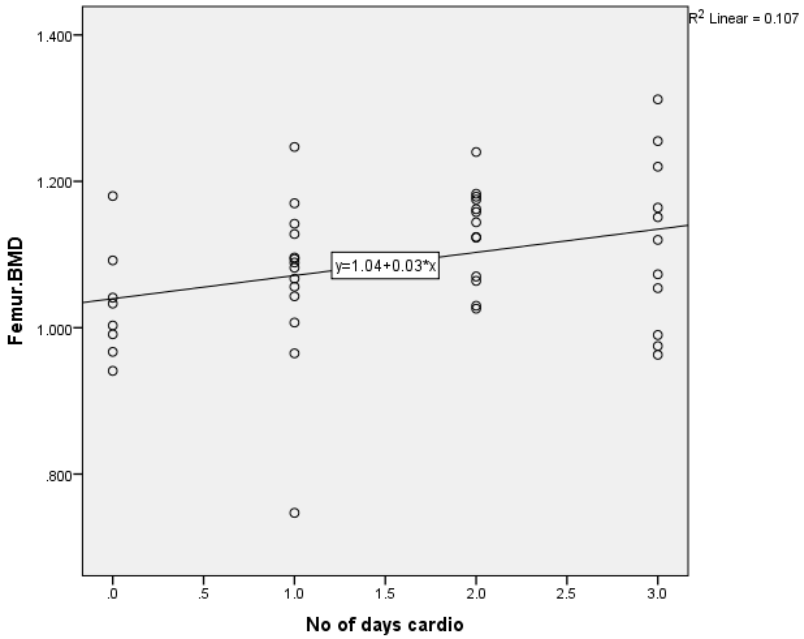

Table 4. Descriptive statistics of two stress scales (PSS & DASS) completed by each of the 46 research participants.

	Range	Minimum	Maximum	Mean	Std. Deviation
DASS.Stress	3.0	1.0	4.0	1.304	.8398
PSS	2.0	1.0	3.0	1.848	.8156

Table 5. Descriptive statistics of all BMD measures obtained from each of the 46 research participants.

	Range	Minimum	Maximum	Mean	Std. Deviation
Spine.Z	5	-3	2	.26	.873
Spine.T	5	-3	2	.28	.883
Spine.BMD	1	1	1	1.22	.109
Femur.Z	5	-2	2	.52	.817
Femur.T	4.5	-2.1	2.4	.622	.8110
Femur.BMD	.565	.747	1.312	1.08991	.101358

Appendix B: Informed Consent

Consent to Participate in Research

Identification of Investigators & Purpose of Study

You are being asked to participate in a research study conducted by Caitlin Cadematori, Grace Berardini, and Jeremy Akers from James Madison University. The purpose of this study is to determine if there is a relationship between depression and stress and decreased bone mineral density. This study will contribute to the researcher's completion of their Senior Honor's Theses.

Research Procedures

Should you decide to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. This study consists of a variety of surveys and a Dual-Energy X-Ray Absorptiometry Scan (DXA) that will be administered to individual participants in Burruss Hall. You will be asked to provide answers to a series of questions related to depression, stress, health history, and nutrient intake.

Time Required

Participation in this study will require 1 session and around 1 total hour of your time.

Risks

The investigator does not perceive more than minimal risks from your involvement in this study (that is, no risks beyond the risks associated with everyday life). According to the manufacturer's specifications (i.e., GE Healthcare.), whole body DXA analysis exposes participants to 1.5 mrem of radiation. The exposure to radiation during a single chest x-ray (i.e., 5 mrem) is more than 3 times greater than radiation from DXA. Also, background radiation from DXA is about equal to the amount of radiation one experiences during a flight from New York to London. The effect of your DXA scan is cumulative and the risk is dependent upon your prior exposure to radiation.

Benefits

Potential benefits from participation in this study include receiving a copy of your DXA scan, which will contain your bone mineral density. The community will benefit from this research because it has the potential to identify potential risk factors for decreased bone mineral density.

Confidentiality

Any information provided will be kept confidential and safely stored. Once the consent form has been signed all participants will be assigned a number for the remainder of participation.
The results of this research will be presented at the Honor's Symposium in the spring of 2016. They may also be presented at a national conference if results are found to be favorable. The results of this project will be coded in such a way that the respondent's identity will not be attached to the final form of this study. The researcher retains the right to use and publish non-identifiable data. While individual responses are confidential, aggregate data will be presented representing averages or generalizations about the responses as a whole. All data will be stored

in a secure location accessible only to the researcher. Upon completion of the study, all information that matches up individual respondents with their answers will be destroyed.

Participation & Withdrawal

Your participation is entirely voluntary. You are free to choose not to participate. Should you choose to participate, you can withdraw at any time without consequences of any kind.

Questions about the Study

If you have questions or concerns during the time of your participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

Caitlin Cadematori or Grace Berardini
Health Sciences
James Madison University
cademaca@dukes.jmu.edu; berardgc@dukes.jmu.edu

Jeremy Akers
Health Sciences
James Madison University
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akersjd@jmu.edu

Questions about Your Rights as a Research Subject

Dr. David Cockley
Chair, Institutional Review Board
James Madison University
(540) 568-2834
cocklede@jmu.edu

Giving of Consent

I have read this consent form and I understand what is being requested of me as a participant in this study. I freely consent to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form. I certify that I am at least 18 years of age.

_____
Name of Participant (Printed)

_____ _____
Name of Participant (Signed) Date

_____ _____
Name of Researcher (Signed) Date

Appendix C: DASS

DASS *Name:* *Date:*

Please read each statement and circle a number 0, 1, 2 or 3 that indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

1	I found myself getting upset by quite trivial things	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I just couldn't seem to get going	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I had a feeling of shakiness (eg, legs going to give way)	0	1	2	3
8	I found it difficult to relax	0	1	2	3
9	I found myself in situations that made me so anxious I was most relieved when they ended	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting upset rather easily	0	1	2	3
12	I felt that I was using a lot of nervous energy	0	1	2	3
13	I felt sad and depressed	0	1	2	3
14	I found myself getting impatient when I was delayed in any way (eg, elevators, traffic lights, being kept waiting)	0	1	2	3
15	I had a feeling of faintness	0	1	2	3
16	I felt that I had lost interest in just about everything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I perspired noticeably (eg, hands sweaty) in the absence of high temperatures or physical exertion	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life wasn't worthwhile	0	1	2	3

Reminder of rating scale:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

22	I found it hard to wind down	0	1	2	3
23	I had difficulty in swallowing	0	1	2	3
24	I couldn't seem to get any enjoyment out of the things I did	0	1	2	3
25	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
26	I felt down-hearted and blue	0	1	2	3
27	I found that I was very irritable	0	1	2	3
28	I felt I was close to panic	0	1	2	3
29	I found it hard to calm down after something upset me	0	1	2	3
30	I feared that I would be "thrown" by some trivial but unfamiliar task	0	1	2	3
31	I was unable to become enthusiastic about anything	0	1	2	3
32	I found it difficult to tolerate interruptions to what I was doing	0	1	2	3
33	I was in a state of nervous tension	0	1	2	3
34	I felt I was pretty worthless	0	1	2	3
35	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
36	I felt terrified	0	1	2	3
37	I could see nothing in the future to be hopeful about	0	1	2	3
38	I felt that life was meaningless	0	1	2	3
39	I found myself getting agitated	0	1	2	3
40	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
41	I experienced trembling (eg, in the hands)	0	1	2	3
42	I found it difficult to work up the initiative to do things	0	1	2	3

Appendix D: PSS

Participant ID # _____

PSS

INSTRUCTIONS:

The questions in this scale ask you about your feelings and thoughts during THE LAST MONTH. In each case, please indicate your response by placing an "X" over the circle representing HOW OFTEN you felt or thought a certain way.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
	0	1	2	3	4
1. In the last month, how often have you been upset because of something that happened unexpectedly?	O	O	O	O	O
2. In the last month, how often have you felt that you were unable to control the important things in your life?	O	O	O	O	O
3. In the last month, how often have you felt nervous and "stressed"?	O	O	O	O	O
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	O	O	O	O	O
5. In the last month, how often have you felt that things were going your way?	O	O	O	O	O
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	O	O	O	O	O
7. In the last month, how often have you been able to control irritations in your life?	O	O	O	O	O
8. In the last month, how often have you felt that you were on top of things?	O	O	O	O	O
9. In the last month, how often have you been angered because of things that were outside your control?	O	O	O	O	O
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	O	O	O	O	O

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