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The effect of depression on bone mineral density in college-aged females

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The Effect of Depression on Bone Mineral Density in College-Aged Females

An Honors Program Project Presented to

the Faculty of the Undergraduate

College of Health and Behavioral Studies

James Madison University

by Caitlin Anne Cadematori

May 2016

Accepted by the faculty of the Department of Health Sciences, James Madison University, in partial fulfillment of the requirements for the Honors Program.

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PUBLIC PRESENTATION

This work is accepted for presentation, in part or in full, at Madison Union Ballroom on April 15, 2016 .

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Abstract

Research regarding the relationship between depression and bone mineral density (BMD) has produced very inconsistent and limited results, especially in younger females. The purpose of this study was to examine the relationship between depression scores and BMD in college-aged female students. Forty-six participants, ages 18-24 (+/-1.0368) completed a 24-hour dietary recall, medical history, Beck's Depression Inventory and the Depression, Anxiety, and Stress Scale (DASS) and had their femur and sacral vertebrae BMD, z-score, and t-score measured in the Dual X-Ray Absorptiometry (DXA) machine. Participant demographics were analyzed with descriptive statistics and potential variable correlations were analyzed by partial and bipartial correlation tests. Findings indicated no significant relationship between depression and BMD, but there was a significant positive correlation between the number of days of cardiovascular activity per week and femur BMD ($p=0.027$) and t-score ($p=0.036$). Future research should continue to analyze the potential relationship between depression and BMD in this age group with a larger sample size and random sampling.

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Chapter I: Introduction and Review of Literature

Depression

The prevalence of mental health problems is a growing concern on college campuses around the country. According to the American Psychological Association (APA), 95% of college counseling center directors feel that the number of students with significant psychological problems is continually rising (APA, 2013). Following anxiety, depression is the second most common mental illness in this age group, with alarming rates of 36.4% of students suffering on college campuses (APA, 2013). Depression can result in many social and biological consequences, in addition to the more obvious psychological consequences (Erdal, Yildrim, & Karatay, 2007). The prominence of anxiety and depression in college-aged students may be the result of a combination of stressors including, but not limited to being away from home, social demands, and increased pressure to succeed in exceedingly rigorous courses (National Institute of Health [NIH], 2012).

Symptoms of depression may include, "a lack of interest and pleasure in daily activities, significant weight loss or gain, insomnia or excessive sleeping, lack of energy, inability to concentrate, feelings of worthlessness or excessive guilt and recurrent thoughts of death or suicide" (APA, 2013, p.1). Awareness of these symptoms is extremely important because the most common age of onset for depression is between the ages of 20 and 30, increasing the vulnerability of college students to an even higher degree (Oh et al., 2013). The age of onset may be related to the fact that young adulthood is when most people leave home and begin to be held accountable for their futures (NIH, 2012). There is the potential that this sort of accountability is overwhelming and may act as a risk factor for mental illness (NIH, 2012). Although mental health services are offered to students at most colleges for little to no cost, many students never

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utilize these services and continue to struggle during their college years and in the years following (NIH, 2012).

Osteoporosis

Osteoporosis is "a condition characterized by bone fragility and increased risk of bone fracture" (Erdal et al., 2007, p.151). When fractures occur, they have huge repercussions for the healthcare system in addition to causing pain, skeletal mutilation, loss of independence, and increased mortality for individuals with the disease (Bab & Yirmaya, 2010). This increased mortality may be a result of the elderly falling and being unable to call for help or never fully being able to recover after experiencing an osteoporotic fracture. BMD generally decreases with age, leading to an increased prevalence of osteoporosis in the elderly population and over 200 million cases worldwide (Oh et al., 2013). Osteoporosis is a particularly unfortunate disease because it does not usually produce any symptoms in its early stages and many people are not diagnosed until after they have one or more bone fractures resulting from extremely low BMD (Yirmiya & Bab, 2009). Once the disease has progressed to the point of fractures occurring, it is often too late to try and effectively treat it (Yirmiya & Bab, 2009). If preventative scanning procedures were more common and decreasing BMD was recognized earlier, there would be greater potential to slow its course through antiosteoporotic treatments (Yirmiya & Bab, 2009). Although this condition typically develops in old age, there is growing evidence that decreasing bone density, termed osteopenia, may begin to occur as young as in the college years (NIMH, 2012).

There are many documented risk factors for osteoporosis including increasing age, female sex, smoking, alcohol use, hyperthyroidism, anorexia nervosa, drug use, lack of sunshine exposure, immobility, and low calcium intake (Wu, Magnus, Liu, Bencaz, & Hentz, 2009; Erdal

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et al., 2007). These risk factors may be particularly harmful in young adulthood because this age constitutes the last few years during which peak bone mass is attained (Dorn et al., 2008). Osteopenia typically develops in middle to late age but may begin to develop earlier if peak BMD was not fully developed during adolescence and young adulthood (Dorn et al., 2008). It has been estimated that a modest failure to achieve ideal bone mass in young adulthood can double the chances of becoming osteoporotic later in life (Calarge et al., 2014). Ideally, bone mass accumulation will be significant enough to counterbalance the decreasing bone density that will naturally occur later on (Dorn et al., 2008). Perhaps if a person avoids exposure to the controllable risk factors, it may be possible to slow the process of decreasing bone density. This in turn may slow or stop the progression of eventual osteoporosis development. Continuing research seeks to examine other possible risk factors for this disease, including depression.

Depression and Decreased BMD

There is a growing body of literature examining the relationship between depression and low BMD; the results are mixed. Some studies have revealed a strong relationship between the two diseases while others have reported insignificant results (Yirmiya & Bab, 2009; Mussolino, Jonas, & Looker, 2004; Wu et al., 2008). Additionally, some studies have found varying results depending on race, gender, or the region of the body that is scanned for bone density (Mussolino et al., 2004; Wu et al., 2008). As a result, depression is not currently recognized by any major health organization as a definitive risk factor for low BMD. This study aims to develop more of an understanding regarding this relationship.

Past research has begun to unravel the potential relationship between depression and decreased BMD. Although the correlation remains unclear, it is thought that depression may cause decreased BMD because of its association with elevated cortisol levels, which have a

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negative impact on bone cells (Kurmanji, Sulaiman, Kah, & Chandrasekaran, 2010). Serum cortisol has been found to increase the activity of osteoclasts, which break down bone, and decrease the activity of osteoblasts, which form bone (Kurmanji et al., 2010). These imbalances within bone lead to discrepancies in what is referred to as the remodeling process, and ultimately lower BMD (Erdal et al., 2007). Excessive cortisol levels are viewed as a result of over activity in the hypothalamic-pituitary-adrenal axis, which has been linked to increased fracture rates and bone loss (Jacka et al., 2005). Depression has also been documented as having an impact on the immune system by increasing interleukin-6, which causes major increases in bone resorption (Eskandri et al., 2007). It is hypothesized that the physiological side effects of depression may be causing an overall decrease in BMD. Some of the most significant research on this topic so far has found a correlation between diagnosed major depressive disorder and decreased BMD, but research conducted with participants who have never been officially diagnosed with mental illness was less definitive (Jacka et al., 2005).

In addition to a potential direct physiological link between depression and lower BMD, depression has been associated with behavioral risk factors linked to osteoporosis including higher rates of smoking, poor dietary habits, and lower rates of physical activity (Kurmanji et al., 2010; Fazeli et al., 2013; Erdal et al., 2007). Associations have also been reported with a number of medical conditions including cardiovascular disease, immune alteration, insulin resistance, diabetes mellitus, and obesity (Cizza et al., 2012). Additionally, individuals who take antipsychotic and antidepressant medications are at higher risk for developing osteopenia and osteoporosis (Erez et al., 2012). These relationships must be considered and controlled for in research studies on this topic.

Females and Decreased BMD

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Research has indicated that 71% of osteoporotic fractures occur in women and that women are three times more likely to be diagnosed with depression (Cizza et al., 2012; Bab & Yirmiya, 2010). Because of this, the likelihood of finding a relationship between the two diseases is much higher in females than in males. It has been hypothesized that this gender difference may be related to the fact that women are more susceptible to general life stress (Bab & Yirmiya, 2010). Higher stress levels equate to higher cortisol levels, which has been linked to a more rapid breakdown of BMD. In terms of osteoporosis, the drastic gender difference may be the result of women's tendency to have naturally thinner and smaller bones than men (National Osteoporosis Foundation [NOF], n.d.). Women are also more likely than men to suffer from eating disorders and can experience amenorrhea for a variety of reasons, both of which are associated with a higher risk of developing osteoporosis (NOF, n.d.). Additionally, when women reach menopause, natural estrogen levels that are involved in protecting bone, drop dramatically (NOF, n.d.). When menopause begins, one of the greatest indicators for future bone health is related to how much bone density a person possesses when entering this stage of life (NOF, n.d.).

Purpose

To the author's knowledge, there are a limited number of research studies that have focused on the potential correlation between BMD and depressive symptoms in college-aged females. Many of the studies reviewed have a much older participant pool because osteoporosis is typically associated with old age. Studies of this type are unable to determine when decreased BMD may have begun. Although osteoporosis is a disease often associated with old age, the beginnings of incomplete bone formation and BMD loss can begin as young as early adulthood (NOF, n.d.). With an earlier indication of osteoporosis, there may be a greater opportunity for treatment and prevention before permanent loss of BMD occurs. The purpose of the study was to

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examine if females aged 18-24 who displayed increased depressive symptoms had lower BMD scores than those who had less depressive symptoms.

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Chapter II: Methodology

Participants in this research were female students at James Madison University, ages 18-24. Those who were pregnant, planning to become pregnant, or smoked were excluded from the research. The sample size was 47 participants. The participant recruitment process occurred through a bulk email sent out to the entire university and by word of mouth. Potential participants who showed interest were contacted to schedule a single laboratory appointment. During the laboratory visit, each participant signed consent forms, completed surveys and had BMD tested using Dual X-ray Absorptiometry (DXA). The Institutional Review Board (IRB) accepted the research process in full with the protocol being assigned No.16-0042.

Upon arrival to the lab, researchers read through the informed consent line by line with participants and answered any questions. If still interested in the study, participants signed the informed consent form and both the researchers and participants were provided with a copy of this form (Appendix 1). Next, participants were asked to sign a form to identify if there was any chance that they could be pregnant. DXA scans produce low doses of radiation, which can be extremely harmful to a developing fetus and potentially result in early termination of a pregnancy (Groen, Bae, & Lim, 2012). If participants agreed that there was no chance of pregnancy, they were included in the study. If they refused to sign the form or signed that there was a potential for pregnancy, they were thanked for their time and were not included in the study. Researchers then conducted a 24-hour food recall using a three-pass method to ensure the highest level of accuracy possible. The researchers reviewed each meal throughout the day before with the participant, asking them to recall what they ate. Then, all 24 hours of intake were discussed two more times with additional passes during which researchers tried to encourage detailed recollection of all aspects of intake including more minor details such as beverages and condiments. Additionally, a general health survey that was created by the researchers was

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completed and included questions regarding health history that may have related to bone health. Lastly, participants completed the Revised Beck's Depression Inventory (Appendix 3) and the Depression Anxiety Stress Scale (DASS) (Appendix 2). The Revised Beck's Depression Inventory contains 21 items, which have ratings from 0-3 as scores of intensity on each question or statement (Beck & Steer, 1984). The items on the inventory measure symptoms and attitudes of depression (Beck & Steer, 1984). Participants were asked to rate each question based on how they had been feeling for the past week, including the day that the inventory was completed (Beck & Steer, 1984). The total score out of 63 was calculated upon completion of the survey, with a total score of 0-13 being considered minimal range for depression, 14-19 as mild, 20-28 as moderate, and 29-63 as severe (Beck, Steer, & Brown, n.d.). The Cronbach's alpha coefficient for this inventory is a 0.86, which indicates high internal consistency (Beck & Steer, 1984). The 42-question DASS contains 14 questions, which measure symptoms and attitudes regarding depression (Lovibond & Lovibond, 1995). Questions are answered using a four-point scale, which measures the severity of a range of symptoms over the past week (Lovibond & Lovibond, 1995). The questions address the following characteristics: dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, and inertia (Lovibond & Lovibond, 1995). The DASS has an internal validity of 0.96 for the depression portion of the survey, indicating that the survey is reliable and valid to use in this research (Brown, Chorpita, Korotitsch, & Barlow, 1997).

Upon completion of all surveys, researchers measured the participant's height and weight, which was used to calculate BMI (kg/m^2). Height was measured without shoes to the nearest 0.5-inch using a stadiometer. Weight was measured without shoes using a calibrated balance scale and was rounded to the nearest 0.1 pounds (Detecto, Webb City, MI). Lastly,

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participants laid in supine position to undergo the BMD scan using the DXA (General Electric Lunar, Madison, WI). This machine was used to determine BMD at the femoral neck of the left leg and in the lumbar region of the spine. During the lumbar scanning, a foam square was placed under the legs to ensure that the back was flat against the machine. During the femoral scanning, both feet were secured and the measured hip joint was rotated to expose the femoral neck. At the end of the process, participants were offered a copy of their DXA scan results. If results were abnormal, participants were encouraged to take the results to their family physician. Once all data collection was complete, analysis occurred using the IBM SPSS 23 package (Adirondack, NY). Results from the general health survey were analyzed and the 24-hour food recall results were entered into iProfile 3.0 (Wiley, Hoboken NJ) so that nutrient intake could be examined for each participant. Potential covariates were identified from the collected data and controlled for to isolate the relationship between depression and BMD.

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Chapter III: Results

Participant Pool Characteristics

The sample population consisted of 47 female participants, who attended James Madison University, and were between the ages of 18-24. Data from 46 participants was analyzed after one participant was eliminated upon learning that she was a regular smoker. Of the 46 participants, 44 identified as Caucasian, 2 identified as African American, and 1 participant chose not to identify. The mean age for participation was 20.24 (+/-1.03) years and the mean BMI was calculated to be 23.0285 (+/-3.06) kg/m^2 (Table 1). The mean scores for femur and spine BMD, z-scores, and t-scores found in Table 2 all fell within the "normal" range for the age group, with the exception of one participant in the sample whose scores were in the range for osteopenia. The mean scores for depression on the Beck's Depression Inventory and DASS indicated minimal levels of depression in the sample (Table 3). Table 5 indicates the mean caloric, vitamin D, and calcium intakes for the sample population.

Effect of Depression on BMD, T-Score, and Z-Score in the Hip and Femur

During analysis, descriptive statistics were used to gain a better understanding of the population in the study (Table 6). In regard to bone health, there are many covariates that were used as controls to isolate the potential relationship between depression scale scores and BMD scores, all of which are displayed in Table 5. Partial correlation testing was used to identify if a relationship existed between any of these covariates and femur or spine BMD (Table 5). Covariates that seemed to have potential for significance were analyzed further with bipartial correlation, but with no further findings established. As is reported in Table 5, the relationship between many factors and BMD, z-score, and t-score was analyzed and no statistical significance was found with alpha set at .05. The only significant correlation found was regarding the amount

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of days per week cardiovascular exercise was reported and femur t-score (p=0.036) and BMD (p=0.027) (Table 5). Figure 2 and Figure 3 display this significance.

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Chapter IV: Discussion and Conclusion

Discussion:

The purpose of this research was to provide additional literature to support or deny the hypothesized relationship between depression and BMD. Most of the existing studies had a much older average age in their sample, creating a gap in the literature for college-aged students. Wu and colleague's meta-analysis combined data from 14 individual studies and reported that women with depression had significantly lower BMD (Wu et al., 2009). The mean age of the participants in the meta-analysis studies ranged from 31-75 years (Wu et al., 2009). The higher mean age in the meta-analysis may have contributed to the significant findings since participants most likely experienced more bone loss than the college-aged participants in this study would have. Perhaps college-aged females are too young to have begun experiencing the long-term effects of depression on BMD. It may be important for future research to try to gain a better understanding of when participants became depressed and when they started experiencing negative bone health consequences later in life. It is also important to consider whether early-onset depression may have an impact on how much peak bone mass a person is able to attain. In addition to having the potential to break down existing bone, depression related hormones such as cortisol have been linked to halting the growth of new bone as well (Kurmanji et al., 2010).

As mentioned in the results section, there are many covariates that have a documented impact on bone health such as vitamin D, calcium intake, caffeine intake, and certain supplements. Some of these covariates have a protective influence on bone health such as vitamin D and calcium, while other covariates have a documented negative impact on bone health such as caffeine and soda intake. Covariates were used in correlation testing. No significant relationships were found between any of the covariates related to intake and any aspects of bone health in the femur or spine. Contrary to this research, many past studies have

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found significance in the relationship between many covariates such as smoking, alcohol use, and low calcium intake and reduced bone density (Wu et al., 2009; Erdal et al., 2007). This difference may be due to the small sample size present in this study. The one significant relationship found during analysis was a positive correlation between increased number of days of cardiovascular activity and BMD. This correlation is to be expected due to the large amount of literature citing the positive impact of exercise on bone health. In research conducted by Greenway and colleagues, premenopausal women with below average BMD saw significant improvement in bone health with the use of an exercise regimen (Greenway, Walkley, & Rich 2015). Although no nutrient-related significance was found, anorexia nervosa has been cited as a risk factor for osteoporosis in past research (Wu et al., 2009; Erdal et al., 2007). Future research may benefit from a larger sample size because it is likely that with more participants would come a broader range of diets and a greater opportunity to find a significant relationship between nutrients and bone health. Peak bone mass is attained during the college-aged years but cannot be fully accrued without the proper nutrients (Dorn et al., 2008).

This study was not without limitations. The sample size was small at 46 participants, making statistical analysis difficult and the chances of finding significance in any of the analyzed areas quite low. The sample was a convenience sample, with participants volunteering after receiving an email advertising the study or after hearing about the study through word of mouth. Future research would benefit from ensuring that the sample is truly indicative of the general population. The sample also lacked diversity, which may have impacted the ability to generalize the findings. Because most of the participants did not classify as depressed or as having low BMD, there was not a very broad range of characteristics to analyze. Future studies should ensure that the sample includes participants who classify as depressed on the scales that were

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utilized so that a stronger comparison can be made to those who classify as very minimally depressed. This study collected information regarding food consumption over the past 24 hours and consumption of supplements and medications that were taken regularly. There are a large number of potential covariates involved and there is the possibility that this research did not account for all of them. It would have been beneficial to have participants bring in the bottles for the medications or supplements that they take so that more detailed information could be recorded. Participants voiced if they were on a multivitamin supplement, but since more information about the multivitamin was not collected it cannot be known if a supplement contained a potential covariate such as vitamin D. Additionally, future studies may want to consider having participants log food intake over the course of multiple days because it cannot be known if the 24-hour recall was indicative of the typical diet of participants.

Research regarding the relationship between depression and BMD has many practical applications in society today. With depression rates continuing to increase in the United States, it is important to gather more information about the potential repercussions of the disease. Peak BMD is reached around the time that students are graduating college, making this relationship extremely relevant in this age group. This research did not find a relationship between the two main variables, but if future research is able to support the hypothesis that depression can have a negative impact on BMD, then that data can be used to communicate a need for primary interventions to be developed. Knowledge of a negative impact on bone health may be enough to motivate some college-aged students who are struggling with depression to seek help. If future studies support the notion that BMD can be affected by depression beginning at this early age, there may be more of a push on college campuses across the country to provide more resources for mental health.

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Conclusion:

Overall, the findings of this research study do not indicate a relationship between depression and decreased BMD. These findings match the results of some past studies, but contradict the findings of others. Further research is needed in order to truly define the relationship between the two variables. Future studies should aim to have a much larger participant pool with a wider range of mental health characteristics for more successful analysis and generalization.

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Tables and Figures

Table 1. Demographics for College-Aged Females Participating in BMD/Depression 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. Spine and Femur Z, T, and Bone Mineral Density Mean Scores in College-Aged Females

Variable	**Mean (± SD)**
Spine Z Score	0.26 (0.87)
Spine T Score	0.28 (0.88)
Spine BMD	1.22 (0.11)
Femur Z Score	0.52 (0.82)
Femur T Score	0.62 (0.81)
Femur BMD	1.09 (0.10)

Table 3. DASS and Beck's Depression Scale Mean Scores in College-Aged Females

Variable	**Mean (± SD)**
DASS (Depression)	1.22 (0.63)
Beck	1.35 (0.74)

Note: Beck's Depression Inventory is a 21-question survey which addresses a variety of factors related to depression. Each question is scaled from 0-3 based on the intensity of the response, with 0 being the minimum and 3 being the maximum.

Note: The DASS contains 14 questions related to depression, each of which is answered on a 0-4 range: 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

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Table 4. Mean Daily Intake for Related Dietary Factors for College-Aged Females

Variable	**Mean**
Caloric Intake	1975 kcal
Vitamin D Intake	2 μg
Calcium Intake	802 mg

Table 5. Correlational Relationship Between Variables and Spine and Femur T, Z, and BMD Scores

		Spine.Z	Spine.T	Femur.Z	Femur.T	Spine BMD	Femur BMD
DASS.depression	Pearson Correlation	.033	.026	-.023	-.031	.019	-.036
	Sig. (2-tailed)	.833	.865	.882	.837	.904	.814
	N	44	45	45	46	45	46
Becks'	Pearson Correlation	-.109	-.115	-.111	-.128	-.121	-.143
	Sig. (2-tailed)	.479	.453	.469	.396	.427	.344
	N	44	45	45	46	45	46
Medications Promote	Pearson Correlation	-.064	-.028	-.073	-.041	-.017	-.032
	Sig. (2-tailed)	.681	.856	.632	.789	.914	.835
	N	44	45	45	46	45	46
Supplements 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

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Reported Caffeine	Pearson Correlation	-.209	-.213	-.010	-.035	-.214	-.003
	Sig. (2-tailed)	.173	.159	.946	.819	.158	.985
	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
Drink EtOH	Pearson Correlation	.140	.119	-.185	-.155	.121	-.156
	Sig. (2-tailed)	.365	.436	.225	.302	.428	.299
	N	44	45	45	46	45	46
Number of Drinks per Week	Pearson Correlation	-.050	-.058	.057	.012	-.059	.010
	Sig. (2-tailed)	.747	.705	.712	.936	.699	.948
	N	44	45	45	46	45	46
Do you exercise	Pearson Correlation	-.070	-.061	.224	.223	-.055	.225
	Sig. (2-tailed)	.652	.690	.138	.137	.720	.133
	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
No of days resistance	Pearson Correlation	-.011	.007	.183	.206	.011	.208

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training	Sig. (2-tailed)	.943	.964	.228	.169	.944	.166
	N	44	45	45	46	45	46
Menstrual Cycle	Pearson Correlation	-.077	-.107	.081	-.002	-.110	-.036
	Sig. (2-tailed)	.617	.482	.598	.989	.473	.811
	N	44	45	45	46	45	46
Ht.In	Pearson Correlation	-.255	-.242	-.089	-.100	-.251	-.125
	Sig. (2-tailed)	.095	.109	.561	.506	.097	.407
	N	44	45	45	46	45	46
Wt.lbs	Pearson Correlation	.040	.052	.149	.162	.046	.161
	Sig. (2-tailed)	.797	.733	.329	.282	.763	.284
	N	44	45	45	46	45	46
BMI	Pearson Correlation	.220	.224	.227	.249	.223	.264
	Sig. (2-tailed)	.152	.138	.133	.096	.140	.077
	N	44	45	45	46	45	46
Age	Pearson Correlation	-.002	-.004	-.045	-.094	-.007	-.058
	Sig. (2-tailed)	.990	.980	.769	.536	.965	.702
	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

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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
EtOH.g	Pearson Correlation	-.028	-.038	.165	.133	-.035	.145
	Sig. (2-tailed)	.855	.807	.280	.377	.820	.337
	N	44	45	45	46	45	46
Caf.mg	Pearson Correlation	-.054	-.071	.138	.116	-.072	.097
	Sig. (2-tailed)	.726	.642	.367	.445	.639	.521
	N	44	45	45	46	45	46

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

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Figure 1. The relationship between the number of days of cardio and femur z-score in college-aged females

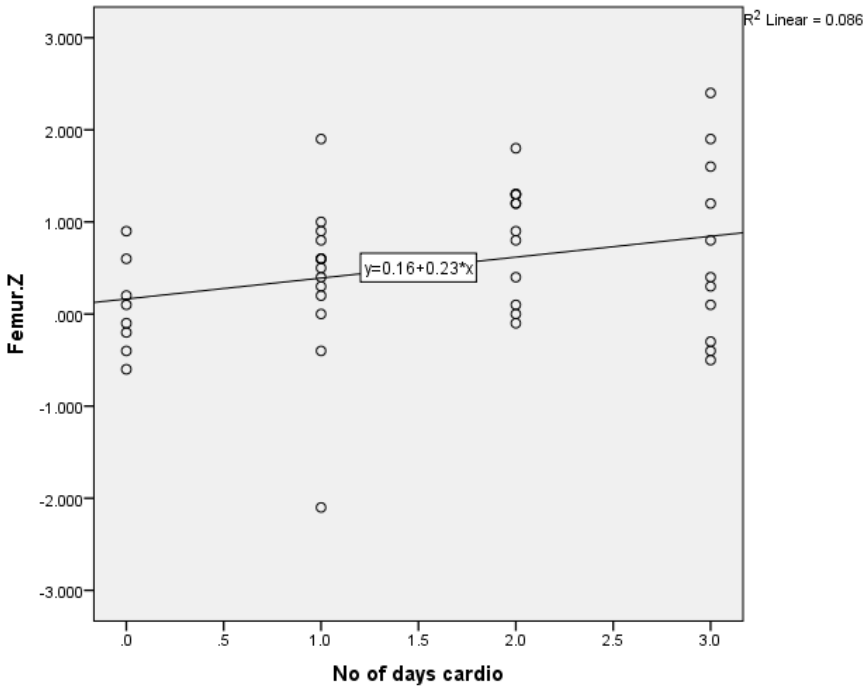

Figure 2. The relationship between the number of days of cardio and femur BMD in college-aged females

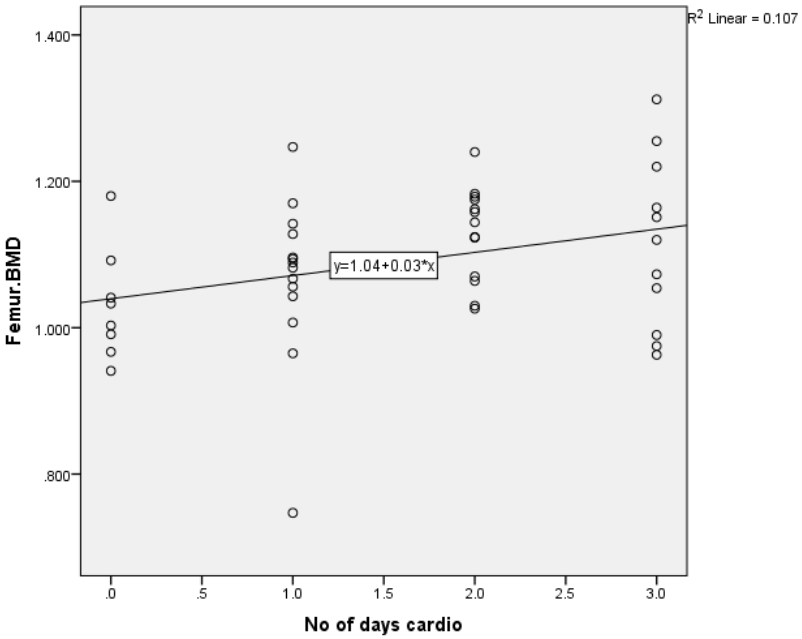

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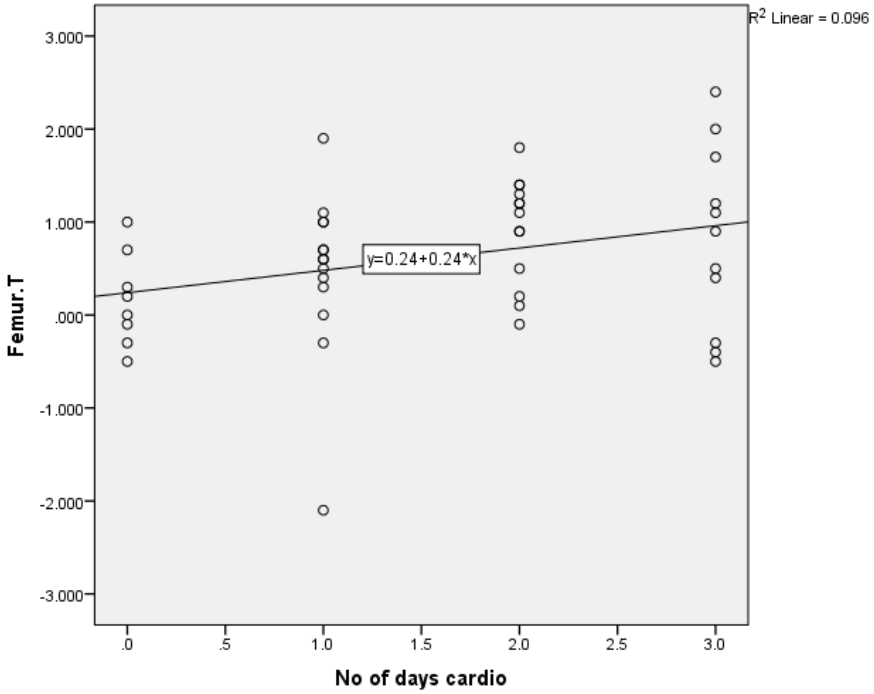
Figure 3. The relationship between the number of days of cardio and femur t-score in college-aged females



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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

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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
Telephone: (540) 568-8974
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

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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

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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

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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

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BDI-II

Date:

Name: _____ Marital Status: _____ Age: _____ Sex: _____

Occupation: _____ Education: _____

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the **one statement** in each group that best describes the way you have been feeling during the **past two weeks, including today**. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).

1. Sadness
- 0 I do not feel sad.
- 1 I feel sad much of the time.
- 2 I am sad all the time.
- 3 I am so sad or unhappy that I can't stand it.

2. Pessimism
- 0 I am not discouraged about my future.
- 1 I feel more discouraged about my future than I used to be.
- 2 I do not expect things to work out for me.
- 3 I feel my future is hopeless and will only get worse.

3. Past Failure
- 0 I do not feel like a failure.
- 1 I have failed more than I should have.
- 2 As I look back, I see a lot of failures.
- 3 I feel I am a total failure as a person.

4. Loss of Pleasure
- 0 I get as much pleasure as I ever did from the things I enjoy.
- 1 I don't enjoy things as much as I used to.
- 2 I get very little pleasure from the things I used to enjoy.
- 3 I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings
- 0 I don't feel particularly guilty.
- 1 I feel guilty over many things I have done or should have done.
- 2 I feel quite guilty most of the time.
- 3 I feel guilty all of the time.

6. Punishment Feelings
- 0 I don't feel I am being punished.
- 1 I feel I may be punished.
- 2 I expect to be punished.
- 3 I feel I am being punished.

7. Self-Dislike
- 0 I feel the same about myself as ever.
- 1 I have lost confidence in myself.
- 2 I am disappointed in myself.
- 3 I dislike myself.

8. Self-Criticalness
- 0 I don't criticize or blame myself more than usual.
- 1 I am more critical of myself than I used to be.
- 2 I criticize myself for all of my faults.
- 3 I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes
- 0 I don't have any thoughts of killing myself.
- 1 I have thoughts of killing myself, but I would not carry them out.
- 2 I would like to kill myself.
- 3 I would kill myself if I had the chance.

10. Crying
- 0 I don't cry anymore than I used to.
- 1 I cry more than I used to.
- 2 I cry over every little thing.
- 3 I feel like crying, but I can't.

Continued on Back

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_____ Subtotal Page 1

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11. Agitation

0 I am no more restless or wound up than usual.
1 I feel more restless or wound up than usual.
2 I am so restless or agitated that it's hard to stay still.
3 I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest

0 I have not lost interest in other people or activities.
1 I am less interested in other people or things than before.
2 I have lost most of my interest in other people or things.
3 It's hard to get interested in anything.

13. Indecisiveness

0 I make decisions about as well as ever.
1 I find it more difficult to make decisions than usual.
2 I have much greater difficulty in making decisions than I used to.
3 I have trouble making any decisions.

14. Worthlessness

0 I do not feel I am worthless.
1 I don't consider myself as worthwhile and useful as I used to.
2 I feel more worthless as compared to other people.
3 I feel utterly worthless.

15. Loss of Energy

0 I have as much energy as ever.
1 I have less energy than I used to have.
2 I don't have enough energy to do very much.
3 I don't have enough energy to do anything.

16. Changes in Sleeping Pattern

0 I have not experienced any change in my sleeping pattern.
1a I sleep somewhat more than usual.
1b I sleep somewhat less than usual.
2a I sleep a lot more than usual.
2b I sleep a lot less than usual.
3a I sleep most of the day.
3b I wake up 1–2 hours early and can't get back to sleep.

17. Irritability

0 I am no more irritable than usual.
1 I am more irritable than usual.
2 I am much more irritable than usual.
3 I am irritable all the time.

18. Changes in Appetite

0 I have not experienced any change in my appetite.
1a My appetite is somewhat less than usual.
1b My appetite is somewhat greater than usual.
2a My appetite is much less than before.
2b My appetite is much greater than usual.
3a I have no appetite at all.
3b I crave food all the time.

19. Concentration Difficulty

0 I can concentrate as well as ever.
1 I can't concentrate as well as usual.
2 It's hard to keep my mind on anything for very long.
3 I find I can't concentrate on anything.

20. Tiredness or Fatigue

0 I am no more tired or fatigued than usual.
1 I get more tired or fatigued more easily than usual.
2 I am too tired or fatigued to do a lot of the things I used to do.
3 I am too tired or fatigued to do most of the things I used to do.

21. Loss of Interest in Sex

0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

3 4 5 6 7 8 9 10 11 12 A B C D E

_____ Subtotal Page 2
_____ Subtotal Page 1
_____ Total Score

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