2018, Volume 1 (Issue 5) OPEN ACCESS

High and Low Impact Physical Activity Positively Influences Female Bone Density

Research Brief

Tobin Silver[1], Anya Ellerbroek[1], Sarah Knafo[1], Corey A. Peacock[1], Jaime Tartar[1], Jose Antonio[1]

[1]*Department of Health and Human Performance, Nova Southeastern University, 3301 College Avenue, Davie FL USA*
[2]*Department of Psychology and Neuroscience, Nova Southeastern University, 3301 College Avenue, Davie FL USA*

Abstract
Introduction: The aim of the current study was to analyze the effects of high and low impact physical activity on female bone health. Exploring lower cost preventative measures to improve bone density may reduce the physical and financial repercussions associated with health risks such as osteoporosis.
Methods: Fifty-four female athletes had total bone mineral density tested using a dual-energy x-ray absorptiometry (DXA) machine. Athletes were defined as either high intensity (HI) or low intensity (LI) based on training mode.
Results: There was not a significant difference between groups in bone mineral density for HI females (M=1.25, SD=0.10) and LI females (M=1.22, SD=0.11); t(51) = -1.057, p=.295.
Conclusion: Females that regularly take part in either high or low intensity activities may benefit from having improved bone mineral density.

Key Words: DXA, Impact, Bone

Corresponding author: Tobin Silver, tsilver@nova.edu

Introduction

A 2005-2008 survey found osteoporosis affected 9% of Americans over the age of 50 and 49% had low bone mass at the neck of the femur or lumbar spine.[1] Furthermore, in 2010 there were 310,800 hip replacements for adults aged 45 and up.[2] It has been estimated that osteoporosis cost the United States 22 billion dollars in 2008.[3] Exploring lower cost preventative measures to improve bone density may reduce such physical and financial strains.

Prepubescent boys and girls show negligible differences in bone density.[4] However, there are sex differences in body composition that occur during puberty. These changes reflect the body's adaptation to rapid growth. Mechanical loads increase due to lever arm lengths increasing which increase bending torque to bones. Increased muscle mass deforms bone and thus adaptations must occur to maintain stability. Wolff's law suggests that the architecture of bone changes based on mechanics.[5] Living bone may respond more to strain than stress to signal to the body that mechanical loads have occurred.[5] In men, these changes to bone density are exponential due to increased testosterone and IGF1. The average total body bone mineral density is 1.212 g/cm2 for males and 1.138 g/cm2 for females in the age range of 30-39 years in America (CDC).[6] Maintaining or possibly increasing bone mineral density decreases the occurrence of osteoporosis and fractures.

Per the International Osteoporosis Foundation,[7] exercise is one of three ways to keep bones strong (i.e. maintain bone mineral density). High impact activity (i.e. jogging) tends to help more than low weight baring activity (i.e. walking). However, weight training (per the IOF is not weight baring) is also effective at maintaining bone health. Furthermore, the IOF suggests that low weight baring activities such as swimming and cycling do not enhance bone density. However, low impact activity has shown to maintain bone mineral density just as much as high impact activity.[8] Based on assumptions from Wolff's law and earlier research, one can postulate that all impact (high or low) physical activity positively influences bone density. It is not just the intensity of the impact but the strain on the bone. Therefore, the current study expands on earlier work to give evidence that all physical activity (high or low impact) benefits bone health, specifically in women. It was hypothesized that active females in low and high impact sports will have similar bone mineral density, higher than average.

Methods

Fifty-four physically active women completed the current study. Thirty-four women competed in high impact (HI) activities while the other 20 competed in low impact (LI) activity. Subjects were assigned to the high impact group if they took part in track and field, CrossFit, soccer, high-intensity interval training (HIIT), weight training, or running. Subjects were assigned to the low impact group if they took part in yoga, swimming, stand-up paddling, or rowing. The frequency of training was a minimum of three days per week. Group activity crossover was not controlled for in the current study. The groups were assigned by subject's preferred mode of training, based on self-report. Data used was part of a larger ongoing study. Nova Southeastern University's Human Subjects Institutional Review Board in accordance with the Helsinki Declaration approved all procedures involving human subjects and written informed consent was obtained prior to participation.

Height was measured using standard anthropometry and total body weight was measured using a calibrated scale. Bone mineral density and body fat was measured using a Horizon W model dual-energy X-ray absorptiometry (DXA) machine (Hologic Inc., Waltham, MA). Subjects were positioned within the specified regions of the machine, supine with a straight spine. Subject were asked to remove all metal object. Procedures for the DXA scans were done by following the manufacturer's instructions. Each whole body scan lasted approximately 7 minutes. Data used for the current study from the DXA scan included bone mineral density (g/cm2) and body fat percentage. Bone mineral density was not standardized due to the mean height, weight, and body fat percentage of the groups not being significantly different based off t-test. (see Table 1).

Group differences in bone density were analyzed using an independent sample t-test. SPSS was the statistical software used with a significance set at $p < 0.05$. Results are presented as means and standard deviations.

Results

There was not a significant difference between groups in bone mineral density for HI females (M=1.25, SD=0.10) and LI females (M=1.22, SD=0.11); $t(51) = -1.057$, $p=.295$. These data suggest that low or high impact physical activity results in similar bone mineral density.

Table 1. Demographics of high and low impact activity females

		Age (Yrs.)	Height (cm)	Weight (kg)	Body Fat (%)
Female	HI	27.74 ± 8.36	164.01 ± 4.80	62.27 ± 8.45	21.06 ± 1.25
	LI	34.55 ± 10.14	167.17 ± 8.26	63.59 ± 8.72	21.74 ± 1.22

Data are means ± SD

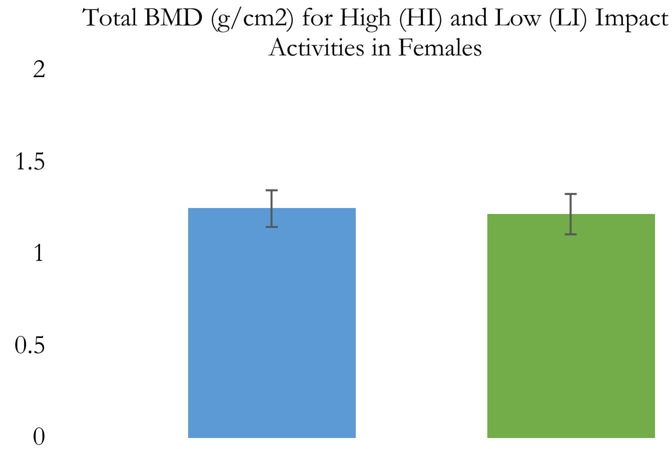

Figure 1. Bone mineral density for HI and LI impact activities in females

Discussion

Our investigation included females that are active in a large variety of physical activities. The current study explored how training for high or low impact activities, such as running or paddling affect bone mineral density. No differences in total bone mineral density between the two groups were found. Females that train for either high or low impact physical activities may benefit in terms of bone health. The current study adds to the literature that being active a minimum of three times per week may improve bone health. Similar to Grove and Londeree's findings, no differences were found in hi or low impact activities that were performed three times per week.[8] Furthermore, their study showed a third, sedentary group's bone mineral decreased. The current study did not use a control group, however; subjects showed mean bone mineral densities of 1.25 g/cm2 and 1.22 g/cm2 for the high and low impact activity females, respectively. These means are greater than the mean bone mineral density of females in the United States aged 20-39, which is 1.13 g/cm2. In fact, our subject's mean bone mineral densities are higher than the mean bone mineral density of men in the United States aged 20 to 39, which is 1.21 g/cm2 (CDC).

The current study is not the first to state that physical activity improves BMD. However, to the best of our knowledge the current study is the first to distinguish high and low intensity physical activity in female athletes. An investigation found that physically active premenopausal women that engage in higher than recommended levels of physical activity have higher BMD.[9] Drake found females entering the military were able to increase total BMD by 5% in the 3.6 years enlisted.[10] Their study supports that bone continues to adapt to stressors and improve density to at least age 22. Turnagol found American football players to have similar BMD regardless of position.[11] Although, the BMD reported in that study were males and did not compare to national averages, the numbers were larger (Z-scores ranging from 2.057 to 0.813).

The current study supports that females that regularly participate in either high or low intensity activities may benefit from having increased bone mineral density. Possibly, the act of being active is sufficient to promote improved bone health.

Limitations

Many factors may have contributed to the current study's results. For example, subjects were asked current activities they train for. One could postulate that a subject trained for endurance running as a child and then changed to paddling in their early 30's. Thus, the peak bone density may have occurred while training for the higher impact activity while they are categorized as low impact for the current study. Furthermore, diet was not assessed in the current study. Calcium, protein, and vitamin D have shown to improve bone health (IOF). It is well known that diet and physical activity are positively correlated.[12] Regardless of these limitations, physically active females showed improved bone health regardless of impact intensity. Study's investigating physical activities, such as the current study, add support for a lower cost preventative measure to improve bone density and thus reduce the physical and financial strains from osteoporosis and other bone related health concerns.

Media-Friendly Summary

Females who perform both Low and High Intensity exercise show adequate levels of bone mineral density. These exercise activities include track and field, CrossFit, soccer, high-intensity interval training (HIIT), weight training, running, yoga, swimming, stand-up paddling, and rowing. Exercise proves to improve Bone quality in females.

Reference

1. Looker, A., Borrud, L., Dawson-Hughes, B., Shepherd, JA., Wright, NC. Osteoporosis or low bone mass at the femur neck or lumbar spine in older adults: United States, 2005–2008. *Centers for Disease Control and Prevention, NCHS Data Brief No.* 93, 2012.
2. Wolford, ML., Palso, K., Bercovitz, A. Hospitalization for total hip replacement among inpatients aged 45 and Over: United States, 2000–2010. *Centers for Disease Control and Prevention, NCHS Data Brief No.* 186, 2015.
3. Blume, SW., Curtis, JR. Medical costs of osteoporosis in the elderly medicare population. *Osteoporosis Int. 22*(6): 1835-1844, 2011.
4. Lang, TF. The bone-muscle relationship in men and women. *Journal of Osteoporosis,* 2011.
5. Frost, HM. Wolff's law and bone's structural adaptations to mechanical usage: An overview for clinicians. *The Angle Orthodontist, 64*(3): 175-188, 1994.
6. U.S. Department of Health and Human Services. Total body bone area, bone mineral content, and bone mineral density for individuals aged 8 years and over: United States, 1999–2006. *Vital and Health Statistics, Series 11, Number 253*, 2013.
7. Bischoff. -Ferrari, HA. Three steps to unbreakable bones. *International Osteoporosis Foundation*, www.iofbonehealth.org. 2011
8. Grove, KA., Londeree, BR. Bone density in postmenopausal women: High impact vs low impact exercise. *Medicine and Science in Sports and Exercise*, 1190-1194, 1992.
9. Saravi, FD., Sayegh, F. Bone mineral density and body composition of adult premenopausal women with three levels of physical activity. *Journal of Osteoporosis*, 2013.
10. Drake, AJ., Armstrong, DW., Shakir, KMM. Bone mineral density and total body bone mineral content in 18- to 22-year-old women. Bone, 34: 1137-1143, 2004.
11. Turnagol, HH. Body composition and bone mineral density of collegiate american football players. Journal of Human Kinetics, 51: 103-112, 2016.
12. Blair, SN., Jacobs, DR. Powell, KE. Relationships between exercise and physical activity and other health behaviors. Public Health Reports, 100(2): 172-180.