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Bone Mineral Density Among Men and Women Aged 35 to 50 Years

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Context: Osteoporosis is characterized by low bone mineral density (BMD) and has been thought to only be a major health concern for postmenopausal women. However, osteoporosis and its risk factors have been greatly understudied in the middle-aged and male populations.

Objective: To assess the likelihood of low BMD and its association with related risk factors in early–middle-aged (defined in this study as 35-50 years) men and women.

Methods: Eligible men and women completed a questionnaire assessing calcium intake, hours per week of exercise, and other related risk factors associated with osteoporosis and osteopenia. The primary outcome variable, BMD, was attained using dual-energy x-ray absorptiometry scans taken at the femoral neck, trochanter, intertrochanteric crest, total femur, and lumbar spine.

Results: Of the 173 participants in this study, 23 men (28%) and 24 women (26%) had osteopenia at the femoral neck. In men, there was a significant and negative correlation between exercise and femoral neck BMD ($r=-0.296$, $P=.01$). In women, correlation analyses showed significant positive correlations between exercise and BMD of the trochanter ($r=0.329$, $P=.003$), intertrochanteric crest ($r=0.285$, $P=.01$), total femur ($r=0.30$, $P=.01$), and lumbar spine ($r=0.29$, $P=.01$).

Conclusions: Osteopenia was found in more than 25% of both male and female participants, which suggests that more osteoporosis screening and prevention programs need to be targeted to persons in the studied age group because osteopenia can lead to osteoporosis.

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Osteoporosis is defined as a reduction in the density and quality of bone.[1] Bone becomes fragile and porous from an imbalance of bone breakdown and bone formation.[2] According to the World Health Organization,[3] osteoporosis occurs when bone mineral density (BMD) is greater than or equal to 2.5 SD below the mean at the femoral neck or total femur. Osteoporosis is a significant public health issue, especially in countries with aging populations.[4] People who have low BMD have an increased risk of fracture and permanent damage. An osteoporotic fracture occurs every 3 seconds and is most commonly found in spinal vertebrae and the femoral head or hip.[5] Osteoporotic fractures can decrease mobility and quality of life and can cause death in extreme cases. By 2050, the worldwide incidence of osteoporotic fractures is projected to have increased by 310% in men and by 240% in women, which greatly increases the burden of osteoporosis in future generations.[6]

Osteoporosis is a significant medical and public health concern for postmenopausal women. Estrogen levels decrease sharply once a women reaches menopause, which influences bone loss.[7] In 2010, an estimated 2.0 million men and 8.2 million women aged 50 years or older had osteoporosis.[8] That number is estimated to rise to 10.2 million women and 3.3 million men in 2020.[9] About 30% of osteoporotic hip fractures occur in men older than 50 years.[10] In Norway, the Tromsø study[11] showed that BMD declined with age in men and women, yet this decline occurred to a greater degree in women. Older men (aged >60 years) have a higher mortality rate resulting from hip fractures than older women (aged >60 years) with similar fractures.[12] However, adults aged 35 years or younger and early–middle-aged men and women (defined in the current study as ages 35-50 years) are also at risk for osteoporosis and osteopenia, which is a BMD decline of less severity than osteoporosis, defined as 1.1 to 2.5 SD below the mean at the femoral neck or total femur.[3] Yet, the early–middle-aged population is a widely understudied group in terms of osteoporosis and BMD research. One prospective population-based study of 33,000 men and women aged 27 to 61 years found an association of osteopenia and osteoporosis with fragility fractures.[13] However, few data predict the risk factors for osteopenia and osteoporosis in this population. The modifiable risk factors for osteopenia and osteoporosis in adults aged 60 years or older are immobility (lack of physical activity/exercise), low body mass index (BMI), use of steroids, smoking, excessive alcohol drinking, low calcium consumption, low sunlight exposure, and use of antidepressants and antacids.[4,14,15] Age, gender, and race are well-established nonmodifiable risk factors.

Few studies have been conducted assessing risk factors for osteoporosis in middle-aged men and women. In one of these studies,[16] participants successfully modified their weight-bearing exercise routine, calcium intake, and caffeine intake. Another study[17] used computer-based instruction to address risk factors in middle-aged women and found that higher self-efficacy equated to higher calcium intake. The purpose of the present study was to assess the likelihood of low BMD and its associated risk factors in men and women aged 35 to 50 years.

Methods

Study Design, Population, and Sampling

This cross-sectional study began in June 2009 when a convenience sample of participants was recruited through mass emails and flyers around the campus of the University of Mississippi in Oxford and in the local community. Potential participants were briefed on the procedures and focus of the study. To be included in this study, participants had to be between the ages of 35 and 50 years with no previously known health issues, and they had to be able to read and write in English. Women were required to undergo a urine pregnancy test administered by appropriate personnel; women who were pregnant were excluded from the study. Potential participants were also excluded if they were postmenopausal, if they weighed 300 lb or more, or if they took medications that are known to affect BMD (eg, proton pump inhibitors, glucocorticoids, antidepressants). Participants were required to provide informed consent before data collection began. This study was approved by the institutional review board prior to data collection.

Instruments

Bone mineral density was obtained at the femoral hip (femoral neck, trochanter, intertrochanteric crest, and total femur) and lumbar spine using dual-energy x-ray absorptiometry (DXA). Dual-energy x-ray absorptiometry scanning has been proven to be both precise and simple to operate while providing a minimal dose of radiation.[17] Participants completed a questionnaire assessing calcium intake, number of times of exercise (≥30 minutes) per week, gender, smoking habits, family history of low BMD, and any history of musculoskeletal injury. Data were stored in a secure location in the possession of 1 of the participating researchers.

Statistical Analyses

Descriptive statistics were performed to assess means and SDs of the variables age, height, weight, BMI, daily dairy intake, and number of times exercise was done per week, as well as BMD. For frequency assessment, BMI data were categorized as underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), and obese (≥30.0). Dairy intake was categorized as less than 3 servings per day or 3 or more servings per day. Exercise was categorized as either exercising for at least 30 minutes 20 or more times per month, which meets the American College of Sports Medicine recommendation of 5 days per week, or exercising less than 20 times per month. Bone mineral density was categorized by T score as healthy (greater than −1.1), osteopenia (−1.1 to −2.49), or osteoporosis (≤2.5). Pearson product-moment correlation (for continuous variables) and χ^2 (for categorical variables) analyses were conducted to determine relationships between BMD and age, weight, BMI, dairy intake, and exercise. Statistical significance was denoted by $P \leq .05$. SPSS version 23 (IBM) was used for this study.

Results

Characteristics of the participants (N=173) are presented in **Table 1**. Of the 173 participants, 81 (47%) were men, 92 (53%) were women, and 162 (94%) were white. Of the men, 25 (30%) were classified as normal weight, 38 (48%) as overweight, and 18 (23%) as obese. For women, 1 participant (1%) was classified as underweight, 45 (49%) as normal weight, 26 (28%) as overweight, and 20 (22%) as obese. Seventy-five men and 78 women responded to questions regarding dairy intake and exercise frequency. The majority of both men (65 [87%]) and women (67 [86%]) consumed fewer than 3 servings of dairy per day. Fifty-one men (68%) reported exercising 20 times or more per month, and 44 women (56%) reported exercising 20 times or more per month.

Table 1.
Characteristics of Male (n=81) and Female (n=92) Bone Mineral Density Study Participants Aged 35 to 50 Years[a]

Characteristic	Men	Women
Race/Ethnicity		
White	78 (96.3)	85 (92.4)
Black	3 (3.7)	6 (6.5)
Hispanic	0	1 (1.1)
Body Mass Index		
Underweight	0	1 (1.1)
Normal weight	25 (30)	45 (48.9)
Overweight	38 (47.5)	26 (28.3)
Obese	18 (22.5)	20 (21.7)
Dairy Intake		
<3 servings/d	65 (86.7)	67 (85.9)
≥3 servings/d	10 (13.3)	11 (14.1)
Exercise		
<20 times/mo	24 (32)	34 (43.6)
≥20 times/mo	51 (68)	44 (56.4)

[a] Data are given as No. (%). Some participants did not respond to dairy and exercise frequency questions. Percentages may not total 100 because of rounding.

The BMD of men and women in this study is shown in **Table 2**. Twenty-three men (28%) and 24 women (26%) had osteopenia at the femoral neck. Five men (6%) and 2 women (2%) had osteoporosis at the lumbar spine.

Results of the correlation analyses showed that exercise status of men was significantly and negatively correlated with the femoral neck BMD (r=−0.296, P=.01). The results of the correlation analyses showed that among women, there was a significant and positive correlation of exercise status with BMD of the trochanter (r=0.329, P=.003), the intertrochanteric crest (r=0.285, P=.01), the total femur (r=0.30, P=.01), and the lumbar spine (r=0.29, P=.01).

Table 2.
Bone Mineral Density Levels of Male (n=81) and Female (n=92) Study Participants Aged 35 to 50 Years[a]

	Healthy BMD		Osteopenia		Osteoporosis	
Location	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Femur						
Neck	58 (71.6)	68 (74.0)	23 (28.4)	24 (26.1)	0	0
Trochanter	74 (91.4)	77 (83.7)	7 (8.6)	15 (16.3)	0	0
Intertrochanteric crest	78 (96.3)	86 (93.5)	3 (3.7)	6 (6.5)	0	0
Total femur	77 (95.1)	86 (93.5)	4 (4.9)	6 (6.5)	0	0
Lumbar Spine	59 (72.8)	76 (82.6)	17 (21)	14 (15.2)	5 (6.2)	2 (2.2)

[a] Data are given as No. (%).

Abbreviation: BMD, bone mineral density.

The trochanter, intertrochanteric crest, total femur, and lumbar spine BMDs each had a significant relationship with weight and BMI for men (P<.05). Women had a significant relationship with weight at each site; however, BMI was significant only for the femoral sites but not the lumbar spine (P>.05). The χ^2 analysis indicated no significant association between dairy intake category and all BMD measures (P<.05).

Discussion

The objective of this study was to assess the likelihood of low BMD and related risk factors in men and women aged 35 to 50 years. We found that 28% of men and 26% of women had osteopenia at the femoral neck region. These findings are similar to the Tromsø study,[11] which showed that BMD begins to decline in men and women during early–middle-age and progresses into old age. The sample in the current study consisted of men and women in the age group of 35 to 50 years, so the finding of osteopenia is significant, as osteopenia could lead to osteoporosis in old age. Therefore, it is important to target men and women in this age group for osteoporosis screening and prevention programs.

Osteopenia and osteoporosis screening measures and preventive interventions are needed for early–middle-aged men and women. Screening through DXA scanning is an effective measure for the detection of osteopenia and osteoporosis. However, the general population may not be adequately informed about the DXA scan or have little interest in getting scanned owing to fears about radiation exposure and cost. Educational interventions must be implemented to allay such misperceptions and barriers. Preventive interventions should aim at maintaining BMD and bone mass in early–middle-aged people with nutritious diets containing adequate amounts of calcium and vitamin D. Future studies should consider assessing the hormonal status of men and women, serum vitamin D_3 levels, genetic influences, and medical conditions that may influence BMD. Physicians and other health care professionals should also focus on increasing weight-bearing physical activities.

Osteopathic physicians are in a distinct position to provide holistic plans for the prevention, screening, and management of osteopenia and osteoporosis. The patient-centered philosophy of osteopathic medicine and the intimate relationship between the patient and osteopathic primary care physician provides the ideal setting for educational and preventive interventions uniquely designed for each patient. An understanding of unique risk factors that warrant osteoporosis screening, such as estrogen deficiency, long-term use of prednisone, and patient history of hyperparathyroidism, can inform prevention and treatment efforts.[18] Prevention programs may provide additional benefit. For example, Brecher et al[19] found that prevention programs increased patient knowledge of osteoporosis as well as increased calcium intake.[19] Although studies related to osteopathic manipulative treatment and osteoporosis are lacking, investigation of osteopathic manipulative treatment to address osteoporosis-related back pain may be warranted.

On an annual basis, osteoporotic fractures in the United States account for 500,000 hospitalizations and more than 800,000 visits to emergency departments.[20] By the year 2025, it is predicted that there will be more than 3 million fractures due to osteoporosis, costing $25.3 billion annually.[21] To help alleviate this economic burden, insurance companies could offer incentives to people younger than 50 years who participate in activities that would help reverse modifiable risk factors for osteoporosis, such as stopping smoking, participating in weight-bearing exercise, increasing calcium intake, and lowering alcohol consumption. Insurance companies could also pay for preventive diagnostic tests, such as DXA scans for persons in the 35- to 50-year age bracket. Earlier detection would allow for behavior modification that would prevent osteoporosis. By funding preventive screening and incentives, insurance companies would lessen the amount spent on osteoporotic fractures by individual consumers as well as by the insurance companies.

Limitations

One limitation of this study was that the participants were predominately white (93.6%); therefore, the results cannot be generalized to all races. Future studies should include random samples that are more generalizable to broader populations. This study included a large proportion of overweight men, which could affect the true assessment of osteopenia and osteoporosis. Future studies should control for weight status in the study design or data analysis. The majority of men (68%) and women (56%) engaged in exercise, which protects against osteopenia and osteoporosis. However, this level of exercise is not typical of the US population on the basis of the 2014 Centers for Disease Control and Prevention data,[22] which show only 21% meeting the American College of Sports Medicine guidelines. In the current study, the level of exercise was measured simplistically. Subsequent studies should measure frequency, duration, and intensity of exercise according to established measures. Also, the current study did not account for nondairy sources of calcium. Future studies should include data regarding intake of nondairy calcium sources, such as fortified juices and cereals, fish, soy, nuts, beans, and green leafy vegetables.[23]

Our finding of a significant negative relationship of femur neck BMD with exercise in men conflicts with previous studies.[15,24,25] Kukuljan et al[25] assessed an exercise program in men aged 50 to 79 years and found a significant main effect ($P<.05$) of weight-bearing exercise on femoral neck BMD. A meta-analysis conducted by Kelly et al[24] reported “a moderate and statistically significant benefit of exercise on femur neck BMD.” In the current study, men reported exercising a mean of 4.32 times per week. This amount is slightly below the American College of Sports Medicine’s recommended amount (30 minutes, 5 days per week). However, the level of exercise of the men may not have been as rigorous as that of previous studies, resulting in the negative finding. Future studies should assess exercise participation in greater detail.

Studies have reported low BMI as a risk factor for osteoporosis and resulting bone fractures.[26-28] In the study sample we used, the majority of men were overweight or obese, which could be a protective factor against osteopenia and osteoporosis. Therefore, this assessment could underestimate risk for low BMD in men. Future studies should take this factor into account in planning and evaluation.

Also in the current study, the majority of men and women consumed less than 3 servings of dairy per day. These findings are compatible with the relationship of decreased calcium intake and the development of osteopenia and osteoporosis in population-based studies.[4,14] Future interventions for preventing osteopenia and osteoporosis must aim at increasing calcium intake through the consumption of dairy products in early–middle-aged men and women.

Conclusion

This cross-sectional study found a high level of low BMD in men and women aged 35 to 50 years. It is important that early detection of the precursors for osteoporosis become part of the annual physical for people in this age range, as well as in older patients. Primary care physicians should begin educating patients as early as adolescence or young adulthood so the consequences of osteoporosis can be prevented. The result would be the prevention of future bone fractures and the morbidity and mortality associated with bone fractures, thus leading to improved quality of life.

Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. What is osteoporosis? International Osteoporosis Foundation website. https://www.iofbonehealth.org/what-is-osteoporosis. Accessed December 8, 2016.
2. Osteoporosis. Mayo Clinic website. http://www.mayoclinic.org/diseases-conditions/osteoporosis/home/ovc-20207808. Accessed December 08, 2016.
3. *Assessment of Fracture Risk and Its Application to Screening of Postmenopausal Osteoporosis*. Geneva, Switzerland: World Health Organization; 1994.
4. Hirsch R, Hochberg M. Arthritis and other musculoskeletal diseases. In: Remington P, Brownson R, Wegner M, ed. *Chronic Disease Epidemiology and Control*. 3rd ed. Washington, DC: American Public Health Association; 2010:581-590.
5. Johnell O, Kanis J. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int*. 2006;17(12):1726-1733. doi:10.1007/s00198-006-0172-4
6. Gullberg B, Johnell O, Kanis J. World-wide projections for hip fracture. *Osteoporosis Int*. 1997;7(5):407-413.
7. What women need to know. National Osteoporosis Foundation website. https://www.nof.org/preventing-fractures/general-facts/what-women-need-to-know/. Accessed September 6, 2018.
8. Wright NC, Looker AC, Saag KG, et al. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. *J Bone Miner Res*. 2014;29(11):2520-2526. doi:10.1002/jbmr.2269
9. *America's Bone Health: The State of Osteoporosis and Low Bone Mass in Our Nation*. Washington, DC: National Osteoporosis Foundation; 2002:1-55.
10. Khosla S, Amin S, Orwoll E. Osteoporosis in men. *Endocr Rev*. 2008;29(4):441-464. doi:10.1210/er.2008-0002
11. Emaus N, Omsland T, Ahmed L, Grimnes G, Sneve M, Berntsen G. Bone mineral density at the hip in Norwegian women and men—prevalence of osteoporosis depends on chosen references: the Tromsø Study. *Eur J Epidemiol*. 2009;24(6):321-328. doi:10.1007/s10654-009-9333-z
12. Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet*. 1999;353(9156):878-882. doi:10.1016/S0140-6736(98)09075-8
13. Holmberg AH, Johnell O, Nilsson PM, Nilsson J, Berglund G, Akesson K. Risk factors for fragility fracture in middle age. a prospective population-based study of 33,000 men and women. *Osteoporos Int*. 2006;17(7):1065-1077. doi:10.1007/s00198-006-0137-7
14. Włodarek D, Głąbska D, Kołota A, et al. Calcium intake and osteoporosis: the influence of calcium intake from dairy products on hip bone mineral density and fracture incidence—a population-based study in women over 55 years of age. *Public Health Nutr*. 2014;17(2):383-389. doi:10.1017/S1368980012005307
15. Allison SJ, Folland JP, Rennie WJ, Summers GD, Brooke-Wavell K. High impact exercise increased femoral neck bone mineral density in older men: a randomised unilateral intervention. *Bone*. 2013;53(2):321-328. doi:10.1016/j.bone.2012.12.045
16. Turner L, Wallace L, Hunt S, Gray A. Changes in behavior and behavioral intentions among middle-age women: results from an osteoporosis prevention program. *Psychol Rep*. 2003;93(2):521-526. doi:10.2466/PR0.93.6.521-526
17. Ryan P, Maierle D, Csuka M, Thomson A, Szabo A. Computer-based intervention to enhance self-management of calcium and vitamin D intake in women. *West J Nurs Res*. 2013;35(8):986-1010. doi:10.1177/0193945913483369
18. Your Medicare coverage. Medicare website. https://www.medicare.gov/coverage/bone-density.html. Accessed September 3, 2018.
19. Brecher LS, Pomerantz SC, Snyder BA, Janora DM, Klotzbach-Shimomura KM, Cavalieri TA. Osteoporosis prevention project: a model multidisciplinary educational intervention. *J Am Osteopath Assoc*. 2002;102(6):327-335.
20. Shuler FD, Conjeski J, Kendall D, Salava J. Understanding the burden of osteoporosis and use of the world health organization FRAX. *Orthopedics*. 2012;35(9):798-805. doi:10.3928/01477447-20120822-12
21. Burge R, Dawson-Hughes B, Solomon D, Wong J, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in

the United States, 2005–2025. *J Bone Miner Res.* 2007;22 (3):465-475. doi:10.1359/jbmr.061113

22. Facts about physical activity. Centers for Disease Control and Prevention website. 2014. https://www.cdc.gov/physicalactivity/data/facts.htm. Accessed May 2018.
23. USDA National Nutrient Database for Standard Reference. U.S. Department of Agriculture website. https://ndb.nal.usda.gov/ndb/nutrients/index. Accessed April 19, 2019.
24. Kelly GA, Kelly KS, Kohrt WM. Exercise and bone mineral density in men: a meta-analysis of randomized controlled trials. *Bone.* 2013; 53(1):103-111. doi:10.1016/j.bone.2012.11.031
25. Kukuljan S, Nowson C, Sanders K, et al. Independent and combined effects of calcium-vitamin D_3 and exercise on bone structure and strength in older men: an 18-month factorial design randomized controlled trial. *J Clin Endocrinol Metab.* 2011;96(4):955-963. doi:10.1210/jc.2010-2284
26. Holmes B, Ludwa I, Gammage K, Mack D, Klentrou P. Relative importance of body composition, osteoporosis-related behaviors, and parental income on bone speed of sound in adolescent females. *Osteoporos Int.* 2010;21(11):1953-1957. doi:10.1007/s00198-009-1152-2
27. Mendoza ES, Lopez AA, Valdez VA, Mercado-Asis LB. Osteoporosis and prevalent fractures among adult Filipino men screened for bone mineral density in a tertiary hospital. *Endocrinol Metab (Seoul).* 2016;31(3):433-438. doi:10.3803/EnM.2016.31.3.433
28. Nahar V, Nelson K, Ford M, et al. Predictors of bone mineral density among Asian Indians in Northern Mississippi: a pilot study. *J Res Health Sci.* 2016;16(4):228-232.