General Original Article

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Osteoporosis knowledge and health beliefs among middle-aged men and women in the Southern United States

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Abstract

Context: The most common skeletal disease, osteoporosis, causes bone fragility due to decreased bone mass and bone microarchitecture destruction. The health belief model is often applied to asymptomatic, prevention-related diseases such as osteoporosis. Steps to mitigate the insidious nature of osteoporosis, including education, motivation, and monitoring of bone mineral density, must begin at an earlier age.

Objectives: This study evaluates the knowledge and health beliefs surrounding osteoporosis in a population of males and females 35–50 years old to determine sex-based differences in osteoporosis knowledge and beliefs and to assess the correlation between perceptions and health motivation.

Methods: Participants (81 males, 92 females) completed two questionnaires: the Osteoporosis Knowledge Test and the Osteoporosis Health Belief Scale. Descriptive statistics were performed along with Pearson product-moment correlation analysis to determine the relationships between the variables. Sex-based differences were calculated utilizing independent *t*-tests.

Results: We discovered a statistically significant negative correlation between the barriers to exercise and health motivation (–0.434, $p < 0.001$) and a statistically significant positive correlation between the benefits of exercise and health motivation (0.385, $p < 0.001$). However, there was not a statistically significant correlation between health motivation with the following: the benefits of calcium, susceptibility, and the seriousness of osteoporosis. Between males and females, there was a statistically significant difference in exercise and calcium knowledge, susceptibility, and the benefits of both exercise and calcium ($p < 0.05$).

Conclusions: Males and females 35–50 years old perceive themselves to have a low susceptibility to osteoporosis. They do not consider osteoporosis a serious disease and have little motivation to mitigate its inception or progression. Their perceptions show that barriers to exercise impact health motivation more than the perceived benefits of exercise.

Keywords: bone; calcium; exercise; health belief model; motivation; osteoporosis; perceptions.

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The most common skeletal disease, osteoporosis, is often underappreciated despite its exorbitant cost to the health, social, and economic well-being of Americans [1]. It is estimated that 54 million Americans currently have osteoporosis or are at risk for the disease [2, 3]. In the United States, there are approximately two million osteoporotic fractures annually at a societal cost of $52 billion. These fractures account for more hospitalizations than the

combined total for heart attacks, strokes, and breast cancer [2, 3]. In addition, the cost for hospitalizations due to osteoporotic fracture outpaces the expenses for hospital stays due to myocardial infarction, stroke, urinary tract infection, cardiac dysrhythmia, congestive heart failure, pneumonia, and septicemia [4, 5]. The long-term societal burden of osteoporotic fracture is readily apparent, with many victims experiencing one or more long-term consequences including a decline in overall health, reduction in the ability to perform activities of daily living, decreased mobility, and institutionalization in a nursing home [2].

Osteoporosis is a chronic disease that causes bone to become fragile due to decreased bone mass and destruction of the bone's microarchitecture. These changes in the bone result from an imbalance in bone remodeling when the breakdown of bone outpaces the rate at which bone is constructed [6, 7]. For postmenopausal women and men over 50 years of age, the World Health Organization classifies osteoporosis as bone mineral density (BMD) that is 2.5 standard deviations (SDs) below that of a young healthy adult when measured at the hip (total proximal femur or femoral neck) or lumbar spine [6].

It is important to note that while osteoporosis affects both males and females, it is more commonly seen in females due to the sharp decrease in estrogen production during menopause, females attaining peak bone mass at an earlier age than males, and reduced bone density and strength in females [8]. It is estimated that 80% of Americans with osteoporosis are females, and 50% of those females over 50 years of age will suffer an osteoporotic fracture [9]. Although both males and females have progressive bone loss, the onset of bone loss is earlier and at an accelerated rate in females [10–12]. However, males suffer greater mortality following low-trauma (osteoporotic) fractures of the hip, femur, and pelvis [13].

Osteoporosis is an insidious disease similar to cardiovascular disease in that it demonstrates a uniquely asymptomatic silent progression. Because patients do not have an immediate decline in comfort or overall health at the onset of osteoporosis, this disease is perceived differently than other diseases displaying more acute symptoms such as pain or discomfort. To mitigate the silent progression of osteoporosis, awareness of risk factors and monitoring of BMD must begin at an earlier age. For example, one study that included 22,444 males (mean age, 44 years old) and 10,902 females (mean age, 50 years old) observed an association between impaired bone strength with increased fragility fractures [14]. Unfortunately, there are few studies that investigate the knowledge of risk factors or BMD in younger populations. However, programs that target the middle-aged may help promote bone-healthy behaviors that limit the progression of osteoporosis. One such program, the Osteoporosis Prevention Program, showed positive behavioral changes among 342 middle-aged females (mean age, 49.5 years old) that included modification of their weight-bearing exercise routine as well as adjustments to the intake of both calcium and caffeine [15]. These behaviors are important to reach and maintain peak bone mass [16].

The health belief model (HBM) was developed by Rosenstock in the 1950s to address the decisions people made regarding the use of preventative services offered by public health departments. The premise behind the HBM is that perceived risk and benefit drives action. The HBM aids in understanding why people participate in preventive health behaviors [17]. The HBM is often utilized to understand why people proactively choose preventative measures such as early testing or modifications to diet and exercise. The HBM is often applied to asymptomatic, prevention-related conditions such as cancer, hypertension, and osteoporosis [18]. For example, preventative behavior is more likely to occur when an individual feels susceptible to a health condition, perceives the health condition to be serious, believes that the benefit of action is greater than the barriers to that action, and exhibits motivation to be healthy [19].

The purpose of this study was to evaluate the knowledge and health beliefs surrounding osteoporosis in a population of males and females aged 35–50 years old, to determine sex-based differences in osteoporosis knowledge and beliefs, and to assess the correlation between perceptions and health motivation.

Methods

Study design

The University of Mississippi's Institutional Review Board approval (protocol number 09-132) was obtained prior to data collection. This cross-sectional study was conducted from June 2009 through June 2010. For recruitment purposes, a mass email was sent to all faculty and staff at the university, and fliers were posted around the local community and given to Church groups inviting those interested to participate in this study. Potential participants were briefed on the study purpose and design. After providing informed consent, 173 participants who met the following requirements were included in the study: 35–50 years of age, no known health issues, and ability to read and write in English. The exclusion factors included: pregnancy (confirmed by a urine pregnancy test administered by appropriate personnel), postmenopausal status, weight of >300 pounds, or current medications that have been shown to alter BMD such as proton pump inhibitors, glucocorticoids, and antidepressants.

Table 1: Descriptive characteristics of study variables.

Variable	Possible range	Observed range	Mean (SD)	Cronbach's alpha
Exercise knowledge	0.00–16.00	2.00–16.00	10.65 (2.65)	0.65
Calcium knowledge	0.00–17.00	3.00–17.00	11.21 (2.41)	0.57
Perceived susceptibility to osteoporosis	6.00–30.00	6.00–30.00	16.25 (5.44)	0.91
Perceived seriousness to osteoporosis	7.00–35.00	7.00–26.00	17.24 (3.53)	0.71
Perceived benefits of exercise	6.00–30.00	14.00–30.00	24.85 (3.20)	0.85
Perceived benefits of calcium	6.00–30.00	13.00–30.00	22.24 (2.92)	0.75
Perceived barriers to exercise	6.00–30.00	6.00–21.00	10.81 (3.89)	0.81
Perceived barriers to calcium intake	6.00–30.00	6.00–20.00	11.31 (3.90)	0.87
Health motivation	6.00–30.00	11.00–30.00	23.33 (3.55)	0.79

SD, standard deviation.

Table 2: Zero-order correlation matrix of study variables.

	1	2	3	4	5	6	7	8	9
1. Exercise knowledge	–	0.773**	0.119	−0.015	0.345**	0.203**	−0.057	−0.180*	0.267**
2. Calcium knowledge		–	0.146	−0.017	0.350**	0.197*	−0.006	−0.229**	0.271**
3. Perceived susceptibility to osteoporosis			–	0.222**	0.158*	0.109	0.083	0.011	−0.065
4. Perceived seriousness of osteoporosis				–	0.100	0.152*	0.161*	0.223**	0.043
5. Perceived benefits of exercise					–	0.419**	−0.254**	−0.265**	0.385**
6. Perceived benefits of calcium						–	0.032	−0.032	0.110
7. Perceived barriers to exercise							–	0.586**	−0.434**
8. Perceived barriers to calcium intake								–	−0.382**
9. Health motivation									–
Mean	10.65	11.21	16.25	17.24	24.85	22.24	10.81	11.31	23.33
Standard deviation	2.65	2.41	5.44	3.53	3.20	2.92	3.89	3.90	3.54

*$p < 0.05$; **$p < 0.001$.

Instruments

The participants completed two questionnaires that they accessed through Survey Monkey or obtained a hard copy from the researchers to be completed prior to the lab visit. The Osteoporosis Knowledge Test (OKT) assessed general knowledge of the risks of osteoporosis as well as calcium intake and exercise for the prevention of osteoporosis [20]. The Osteoporosis Health Belief Scale (OHBS) assessed perception of personal benefits and barriers to calcium intake and exercise participation as well as susceptibility to osteoporosis [21].

The OKT consists of 24 questions, with the first nine items assessing the general knowledge of osteoporosis risk, eight items regarding calcium, and seven items addressing exercise. This instrument developed by Kim et al. [20] is well validated as supported by its widespread use, with internal reliability coefficients of 0.72 for OKT calcium (items 1–9 and 17–24) and 0.69 for OKT exercise (items 1–16) [22]. Individual scores were calculated by adding up the number of correct responses. The range for the calcium knowledge items is 0.00–17.00 and the range for the exercise knowledge items is 0.00–16.00 (Table 1).

The OHBS has an overall test-retest reliability of 0.90, and validation is evidenced in its extensive application [21, 22]. It was developed by Kim et al. [21] and based on Rosenstock's HBM. This instrument consists of 42 items with seven subscales that are rated on a five-point scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). The seven subscales include: perceived susceptibility, perceived seriousness, perceived benefits and barriers to calcium intake and exercise, perceived barriers to calcium intake and exercise, and health motivation. For the subscales, the scores can range from 6.00 to 35.00 (Table 1).

Statistical analysis

Descriptive statistics were performed to determine the possible ranges, observed ranges, means, and SDs of the following study variables: exercise knowledge, calcium knowledge, perceived susceptibility, perceived seriousness, perceived benefits of exercise, perceived benefits of calcium, perceived barriers to exercise, perceived barriers to calcium intake, and health motivation (Table 1). A Pearson product-moment correlation analysis was conducted to determine the relationships between the nine study variables (Table 2). Sex-based differences were calculated utilizing independent *t*-tests (Table 3). Statistical significance was expressed as $p \leq 0.05$. SPSS version 23 (IBM, Armonk, NY) was utilized for this study.

Results

There were 173 participants in the study, with 92 (53.2%) females and 81 (46.8%) males, of which 163 (94.2%) were White, 9 (5.2%) Black, and 1 (0.6%) Hispanic. Descriptive

Table 3: Tests of sex-based differences in study variables.

Variable		n	Mean	SD	Mean difference	t	p-Value	Effect size
Exercise knowledge	Male	75	9.96	2.90	1.27	3.15	**0.002**	0.49
	Female	90	11.23	2.29				
Calcium knowledge	Male	75	10.36	2.51	1.58	4.41	**<0.001**	0.69
	Female	88	11.94	2.08				
Perceived susceptibility	Male	78	13.94	4.53	4.33	5.65	**<0.001**	0.86
	Female	89	18.23	5.38				
Perceived seriousness	Male	79	16.89	3.26	0.66	1.23	0.222	0.19
	Female	91	17.55	3.73				
Perceived benefits of exercise	Male	78	23.59	3.09	2.34	5.08	**<0.001**	0.78
	Female	91	25.93	2.89				
Perceived benefits of calcium	Male	78	21.63	2.46	1.12	2.59	**0.011**	0.39
	Female	92	22.75	3.19				
Perceived barriers to exercise	Male	80	10.21	3.72	1.12	1.89	0.061	0.29
	Female	90	11.33	3.99				
Perceived barriers to calcium	Male	79	11.42	3.90	0.20	0.33	0.739	0.05
	Female	92	11.22	3.92				
Health motivation	Male	78	22.96	3.65	0.68	1.25	0.214	0.19
	Female	92	23.64	3.44				

SD, standard deviation. Effect size is measured as Cohen's *d*. Perceived seriousness and susceptibility refer to development of osteoporosis. Bold values denote statistical significance at the $p < 0.05$ level.

statistics for the study variables are presented in Table 1. Overall, the participants did not regard osteoporosis as a serious disease (range, 7.00–35.00; mean, 17.24 ± 3.53; $\alpha = 0.71$) nor did they perceive themselves as susceptible to the disease (range, 6.00–30.00; mean, 16.25 ± 5.44; $\alpha = 0.91$). However, their perception of the benefits of exercise was high (range, 6.00–30.00; mean, 24.85 ± 3.20; $\alpha = 0.85$) with the barriers to exercise low (range; 6.00–30.00; mean, 10.81 ± 3.89; $\alpha = 0.81$). However, they had only moderate motivation to participate in preventative behaviors (range, 6.00–30.00; mean, 23.33 ± 3.55; $\alpha = 0.79$) (Table 1).

In this cohort, there was a statistically significant negative correlation between the perceived barriers to exercise and health motivation ($r = -0.434$, $p < 0.001$). Alongside this statistic is a statistically significant positive correlation between the perceived benefits to exercise and health motivation ($r = 0.385$, $p < 0.001$). There was not a statistically significant correlation between health motivation with the following: perceived benefits of calcium ($r = 0.110$, $p > 0.05$), susceptibility ($r = -0.065$, $p > 0.05$), and seriousness of osteoporosis ($r = 0.043$, $p > 0.05$) (Table 2).

When each subscale was analyzed by sex (Table 3), there was a statistically significant difference in exercise and calcium knowledge, perceived susceptibility, and the perceived benefits of both exercise and calcium between males and females. Females have statistically significant more exercise knowledge (mean, 11.23) than males (mean, 9.96) ($t = 3.15$, $p = 0.002$, $d = 0.49$), as well as more knowledge regarding calcium (mean, 11.94) than males (mean, 10.36) ($t = 4.41$, $p < 0.001$, $d = 0.69$). Females also viewed themselves as more susceptible to osteoporosis (mean, 18.23) than males (mean, 13.94) ($t = 5.65$, $p < 0.001$, $d = 0.86$). There was also a statistically significant difference regarding the perceived benefits of exercise between females (mean, 25.93) and males (mean, 23.59) ($t = 5.08$, $p < 0.001$, $d = 0.78$). In addition, females' perception of the benefits of calcium (mean, 22.75) was higher than males (mean, 21.63) ($t = 2.59$, $p = 0.011$, $d = 0.39$). There was no statistically significant difference in perceived seriousness, barriers to exercise and calcium, or health motivation (Table 3) between males and females.

Discussion

The purpose of this study was to evaluate the knowledge and health beliefs surrounding osteoporosis, including sex-based differences, in a population of males and females 35–50 years old. More specifically, this study evaluated knowledge of exercise and calcium, perceptions of the seriousness and susceptibility to osteoporosis, the perceived benefits and barriers to exercise and calcium intake, and the corresponding motivation to participate in measures to prevent osteoporosis. This study found that the perceived barriers to exercise drive health motivation

more than the knowledge that exercise and calcium can have positive effects on bone health. As such, it is critical to implement strategies to increase health motivation.

The perceived barriers are often the most predictive construct of action in the HBM [23, 24]. Corresponding to this construct, the negative correlation between motivation and barriers to exercise outweighed the positive correlation between the benefits of exercise with health motivation in this cohort of early- to middle-aged males and females. As the present study indicates, when the perceived negative attributes (i.e., barriers) of exercise outweigh the perceived benefit, then participation in exercise is less likely, even when you know it is good for you. A study of 273 females (mean age, 28.34) by Wallace [19] concluded that interventions should be implanted to increase self-efficacy and lower the perceived barriers to exercise and calcium intake. Heath care practitioners, including physicians, physician assistants, nurse practitioners, and physical and occupational therapists, must make it a priority to provide osteoporosis education and intervention plans for their patients.

Osteopathic physicians have a unique opportunity to provide education on bone health, build patient self-efficacy, and develop positive lifestyle interventions with their patients as partners in the process. This holistic focus of osteopathic medicine empowers the patient to work past perceived hindrances to exercise and diet modification with their doctor while developing the motivation to follow a healthier lifestyle. Maintenance and initiation of healthy behaviors are reinforced by self-efficacy and autonomous motivation [25, 26]. Castillo-Mayén et al. concluded that there is a positive relationship between self-efficacy, autonomous motivation to follow a healthy lifestyle, and satisfaction with life (n = 755; average age, 64.60 years; SD ± 9.03) [26].

The intimate relationship between the osteopathic physician and patient provides the opportunity to educate the patient regarding the severity of osteoporosis and his or her susceptibility to this debilitating disease. Education should include concrete steps such as comparing radiographs of normal and osteoporotic bone as well as a discussion of the pathologic conditions for which the osteoporotic patient is at risk. This process will help the patient visualize the damage caused by osteoporosis and help him or her to gain a better understanding of the seriousness of this disease. Continued conversation about the benefits of exercise and diet changes as well as the risks associated with noncompliance could increase the patient's motivation to make those changes. Pursuant to the HBM, people are more likely to make positive health modifications if they think that a disease is serious and if they have a better understanding of their risk factors [17, 27]. For example, Laslett et al. [28] (≥50 years of age, n = 146) found that osteoporosis education can be effective at increasing knowledge and behaviors such as calcium intake. Subsequent research should further evaluate the ways to increase patient motivation in making healthy lifestyle changes.

Although osteoporosis and fragility fractures are health concerns for males [29], our study demonstrated that males have less knowledge than females regarding exercise and calcium as they relate to osteoporosis. In our study, males also regarded themselves as less susceptible to osteoporosis than females and had a lower perception of the benefits of exercise and calcium intake. The threat of osteoporosis for males is a reality. According the National Osteoporosis Foundation, males experience increased mortality after suffering a hip fracture and males over 50 are more likely to suffer an osteoporosis-related fracture than get prostate cancer [30]. Males can also develop idiopathic osteoporosis at a younger age before age-related factors are evident [29]. Educating this population must be a priority to trigger changes in the understanding of their susceptibility to osteoporosis and the seriousness of this disease as well as the benefits of exercise and calcium intake. Insurance companies should provide online modules on osteoporosis, providing credit to those who complete the modules. Education interventions based on the HBM have been shown to increase knowledge and belief scores, as well as behaviors that reduce the risk of developing osteoporosis [31]. Future studies should assess the most effective vehicle for educational programs focused on males.

Implementing concrete ways to remove both real and perceived barriers among those 35–50 years of age are needed to promote healthy behaviors. Because many individuals in this age range are part of the workforce, employers should provide resources in the form of the time and means to exercise. An employer can alleviate some of the barriers and increase motivation by offering release time during the workday for exercise, paying for gym memberships, providing seminars on healthy lifestyles during lunch so the workday is not interrupted, or supplying on-site workout equipment and locker rooms. Other employer-provided benefits that could create compounding effects include walking breaks, standing desks, and open work environments that promote mobility. Workplace health promotion programs have been shown to have a positive effect on health behaviors and biometric measures as well as positive financial outcomes [32].

Future studies should be conducted that continue to evaluate the effects of specific workplace health promotion practices on motivating healthy lifestyles.

Insurance companies are in a particular position of influence and power when it comes to increasing healthy behavior and motivation to participate in healthy endeavors such as exercise or dietary changes. An ongoing trend that must be perpetuated is connecting higher levels of activity with lower healthcare premiums. The utilization of smart technology and wearables allows insurance companies to collect data on the insured individual's level of activity. Employers could support increased activity levels by promoting workplace competitions such as a daily step competition. This creates both lower premiums for the employee and the employer, while providing a health benefit that could reduce the risk of osteoporosis. Future studies should evaluate the relationship between wearable technology and perceptions of barriers to exercise.

Limitations

There are some potential limitations to the current study. First, the majority of the participants (93.6%) were White; therefore these findings cannot be applied to people of other raced/ethnicities. Second, this study's findings are based on self-reported data, which could result in recall and social desirability biases. Third, because the population was drawn from a convenience sample of the local community, self-selection bias cannot be ruled out. Finally, the sample size was rather limited, thereby decreasing the generalizability of the findings to larger groups. Future studies should utilize a random sample size and a larger sample size to ensure that the findings can be applied to other populations.

Conclusions

This study found that males and females ages 35–50 years perceive that they have low susceptibility to osteoporosis and do not consider it to be a serious disease. We also found that the barriers to exercise have a stronger correlation to health motivation than the perceived benefits of exercise. These results indicate that this population of males and females has little motivation to mitigate the inception and progression of osteoporosis. Osteopathic physicians should partner with their patients in this age range to develop interventions and provide education on osteoporosis. Employers and insurance companies must provide opportunities and incentives that promote both education and healthy activities such as participation in exercise and increasing calcium intake to alleviate the modifiable risk factors of osteoporosis. These steps to provide osteoporosis education and intervention in this age group would help to promote bone health, consequently alleviating some of the economic, social, and health burdens of osteoporosis.

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