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Physical Activity and Osteoporotic Fracture Among Older Women

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Objective: To determine the importance of physical activity in the occurrence of osteoporotic fracture and to examine the impact of exercise frequency on osteoporotic fracture among a national sample of women aged 50 years and older.

Design and Setting: This study involved female participants in the Third National Health and Nutrition Examination Survey (NHANES III), Phase 1.

Subjects: The sample consisted of 2,325 women aged 50 years and older who were interviewed for Phase 1 of NHANES III.

Measurements: Predictor variables that were examined in this study included heredity, age, race, body mass index, physical activity, smoking status, alcohol use, and dairy product intake. Multivariate analysis was conducted.

Results: Race, age, body mass index, and inactivity were significant risk factors predicting the occurrence of osteoporotic fracture.

Conclusions: Athletic trainers in clinical settings are in an ideal position to educate female patients about risk factors for osteoporotic fracture. The clinical athletic trainer may incorporate balance training, generalized strengthening, and other fall-prevention activities into rehabilitation programs in order to help prevent osteoporotic injuries.

Key Words: osteoporosis, bone density, exercise

Fractures from osteoporosis are a major public health problem in the western world.[1] Osteoporosis is one of the most prevalent diseases of aging, affecting more than 25 million people in the United States, 80% of whom are women.[2] This disease is responsible for approximately 250,000 hip fractures a year and an annual total of 1.5 million fractures in the United States.[3] Among women in 1991, osteoporotic fractures totaled more than 1 million.[4] The economic cost of osteoporotic fracture in the United States is estimated to be $10 to $12 billion annually, or $27 million a day.[1]

The federal government has recognized the urgent need to reduce the incidence of hip fractures and deaths from falls.[5] Falls are the leading cause of death resulting from injury for people aged 65 years and older. Federal government health objectives aim to reduce hip fracture among people aged 65 and older so that hospitalizations are no more than 607 per 100,000 people.[5] However, hospitalization rates for hip fractures for all people have increased from 714 per 100,000 people in 1988 to 814 per 100,000 in 1993.[6]

In 1988, there were 2,721 hip fracture hospitalizations per 100,000, and, by 1993, this rate had increased to 3,035 hospitalizations per 100,000.[6] Older women are recognized as a high-risk group for osteoporotic fracture. National health objectives include the need to reduce hip fracture among white women aged 65 years and older to 2,177 per 100,000.[5] Unfortunately, hip fracture rates among white females over the age of 65 are also increasing.[6]

Physical activity has been shown to have positive impacts on bone density.[7–9] Rogers and Evans[10] reported that the adaptations in aging skeletal muscle to exercise training enhance the ease of carrying out the activities of daily living and exert a beneficial effect on osteoporosis. Muscle stresses are important in fostering and maintaining bone mineral density. Other research[11] shows that moderate levels of physical activity exert a protective effect against hip fracture in postmenopausal women. However, much information regarding physical activity is unknown. Since factors other than exercise play major roles in the development of this disease, the order of importance of physical activity, when compared with other risk factors, is not known.[12,13] While physical activity guidelines exist for general health, specific exercise guidelines are not available for bone health.[2]

Certified athletic trainers are the ideal providers of health care to the physically active. In this role, athletic trainers are faced with injuries and other health issues of physically active individuals, including geriatric populations. It is imperative that athletic trainers be well versed in the health concerns, such as osteoporosis, that are unique to members of this population.

Most certified athletic trainers are employed in clinical settings.[14] In the clinical setting, in particular, athletic trainers will be called on to develop rehabilitation protocols for female patients. Because this segment of the population is more prone to the development of osteoporosis, an awareness of the role that physical activity plays will help the athletic trainer design programs to assist in osteoporosis prevention and the mitigation of osteoporotic symptoms. Our purpose was to determine the importance of physical activity in the occurrence of osteoporotic fracture and to examine the impact of exercise

frequency on osteoporotic fracture among a national sample of women aged 50 years and older.

METHODS

Subjects

The subjects included in this study were participants in the Third National Health and Nutrition Examination Survey (NHANES III), Phase 1. Subjects were selected from the civilian, noninstitutionalized population aged 2 months and older of the United States from 1988–1991 (n = 20,277).[6] This largest-scale national health survey was conducted by the National Center for Health Statistics.

A total of 20,277 sample persons were identified for Phase 1; 17,464 sample persons (86%) were interviewed.[15] For purposes of this study, only women aged 50 years and older were studied because osteoporosis has been studied most extensively in older women.[16] In addition, these women were considered at risk for osteoporotic fractures.[17] The sample for this study included 2,325 women aged 50 years and older who resided in households interviewed for NHANES III, Phase 1. The mean age of the women in this study was 68.8 years (SD = 11.5, range, 50 to 100). Thirty-seven percent (n = 867) of the women were aged 50 to 64 years, while 63% (n = 1,458) were 65 years or older. Fifty-nine percent (n = 1,364) were white, 22% (n = 505) were black, 18% (n = 409) were Hispanic American, and 2% (n = 47) were from other ethnicities (1% is attributable to rounding error).

Oversampling of older and minority populations, a unique feature of NHANES III, is evident in these frequencies. A total of 195 women experienced either a wrist and/or a hip fracture.

Data Collection

Phase 1 data collection took place between October 1988 and October 1991. Hispanic Americans, African Americans, and people aged 60 years and older were oversampled to provide reliable estimates of health and nutritional characteristics for these groups.[18]

The 9 predictor variables examined in this study have been frequently cited as risk factors for osteoporotic fracture.[1] They included age, race, biologic mother's osteoporosis status, biologic mother's hip fracture status, body mass index (BMI), physical activity, smoking status, alcohol use, and dairy product intake. Physical activity information was obtained from self-reported data for the following items: "In the past month, how often did you walk a mile or more at a time without stopping; jog or run; ride a bicycle or an exercise bicycle; swim; do aerobics or aerobic dancing; do other dancing; do calisthenics or exercises; do gardening or yard work; lift weights; do other exercises, sports, or physically active hobbies not mentioned?" Data from each of these responses were summarized to yield a total frequency of physical activity variable. Physical activity was defined in terms of frequency per week.

For general fitness, 20 minutes of exercise 3 times a week is recommended; however, specific guidelines do not exist for bone health.[2] Several studies on bone density and exercise suggest exercise frequencies of 3 times a week,[19,20] while some evidence suggests more moderate activity of 2 times a week may be beneficial.[21] Therefore, we examined both activity levels.

The outcome variable, osteoporotic fracture status, was measured by self-reported information obtained from the following items: "Has a doctor ever told you that you had broken or fractured your hip or wrist?" and "Was that fracture a result of a fall from standing height or less, harder fall, or severe trauma?" ("Harder fall" refers to a fall from a greater height.) Women who respond yes to 1 or both of the fracture questions and yes to the fracture being a result of a fall from standing height or less were classified as positive for osteoporotic fracture status.

Data Analysis

Data for this study were analyzed to develop a predictive model for occurrence of osteoporotic fracture in women aged 50 years and older. A stepwise logistic regression procedure was used. Statistical tests were performed using the PC version of Statistical Analysis System programs (version 6.11, SAS Institute, Cary, NC). SAS programs, widely used in social science research, are commonly used for multivariate analyses.[22]

RESULTS

Logistic regression analyses are displayed in the Table. Race, age, BMI, and inactivity were significant risk factors predicting the occurrence of osteoporotic fracture. Smoking status, alcohol use, dairy product use, activity frequency level of 3 times a week, and measures of heredity (biologic mother's

Independent Risk Factors for Osteoporotic Fracture (n = 2,325)

Variable	Standard Estimate	P Value	Odds Ratio	Confidence Interval
Black	−0.381494	.0001	0.186	0.100, 0.349
Hispanic	−0.155265	.0026	0.477	0.295, 0.772
Age (≥65 y)	0.448795	.0001	5.390	3.273, 8.878
BMI (low)	0.073832	.0500	1.427	1.000, 2.037
Inactivity (exercise <2 times/wk)	0.157484	.0007	1.838	1.293, 2.613

osteoporosis and hip fracture status) were not significant. Activity frequency of 2 or more times per week was significant.

Analysis of race was conducted using white as the reference; results indicated that being black is a significant protective factor (odds ratio (OR) = 0.186, confidence interval (CI) = 0.100, 0.349), as is being Hispanic (OR = 0.477, CI = 0.295, 0.772). Being 65 years of age or older was a significant risk (OR = 5.390, CI = 3.273, 8.878). Being underweight (OR = 1.427, CI = 1.000, 2.037) or inactive (OR = 1.838, CI = 1.293, 2.613) were also significant risk factors. When controlling for other variables, age, race, BMI, and inactivity remained independently significant.

When compared with white women, black women were 19% less likely to suffer a fracture, while Hispanic women were 48% less likely to experience a fracture. Women aged 65 years or older were 4.39 times more likely than women aged 50 to 64 years to suffer an osteoporotic fracture. Women with low BMI were 43% more likely to experience fracture than women in BMI categories of normal, overweight, or severely overweight, while inactive women were 84% more likely to suffer a fracture than females who were active 2 or more times per week.

DISCUSSION AND RECOMMENDATIONS

Physical activity has been shown to have positive impacts on bone density.[7,9] Rogers and Evans[10] reported that the adaptations in aging skeletal muscle to exercise training enhance the ease of carrying out the activities of daily living and exert a beneficial effect on osteoporosis. Other research[11] indicates that moderate levels of physical activity exert a protective effect against hip fracture in postmenopausal women. Our findings confirm present research regarding physical activity. Physical activity was a greater predictor for fracture than heredity, smoking status, alcohol use, and dairy product intake. When providing care to older females, athletic trainers can apply this information and emphasize the strong role physical activity plays in fracture risk. They can design programs that include physical activity and be aware of the presence of other risk factors when dealing with older women who are physically active.

Our results can be applied to 2 domains of athletic training, including the prevention of injuries and rehabilitation and reconditioning. Frequency and intensity of activity are important considerations in both domains. This study supports the concept that moderate activity of 2 or more times per week should be suggested; modest physical activity is recommended to help minimize bone loss.[23] Athletic trainers working with patients in the clinical setting should be keenly aware of the relationships between physical activity and osteoporotic fracture when establishing short-term and long-term goals for at-risk patients. Appropriate levels and intensities of physical activity should be included in the rehabilitation plan goals.

An important consideration in establishing goals is the type of activity. The American College of Sports Medicine position statement[24] regarding physical activity and osteoporosis prevention states that weightbearing activity is essential for maintaining skeletal integrity. An optimal exercise program for older women includes activities for improving strength, flexibility, and coordination, since improvements in these areas reduce the likelihood of falls and fractures.[24] Weightbearing, use of gravitational force, or mechanical loading is suggested.[25] Physical stress is a major stimulus for the remodeling and strengthening of bone; bone tissue adapts to the stress loads it experiences.[26] Therefore, swimming, which is considered a weight-supported activity, is less effective than other weightbearing activities.[27] Athletic trainers should design programs that include resistance training to achieve these goals.

Pollock and Brechue[28] recommended approximately 2 sessions per week of strength-training exercises. They suggest a minimum of 15 minutes of muscle conditioning per session, preceded by a warm-up and followed by a cool-down program. Erickson and Sevier[29] recommended 30 minutes of weightbearing activity a day for older women. Some researchers prefer calisthenics and/or the use of resistance exercise equipment, such as Nautilus machines (Nautilus International, Independence, VA).[28] Resistance exercise equipment that is designed to protect the lower back and prevent loss of balance should be used. A program that involves starting with light weights and gradually increasing resistance in small increments is suggested.

Researchers also recommend other types of physical activity for the older patient, including walking, cycling, low-impact aerobics, rowing, and step aerobics.[28] Running or jogging, basketball, rope skipping, and high-impact aerobics are discouraged for most older patients. Naturally, the selection of type of activity will vary according to the physical status and preferences of the individual. While physical activity is recommended for osteoporosis prevention, excessive exercise is discouraged, since this can lower bone density and precipitate fractures.[29]

While athletic trainers are the ideal providers of health care to the physically active, due to variations in state laws governing athletic training, athletic trainers in clinical settings may assist with the rehabilitation of patients who are not physically active. This offers an excellent opportunity to educate female patients about the risk factors for osteoporotic fracture, especially regarding the importance of physical activity. Athletic trainers can encourage inactive women to avoid a sedentary lifestyle and to begin a moderate and safe exercise program.

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