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Body Mass and Fracture Risk

A Study of 330 Patients

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Low body mass is a major risk factor for low energy hip fractures among women. The purpose of this study was to ascertain whether normal body mass also protects against low energy wrist fractures. A retrospective analysis of body mass indices of 330 women who sustained hip or wrist fractures from falls was performed. Data were grouped by race and age. The mean body mass index for white patients with wrist fractures was 26.4, compared with a mean body mass index of 22.3 in white patients with hip fractures. For black patients, those with wrist fractures had a mean body mass index of 28.5, compared with a mean body mass index of 22.9 for those with hip fractures. Using data from The National Health and Nutrition Examination Surveys, the mean body mass index of patients with wrist fractures was seen to be equal to or greater than the national mean body mass index, whereas that of patients with hip fractures was substantially below average. Accordingly, normal body mass was protective against hip fractures but not against wrist fractures. Because adipose tissue more typically is distributed about the hip than the wrist, the protective mechanism of normal body mass against osteoporotic fractures may promote better preventative interventions against this disease.

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Low body mass, typically related to low stores of body fat, is a major risk factor for hip fractures among women.[15] Two mechanisms have been suggested to explain how body mass may affect fracture risk. One explanation suggests that body fat provides indirect protection from bone loss by providing a source and depot for the peripheral conversion and storage of estrogen.[4,6] An alternative explanation for the role of body fat in the prevention of hip fractures suggests that fat serves as a shock absorber, blunting the transmission of the kinetic energy generated by a fall. The importance of energy absorption can be inferred from the observation of Lotz and Hayes[8] that only 50 J of energy are required to break even young, healthy bone, whereas a fall from the standing position generates approximately 450 J of kinetic energy. Because only a small percentage of falls result in fracture, energy absorption seems to be a clinically important defense mechanism.

Cummings and Nevitt[2,10] showed that the mechanism of falls causing low energy fractures of the distal radius differs from those causing hip fractures: wrist fractures result from falls on the extended forearm, whereas hip fractures result from direct impact on the hip and buttock.

Thus, a soft tissue shock absorber might provide greater protection against hip fractures than against wrist fractures. In addition, adipose tissue more typically is distributed about the hip than the wrist. These factors combine to make the hip, but not the wrist, a natural beneficiary of soft tissue shock absorption.

If the predominant role of body mass in the prevention of osteoporotic fractures is to decrease bone loss (a systemic effect), one would expect the risk of hip fractures and the risk of wrist fractures to be affected by body mass index values; that is, patients with either type of fracture should be characterized by a low body mass index. Alternatively, if the predominant role of body mass in the prevention of osteoporotic fractures is to act as a local shock absorber, only hip fracture risk should be affected by changes in body mass because the hip potentially is padded with fat, whereas the wrist is not. If that conjecture were true, it follows that only patients with hip fractures (and not those with wrist fractures) should have a low body mass index.

MATERIALS AND METHODS

Patients With Hip Fracture

Information on the height and weight of patients with hip fractures was obtained from a concurrent case control study of hip fractures in white and black women.[3] Patients with hip fractures included white and black women 45 years of age or older with a radiologically confirmed diagnosis of a hip fracture from a fall. Patients were admitted to one of 30 participating hospitals in New York and Philadelphia, during a 5-year period. Trained interviewers used a standard questionnaire to ask subjects about numerous factors, including their age, race, height, and weight before the fracture occurred.

Patients With Wrist Fracture

The authors reviewed the inpatient charts of all women older than 45 years of age admitted to the authors' institution with a fracture of the distal radius caused by a fall during the same 5 years. Included in this study were patients whose fracture occurred as a result of a fall from a standing position. Patients with a history of malignant disease or a previous fracture of the involved wrist were excluded. From each chart, the patient's age, race, height, and weight at the time of admission was obtained.

Data Analysis

Because body mass and fracture rates are different among whites and blacks, data were analyzed after stratifying by race. The body weight and height were used to generate a body mass index, given as the weight in kilograms divided by the square of the height in meters. Mean body mass indices in patients with hip fractures were compared with those with wrist fractures by race and age category. The Student's two tailed t test was used to evaluate overall differences and differences in each age and race stratum. In addition, logistic regression was used to evaluate the independent effect of body mass on the risk of hip and wrist fractures, while controlling for age and race.

RESULTS

Three hundred thirty patients were enrolled in the study. Two hundred eight-three patients had hip fracture, and 47 sustained wrist fractures. Of the 283 patients with hip fractures, 162 were white and 121 were black. Among the patients with wrist fractures, 33 were white and 14 were black.

The mean body mass index of white patients with wrist fractures was 26.4 (standard deviation, 4.7; standard error of the mean, 0.8), compared with an index of 22.3 (standard deviation, 4.0; standard error of the mean, 0.3) for white patients with hip fracture ($p < 0.0001$). The body mass index of black patients with wrist fractures was 28.5 (standard deviation, 5.0; standard error of the mean, 1.3), compared with an index of 22.9 (standard deviation, 4.9; standard error of the mean, 0.4) for black patients with hip fracture ($p = 0.0001$)

The age distribution of patients with wrist fractures differed significantly from that of patients with hip fracture in whites and blacks ($p < 0.001$ and $p = 0.012$, respectively). To verify that the discrepancies in overall body mass were not the result of age differences, a comparison within age groups was performed and showed persistence of the difference within all age

TABLE 1. Mean Body Mass Indices by Race and Age

Age (years)	Patients With Hip Fracture	Patients With Wrist Fracture
45–54		
Black	24.0	34.5
White	—	27.0
55–64		
Black	21.7	27.9
White	22.1	26.6
65–74		
Black	23.1	27.0
White	22.2	27.2
75–84		
Black	22.8	27.5
White	22.2	23.4
85 and older		
Black	23.1	—
White	22.0	27.3

— = no patients in this group were enrolled in the study.

groups, stratified by decade (Table 1). Finally, logistic regression models were created in which the outcome was whether the patient sustained a hip or wrist fracture, and the predictor variable was body mass. Even after controlling for age and race, body mass was a significant predictor of fracture type ($p < 0.001$).

The marked difference in body mass seen between groups could be attributed to patients with hip fractures being thin, patients with wrist fractures being heavy, or both. Thus, a comparison of each group to age and race matched national data was performed. Compared with national norms derived from the National Health and Nutrition Examination Survey, as reported by Najjar and Rowland,[9] the mean body mass of patients with wrist fractures was equal to or greater than the national mean body mass index, whereas that of patients with hip fracture was substantially below average. This finding was confirmed for all age groups.

DISCUSSION

This study shows that normal body mass protects against hip fractures but does not protect against wrist fractures. This finding suggests that the predominant protective effect of increased body mass is one of local energy absorption. Had the major role of body mass been to systemically mitigate bone loss and thus the bone's tendency to fracture, wrist and hip fractures should have been prevented by increases in body mass. Instead, it was found that the potential protective effect of increased body mass is absent at the wrist.

This study may be limited by a selection bias: only patients with wrist fractures requiring surgery were studied. Still, there is no a priori reason to assume that patients in the operative group had an average body mass higher than patients in the group including all wrist fractures, and one might argue that because this subgroup had the more severe fractures, they may have had more marked osteoporosis and thus lower than average body mass.

There have been few etiologic studies of wrist fractures, and the authors have found none that focused solely on the role of body mass. Kelsey et al[5] found low body mass was not a risk factor for wrist fractures, a finding consistent with the data presented here, yet no inference or comment was offered. Porter et al[11] measured thoracic kyphosis in women with wrist fractures compared with that of control subjects and reported that the body mass indices of the patients in the wrist fracture group were similar to those of the control subjects. Porter et al offered no explanation of the normal body mass seen among women with low energy fractures of the wrist. One may contend that this apparently normal finding is abnormal (because conventional teaching holds that low body mass is typically a risk factor for low energy fracture) and merits comment and inference.

Osteoporotic fractures represent a major medical challenge to patients and to society. Nearly 33% of women can expect to experience such an injury by the age of 90 years, and 20% of them will die of complications associated with the fracture. Of those who sustain a fracture but survive, most will not return to their premorbid level of function, and approximately one in three will require institutional care. The total annual cost of osteoporotic hip fractures alone has been estimated to exceed $13 billion.[1] The challenge to the research and public health communities is to reduce the incidence of this deadly and costly health problem.

There are numerous risk factors for hip fractures, including osteopenia, falls, smoking, and surgical menopause.[12,14] A substantial amelioration of any one of these might decrease the risk of hip fractures. However, to optimize the efficacy of intervention, public health measures and research efforts might consider using the approach used by nature: to provide greater energy absorbers around the bones at risk.

A prospective randomized study[7] of patients in nursing homes showed that external hip pads could decrease the risk of fracture by 50%. Another, perhaps more natural, method to provide energy absorbers about the hip is to increase fat stores in that region. Although increased body fat might bring with it increased risks for heart disease, among other maladies, a certain level of fat around the hips might offset the expected costs from other diseases, by lessening the risk for hip fracture. This could be attained by greater emphasis on high calorie nutrition for the elderly. In addition, younger women should be alerted to the risks of excessive dieting. In addition, as more is learned about the molecular genetics of regional fat distribution and metabolism, methods might be devised to redistribute fat preferentially to areas where it could have its greatest protective effect on life threatening hip fractures. Although too much fat in the abdominal region may lead to life threatening heart disease, too little fat around the pelvic girdle may lead to life threatening hip fractures.

Additional efforts aimed at decreasing fractures might be directed toward the prevention of falls through public education programs.[6,13] Because most falls resulting in fracture occur in the home, a public health effort might be directed at minimizing risk within the residence. Just as families are encouraged to child proof their medicine cabinets, older women might be encouraged to fracture proof their homes as they enter the age of greatest risk. This has two facets: to decrease the absolute risk for falling and to decrease the amount of energy transmitted to the bone during a fall. Simple measures to attain that dual goal might include provision of adequate lighting, searching for and removing potential causes of falls, and maximizing the amount of padding on the floors and around the patient.

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