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Degree of Trauma Differs for Major Osteoporotic Fracture Events in Older Men vs. Older Women

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Abstract

To examine the degree of trauma in major osteoporotic fractures (MOF) in men vs. women, we used data from 15,698 adults aged ≥ 65 years enrolled in the Osteoporotic Fractures in Men (MrOS) study (5,994 men) and the Study of Osteoporotic Fractures (SOF) (9,704 women). Participants were contacted tri-annually to ascertain incident fractures, which were confirmed by radiographic reports and coded according to degree of self-reported trauma. Trauma was classified

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as *low* (fall from standing height; fall on stairs, steps or curb; minimal trauma other than fall [coughing, turning over]); *moderate* (collisions with objects during normal activity without associated fall); or *high* (fall from > standing height; severe trauma [motor vehicle accident, assault]). MOF included hip, clinical vertebral, wrist and humerus fractures. Mean fracture follow-up was 9.1 years in SOF and 8.7 years in MrOS. 14.6% of the MOF in men vs. 6.3% of the MOF in women were classified as high trauma ($p < 0.001$); men vs. women more often experienced fractures due to severe trauma as well as due to fall > standing height. High trauma fractures were more significantly common in men vs. women at the hip ($p = 0.002$) and wrist ($p < 0.001$), but not at the spine or humerus. Among participants with MOF, the odds ratio of a fracture related to high trauma fracture among men vs. women was 3.12 (95% CI 1.70–5.71) after adjustment for traditional risk factors. Findings were similar in analyses limited to participants with hip fractures (OR 3.34, 95% CI 1.04–10.67) and those with wrist fracture (OR 5.68, 95% CI 2.03–15.85). Among community-dwelling older adults, MOF are more likely to be related to high trauma in men than in women. These findings are not explained by sex differences in conventional risk factors and may reflect a greater propensity among men to engage in risky behavior.

Keywords

fractures; degree of trauma; older adults; men; women

INTRODUCTION

There is scant data concerning the specific circumstances of fracture events in older community-dwelling adults. Specifically, the degree of trauma associated with common fractures is uncertain and it is unknown whether fracture events related to high trauma are similarly common among men versus women. Furthering understanding of any sex differences in the circumstances of fracture events is needed to better target fracture prevention efforts in the growing aged population.

To examine the degree of trauma in major osteoporotic fracture (MOF) events in older men versus older women, we used data from 15,698 adults aged 65 years and older enrolled in the Osteoporotic Fractures in Men (MrOS) study and the Study of Osteoporotic Fractures (SOF) who were contacted every 4 months for up to 10 years to ascertain incident fractures including circumstances of fracture events.

MATERIALS AND METHODS

Study Population

A total of 5994 men (from 2000 to 2002) and 9704 women (from 1986 to 1988) who were at least 65 years old were enrolled in the prospective Osteoporotic Fractures in Men (MrOS) study⁽¹⁾ and Study of Osteoporotic Fractures (SOF)⁽²⁾, respectively. Participants were recruited from population-based listings in six regions (MrOS) and four regions (SOF) of the United States. For both studies, a history of bilateral hip replacement or the inability to walk without the assistance of another person excluded individuals from study participation. The

institutional review board at each participating institution approved each study protocol and written informed consent was obtained from all participants.

Ascertainment of Fractures and Degree of Trauma

In each study, participants were contacted every 4 months to ascertain incident fractures confirmed by radiographic reports. When a fracture was reported, research staff interviewed participants about event circumstances and coded the fracture according to degree of trauma. Degree of trauma was classified as *low* (fall from standing height or less; fall on stairs, steps or curb; minimal trauma other than fall [coughing, turning over]); *moderate* (collisions with objects during normal activity without associated fall); or *high* (fall from more than standing height; severe trauma [motor vehicle accident, assault]). Fractures missing trauma status (n=274) or coded as pathologic (peri-prosthetic or due to malignancy) (n=17) were excluded. Fracture (hip, clinical vertebral, wrist, humerus, MOF [any of the preceding 4 types]) follow-up for both studies was from baseline until 10 years or until time of death or study termination if earlier than 10 years.

Measurements

At baseline in each study, similar questionnaires were administered and examinations were performed to assess potential fracture risk factors.^(3,4) Proximal femur bone mineral density (BMD) was measured in SOF using QDR 1000 densitometers (Hologic, Bedford, Massachusetts) and in MrOS using Hologic QDR 4500W densitometers. Details regarding BMD measurement protocol and quality assurance procedures have been published elsewhere.^(5,6) Femoral neck BMD T-scores were calculated. Gait speed (time in seconds to walk 6 meters at usual pace [m/s]) was measured.

Statistical Analysis

Chi-square tests were performed to compare the percentage of fractures associated with specific levels of trauma between men and women. In addition, absolute fracture rates were calculated according to degree of trauma, sex and fracture type. Among participants with fractures, multivariable-adjusted logistic models were performed to determine the odds of a high trauma event in men versus women, accounting for traditional fracture risk factors.

RESULTS

Mean participant age was 72.4 years (73.7 years in men and 71.7 years in women) (Table 1). During an average follow-up of 9.1 years in SOF, 1683 women (17.3%) experienced 1 MOF (total 1880 events). During a mean follow-up of 8.7 years in MrOS, 446 men (7.4%) experienced 1 MOF (total 465 events). Among all participants, normal BMD was 3-fold more common in men versus women (61.7% vs. 18.6%, $p < 0.001$) (Supplemental Table 1). Among participants with MOF, normal BMD was 5-fold more common in men versus women (35.7% vs. 6.9%, $p < 0.001$).

MOF events were more commonly classified as related to high trauma in men vs. women (14.6% of MOF in men vs. 6.3% of MOF in women; men more often experienced fractures due to severe trauma (motor vehicle accident, assault) as well as due to a fall from more than

standing height ($p < 0.001$ for all comparisons). In men versus women, high trauma MOF events were more frequently a result of performing household/yard chores or participation in sporting activities and less commonly as a result of falling out of bed or being hit by moving vehicle while stationary ($p < 0.001$). The proportion of fractures related to high trauma was greater in men versus women at the hip ($p = 0.002$) and wrist ($p < 0.001$), but not at the humerus (Figure 1). High trauma fractures appeared more frequent in men versus women at the spine, but this difference was not significant ($p = 0.23$). MOF classified as moderate trauma were uncommon, but occurred more frequently in men compared with women (3% of MOF in men vs. 1% of MOF in women, $p = 0.008$). While the majority of MOF events in each sex were classified as low trauma with most resulting from a fall from standing height or less, these proportions were lower in men compared with women (82% of MOF in men versus 93% of MOF in women classified as low trauma [$p < 0.001$] and 66% of MOF in men vs. 75% of MOF in women classified as resulting from a fall from standing height or less [$p < 0.001$]).

The absolute rate of fractures irrespective of degree of trauma was significantly lower in men vs. women for all types, except at the spine, where the rate of clinical vertebral fractures in slightly greater (i.e. 1.1-fold higher) in men than in women (Supplemental Table 2). A similar pattern of differences in fracture rates between men and women was observed for low-trauma fractures. In contrast, absolute rates of high trauma fracture events were not different between men and women for major osteoporotic, hip and wrist fractures and at the spine, the rate of high trauma vertebral fractures was over 2-fold greater in men vs. women.

Among participants with MOF, the odds ratio (OR) of a high trauma fracture among men versus women after adjustment for baseline age, race, clinical center, health status, fall history, body mass index and femoral neck BMD was 3.12 (95% CI 1.70–5.71) (Supplemental Table 3). Similarly, men as compared with women were at increased risk of a fracture event related to high trauma at the hip and wrist (adjusted OR men versus women 3.34 (95% CI 1.04–10.67) among participants with hip fractures and 5.68 (95% CI 2.03–15.85) among participants with wrist fractures). Among participants with clinical vertebral fractures, men appeared to have a higher risk of an event classified as high trauma, but the CI were wide and overlapped 1.0 (OR 1.89, 0.45–7.99). These associations were essentially unchanged after addition of walking for exercise to the multivariable model. The relationships were somewhat attenuated after the further addition of gait speed to the model suggesting that the associations between sex and high trauma fracture events were in part explained by faster gait speed in men versus women. For example, among participants with MOF, the addition of gait speed to the multivariable model attenuated the association by 12%.

DISCUSSION

In this prospective study of community-dwelling older adults, MOF events were more likely to be related to high trauma (and less likely related to low trauma) in men than in women. These findings were not explained by sex differences in traditional fracture risk factors and may reflect a greater propensity among men to participate in risk taking behavior.

A prior study⁽⁷⁾ that utilized 10-year fracture follow-up data from SOF and 5-year fracture follow-up data from MrOS to examine the association between BMD and risk of any nonvertebral high trauma fracture reported that high trauma fractures represented more than twice the proportion of all fractures in men as compared with women (21% versus 9%) and noted that high trauma fractures in men were less commonly caused by motor vehicle crashes. Our study expands on these earlier findings by utilizing comparable long-term fracture follow-up in both cohort studies, focusing on the degree of trauma in MOF including among the 4 specific fracture types, and assessing whether the sex differences in risk of a high trauma event was explained by differences in fracture risk factors.

We observed that nearly 15% of the MOF events in men compared with about 6% of these events in women were the result of high trauma. In particular, hip fracture and wrist fracture events in men versus women were more commonly related to high trauma. We found that the circumstances of high trauma MOF events differed between the sexes as these events in men were more frequently a result of performing chores or engaging in recreational activities and less commonly due to falling out of bed or being hit by a moving vehicle while stationary. In addition, we noted that the difference in prevalence of normal BMD between men and women was even more marked among participants with MOF than among all participants supporting the hypothesis that significant differences in fracture etiology between sexes may exist. In general agreement with our findings, a prior prospective study examining circumstances of falls according to sex in 743 older adults reported that men vs. women had higher rates of outdoor falls, in locations of recreation, during vigorous activity and on snowy/icy surfaces.⁽⁸⁾

As expected from existing knowledge of the epidemiology of fractures in older adults⁽⁹⁾, fracture incidence rates irrespective of degree of trauma and rates of low trauma fractures were lower in men vs. women for any MOF and for hip, wrist and humerus fractures. In contrast, differences between sexes in absolute rates of MOF and hip and wrist fractures did not exist for high trauma events. While the rate of clinical vertebral fractures irrespective of degree of trauma was slightly higher in men vs. women, the rate of high trauma vertebral fractures was over 2-fold greater in men vs. women. A paucity of data is available on the incidence of clinical vertebral fractures in population-based samples, but previous studies have reported a similar incidence of radiographic vertebral fractures in men and women up to age 60 that has been attributed to a higher frequency of traumatic vertebral fractures among younger and middle-aged men.^(9,10)

Among participants with MOF, men compared with women had a 3-fold higher odds of experiencing a high trauma event after accounting for differences between sexes in conventional fracture risk factors including age, race, health status, fall history, walking for exercise, body mass index and hip BMD. After accounting for sex differences in gait speed, the association was somewhat reduced in magnitude suggesting that faster gait speed among men compared with women partly explained their greater propensity to experience high trauma events.

This study has several strengths. It was comprised of two large cohorts of community-dwelling adults with prospective fracture follow-up for 10 years. A standardized assessment

of fracture circumstances, including classification regarding degree of trauma, was utilized. However, this study also has several limitations. The cohort was predominantly older Caucasian community-dwelling adults, so results may not be generalizable to other populations. In addition, may be partly related to temporal differences in the cohorts regarding the timing of each baseline exam. Fracture circumstances were self-reported and might differ if based on review of medical records. Finally, exposure to different intensities of physical activities was not measured with a common instrument in the 2 cohorts. Thus, we were unable to determine if the greater likelihood of a high trauma event in men was in part due to greater time spent participating in vigorous intensity activity.

In conclusion, MOF in older community-dwelling adults are more likely to be related to high trauma (and less likely related to low trauma) in men as compared with women. These results are not entirely explained by sex differences in conventional risk factors and may reflect a greater propensity among men to engage in risk-taking behaviors that lead to traumatic events. These findings indicate that exclusion of high trauma fractures from epidemiologic studies or intervention trials in men excludes events and may bias results and suggest that efforts to reduce the societal burden of fractures in the expanding aged population may require sex-specific prevention targets.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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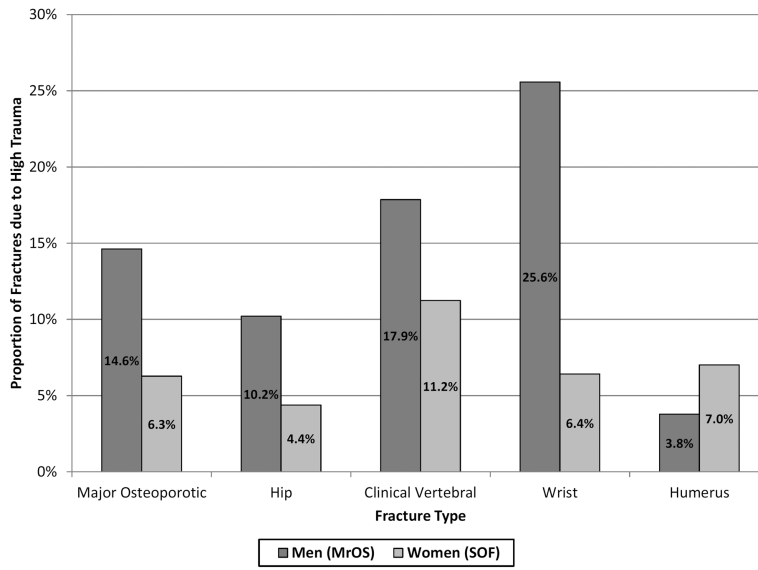


Figure 1.
Percent of Fracture Events Due to High Trauma According to Sex

Table 1

Characteristics of 15,698 Participants

Characteristic	Overall (n=15698)	MrOS (men) (n=5994)	SOF (women) (n=9704)
Age, years, mean (SD)	72.4 (5.6)	73.7 (5.9)	71.7 (5.3)
Caucasian, n (%)	15066 (96.0)	5362 (89.5)	9704 (100.0)
Health status good to excellent, n (%)	13205 (84.1)	5135 (85.7)	8070 (83.2)
Smoking status, n (%)			
Never	8091 (51.7)	2248 (37.5)	5843 (60.4)
Former	6402 (40.9)	3539 (59.1)	2863 (29.6)
Current	1173 (7.5)	206 (3.4)	967 (10.0)
Fell in the past year, n (%)	4183 (26.7)	1268 (21.2)	2915 (30.1)
Walks for exercise, n (%)	7845 (50.0)	2979 (49.7)	4866 (50.2)
Gait speed, m/s, mean (SD)	1.1 (0.2)	1.2 (0.2)	1.0 (0.2)
Body Mass Index, kg/m ² , mean (SD)	26.8 (4.4)	27.4 (3.8)	26.5 (4.7)
Femoral neck BMD, g/cm ² , mean (SD)	0.71 (0.14)	0.78 (0.13)	0.65 (0.11)
Total hip BMD, g/cm ² , mean (SD)	0.84 (0.17)	0.96 (0.14)	0.76 (0.13)
Incident major osteoporotic fracture, n (%)	2129 (13.6)	446 (7.4)	1683 (17.3)
Incident hip fracture, n (%)	843 (5.4)	185 (3.1)	658 (6.8)
Incident clinical vertebral fracture, n (%)	448 (2.9)	163 (2.7)	285 (2.9)
Incident wrist fracture, n (%)	737 (4.7)	83 (1.4)	654 (6.7)
Incident proximal humerus fracture, n (%)	432 (2.8)	55 (0.9)	377 (3.9)