Emergency department visits for fall-related fracture among older adults in the United States

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</table>
Emergency department visits for fall-related fracture among older adults in the United States

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ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fracture among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, the increase in age adjusted fall-related fracture rates was predominantly seen among men at an
annual rate of 1.9\% (95\% CI -0.1-4.0), whereas fracture rates among women remained 
stable at 0.9\% (95\% CI -0.7-2.5) per year.

**Conclusions:** The oldest old, women, and lower trunk fractures account for the 
majority of fall-related fractures among persons aged 65 years or older treated in US 
hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among 
older adults deserve further research.
Article summary

Article focus

- To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

- An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.

- The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.

- EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

- The present study reports national estimates of fall-related fracture by gender and body part among older adults.

- ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (US). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the US, information is scarce about the epidemiology of other fall-related fractures among older adults nationwide. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the US hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. For each study case, data were abstracted from medical records and coded by trained hospital coders for demographic characteristics, principal diagnosis, primary body part affected, disposition at discharge from the ED, and place where the injury occurred. In addition, major categories of external cause of injury and of intent of injury were coded for each case in a manner consistent with the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) coding rules and guidelines. National estimates are considered unstable and potentially unreliable if the number of records is based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based on weighted data), or the coefficient of variation of the estimate is greater than 30%. The NEISS-AIP public use files were downloaded from the Inter-University Consortium for Political and Social Research. [9]

Statistical analysis

All statistical analyses were performed using SPSS Complex Sample software, version 17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to obtain unbiased, nationally representative estimates from the NEISS-AIP sampling
design. Means and proportions were used to describe demographic and clinical characteristics of the study sample. The US Census Bureau population estimates were used as the denominator to calculate fall-related fracture rates per 100,000 persons. 

Fracture rates were then standardized to the US population for the year 2000 to account for changes in the age distribution of the population over time. Joinpoint software, version 3.5.0, was used to examine the annual percentage change in age-adjusted fracture rates and corresponding 95% confidence intervals (95% CI). The annual percentage change is one way to characterize trends over time in which the rates are assumed to change at a constant percentage of the rate of the previous year.

Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age of 80.0 (SD 8.2) years were treated in the US hospital EDs for unintentional fall-related fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of these cases. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. About half of the patients with fall-related fracture were treated and released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip) represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the admissions, respectively.

The frequency and distribution of the fractures according to gender and primary body part affected are shown in Table 1. In general, lower trunk fractures were the most frequently reported injuries in both genders, representing 37.3% (95% CI, 37.2-
39.5) of fall-related fracture visits to EDs in the US during the study period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum) accounted for a considerable proportion of fall-related fractures among women, whereas among men, upper trunk fracture was the second most frequent reason for EDs visits, representing an estimated 197,909 fractures.

Fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. By race, the highest fracture rate was seen in whites, whereas Asians had the lowest rate. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians (figure 2).

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, the increase in age adjusted fall-related fracture rates was predominantly seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 3).

Figure 4 shows the annual disposition of patients evaluated in EDs for fall-related fracture. In general, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008,
with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.

Discussion

In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fracture in the US hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportion of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a previous investigation that reported two-fold higher fracture rates among women aged 65 years or older treated for unintentional fall-related injuries in hospital EDs in the US. [3] Similarly, a recent study showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [12] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [13, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the
highest fracture rates, whereas black and Asian women had the lowest fracture rates. 

[14-15] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study, three risk factors common to all racial groups were older age, positive history of prior fracture after the age of 55 years, and a positive history of two or more falls. [14, 16] Recently, a retrospective study of Medicare beneficiaries also demonstrated that a history of typical osteoporotic fractures (hip, spine, and distal radius/ulna) was associated positively and consistently with the incidence of other fractures. Furthermore, prior non-hip and non-spine fractures in men and women were associated with the incidence of traditional fragility fracture incidence sites (hip, distal radius/ulna, and spine), as well as with fractures of the humerus and tibia/fibula. [17]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required hospitalization and the proportion of older adults hospitalized for these injuries increased during the 8-year study period. Although the present analysis was limited to fall-related fracture, these findings are consistent with a recent study that reported an increase by 50% in the estimated number of fall-related hospitalizations among older adults in the US between 2001 and 2008. Of these, hospitalizations for fractures accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the most common admitting diagnosis among persons aged 65 years or older hospitalized for fall-related injuries in the US between 1988 and 2005, representing 84% of the admissions. [5] Moreover, fall-related injury hospitalization rates increased in both genders during the 18-year period.
Overall, the number of fall-related fractures among older adults treated in EDs increased between 2001 and 2008. After age adjustment, the average annual percentage in fall-related fracture rates increased predominantly among men. The precise reason for this finding is unknown. However, differences in osteoporosis recommendations for screening and prevention between men and women may account for the upward trend in fracture rates seen among men. [18] These results contrast with a previous study among Medicare beneficiaries that reported a significant decrease in hip fracture rates among men and women between 1995 and 2005. [7]

The increased proportion of older Americans with physical limitations (stooping, lifting, reaching, grasping, and walking) over time may also partly explain these findings. In fact, data from the Medicare Current Beneficiary Survey indicate that the age-adjusted proportion of non-institutionalized adults aged 65 years and older with physical limitations increased from 32.7% in 1992 to 38.4% in 2009. [19] Disability of the lower extremities has been associated with increased risk for falls among those aged 75 years or older living in the community and with fall-related hip fracture in women. [20, 6] Moreover, adequate physical activity has been associated with a reduced risk of fractures among fallers, possibly because physical activity can increase physical functioning, maintain mobility, increase muscle strength and balance, improve bone mineral density, and improve reaction time. [21]

Several limitations of this study must be mentioned in interpreting the present findings. First, the number of fall-related fractures among older adults may be underestimated because it includes only those persons who were treated in hospital EDs; the NEISS-AIP does not include persons treated in a physician’s office or other
outpatient settings. Second, some fractures may have been missed because the NEISS-AIP includes the principal diagnosis and primary body part noted during the initial injury visit. In cases with multiple injuries, data for only the most severe injury are recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the primary body part affected and for the principal diagnosis relevant to consumer-product-related injuries. ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified. [3]

Despite these limitations, this study describes the demographic characteristics and incidence of fall-related fracture among older adults nationwide treated in hospital EDs. Since the population 65 years and older in the US will increase by more than double by 2050, rising from 39 million today to 89 million, these demographic changes alone will increase the number of fall-related fractures unless interventions to prevent falls among older adults are effectively implemented. [22]

In conclusion, the oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in the US EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Funding

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Conflict of interest statement

None declared

Acknowledgments

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References


Figure 2. Fall-related fracture rates by race among older adults treated in US hospital EDs

279x215mm (300 x 300 DPI)
Figure 3. Trends in fall-related fracture rates by gender, 2001-2006
Table 1. Frequency and distribution of fall-related fractures among older adults treated in EDs, 2001-2008

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*Parietal and occipital bones; *cervical spine; *thoracic spine, ribs, and sternum; *clavicle; *humerus; *ulna and distal radius; *lumbar spine, pelvis, and hip; *femur; *tibia and tibia.
STROBE Statement—checklist of items that should be included in reports of observational studies

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<td><strong>Title and abstract</strong></td>
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| 1 yes | (a) Indicate the study’s design with a commonly used term in the title or the abstract  
      | (b) Provide in the abstract an informative and balanced summary of what was done  
      | and what was found |
| **Introduction** | 
| 2 yes | Explain the scientific background and rationale for the investigation being reported |
| 3 yes | State specific objectives, including any prespecified hypotheses |
| **Methods** | 
| 4 yes | Present key elements of study design early in the paper |
| 5 yes | Describe the setting, locations, and relevant dates, including periods of recruitment,  
      | exposure, follow-up, and data collection |
| 6 yes | (a) **Cohort study**—Give the eligibility criteria, and the sources and methods of  
      | selection of participants. Describe methods of follow-up  
      | **Case-control study**—Give the eligibility criteria, and the sources and methods of  
      | case ascertainment and control selection. Give the rationale for the choice of cases  
      | and controls  
      | **Cross-sectional study**—Give the eligibility criteria, and the sources and methods of  
      | selection of participants  
      | (b) **Cohort study**—For matched studies, give matching criteria and number of  
      | exposed and unexposed  
      | **Case-control study**—For matched studies, give matching criteria and the number of  
      | controls per case |
| 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect  
   | modifiers. Give diagnostic criteria, if applicable |
| 8 | For each variable of interest, give sources of data and details of methods of  
   | assessment (measurement). Describe comparability of assessment methods if there  
   | is more than one group |
| 9 | Describe any efforts to address potential sources of bias |
| 10 | Explain how the study size was arrived at |
| 11 | Explain how quantitative variables were handled in the analyses. If applicable,  
   | describe which groupings were chosen and why |
| 12 yes | (a) Describe all statistical methods, including those used to control for confounding  
   | (b) Describe any methods used to examine subgroups and interactions  
   | (c) Explain how missing data were addressed  
   | (d) **Cohort study**—If applicable, explain how loss to follow-up was addressed  
   | **Case-control study**—If applicable, explain how matching of cases and controls was  
   | addressed  
   | **Cross-sectional study**—If applicable, describe analytical methods taking account of  
   | sampling strategy  
   | (g) Describe any sensitivity analyses |

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## Results

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes/No</th>
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</tr>
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| Participants            | 13     | (a) Report numbers of individuals at each stage of study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed.  
(b) Give reasons for non-participation at each stage  
(c) Consider use of a flow diagram |
| Descriptive data        | 14     | (a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders.  
(b) Indicate number of participants with missing data for each variable of interest.  
(c) Cohort study—Summarise follow-up time (e.g., average and total amount) |
| Outcome data            | 15     | Cohort study—Report numbers of outcome events or summary measures over time.  
Case-control study—Report numbers in each exposure category, or summary measures of exposure.  
Cross-sectional study—Report numbers of outcome events or summary measures. |
| Main results            | 16     | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included.  
(b) Report category boundaries when continuous variables were categorized.  
(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period. |
| Other analyses          | 17     | Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses. |

## Discussion

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Discuss both direction and magnitude of any potential bias. |
| Interpretation          | 20     | Give a cautious overall interpretation of results, considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence. |
| Generalisability        | 21     | Discuss the generalisability (external validity) of the study results. |

## Other information

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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/; and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.
Emergency department visits for fall-related fracture among older adults in the United States

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<td>22-Oct-2012</td>
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<td>Orces, Carlos; Laredo Medical Center, Medicine</td>
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STROBE Statement—checklist of items that should be included in reports of observational studies

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<tr>
<td><strong>Title and abstract</strong></td>
<td>1 yes</td>
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<td>(a) Indicate the study’s design with a commonly used term in the title or the abstract</td>
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<td>(b) Provide in the abstract an informative and balanced summary of what was done and what was found</td>
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<td>Explain the scientific background and rationale for the investigation being reported</td>
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<td><strong>Objectives</strong></td>
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<td>State specific objectives, including any prespecified hypotheses</td>
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<td><strong>Methods</strong></td>
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<td><strong>Setting</strong></td>
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<td>Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection</td>
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<tr>
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<td><strong>Variables</strong></td>
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<td>Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable</td>
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<td>Describe any efforts to address potential sources of bias</td>
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<td><strong>Study size</strong></td>
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<td>Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why</td>
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<td><strong>Statistical methods</strong></td>
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<td>(a) Describe all statistical methods, including those used to control for confounding</td>
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| **Participants**    | 13     | yes    | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed  
(b) Give reasons for non-participation at each stage  
(c) Consider use of a flow diagram |
| **Descriptive data**| 14     | yes    | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders  
(b) Indicate number of participants with missing data for each variable of interest  
(c) Consider use of a flow diagram |
| **Outcome data**    | 15     | yes    | **Cohort study**—Report numbers of outcome events or summary measures over time  
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Emergency department visits for fall-related fracture among older adults in the United States

Carlos H Orces, MD, MPH
Laredo Medical Center
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ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fracture among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition.

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was predominantly
seen among men at an annual rate of 1.9\% (95\% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9\% (95\% CI -0.7-2.5) per year.

**Conclusions:** The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in US hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Article summary

Article focus

• To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

• An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.

• The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.

• EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

• The present study reports national estimates of fall-related fracture by gender and body part among older adults.

• ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the U.S. hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital. Data obtained on each case include age, race/ethnicity, gender, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (i.e., hospitalized, transferred, treated and released, observation, died), locale where the injury occurred, work-relatedness, and a narrative description of the injury circumstances. Also, major categories of external cause of injury (e.g., motor vehicle, falls, cut/pierce, poisoning, fire/burn) and of intent of injury (e.g., unintentional, assault, intentional self-harm, legal intervention). Trained, onsite hospital coders took data for injury-related cases from ED records at NEISS hospitals. The coders coded all data elements, except for cause of injury. These coded data and a narrative were electronically transmitted to Consumer Product Safety Commission (CPSC) headquarters. NEISS-AIP quality assurance coders at CPSC headquarters reviewed all of the data elements as well as a narrative (description) for each case from each of the 66 NEISS-AIP hospitals. Quality assurance coders then used the narrative and other data to assign codes for the precipitating and direct causes/mechanisms of injury for
each case. The present study included persons 65 years or older treated in the U.S. 
hospital EDs for unintentional fall-related fractures between 2001 and 2008. National 
estimates are considered unstable and potentially unreliable if the number of records is 
based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based 
on weighted data), or the coefficient of variation of the estimate is greater than 30%.
The NEISS-AIP public use files were downloaded from the Inter-University Consortium 
for Political and Social Research. [9]

Statistical analysis
All statistical analyses were performed using SPSS Complex Sample software, version 
17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to 
obtain unbiased, nationally representative estimates from the NEISS-AIP sampling 
design. The sample weight has been adjusted for hospital non-response within each 
NEISS-AIP sample stratum and changes in the number of ED visits annually in the 
sampling frame of US hospital EDs. Means and proportions were used to describe 
demographic and clinical characteristics of the study sample. The U.S. Census Bureau 
population estimates were used as the denominator to calculate fall-related fracture 
rates per 100,000 persons. [10] Fracture rates were then standardized by the direct 
method to the U.S. population for the year 2000 to account for changes in the age 
distribution of the population over time. Linear regression was used to examine the 
statistical significance of trends in fall-related fracture rates over the study period. The 
results are presented as the annual percentage change in rates and corresponding 95% 
confidence intervals (95% CI). The annual percentage change is one way to 
characterize trends over time in which the rates are assumed to change at a constant
percentage of the rate of the previous year. All analyses were performed by using
Joinpoint software, version 3.5.0. [11]

Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age
of 80.0 (SD 8.2) years were treated in the U.S. hospital EDs for unintentional fall-related
fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of
these cases and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white.
Overall, 58.7% (95% CI, 54.0-63.3) of these injuries occurred at home. Moreover, after
a fall-related fracture, 50.6% (95% CI, 47.7-53.5) of the patients were treated and
released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those
hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip)
represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the
admissions, respectively.

The number, national estimates, and fall-related fracture rates according to
gender and primary body part affected are shown in Table 1. In general, lower trunk
fractures were the most frequently reported injuries in both genders, representing 37.3%
(95% CI, 37.2-39.5) of fall-related fracture visits to EDs in the U.S. during the study
period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum)
accounted for a considerable proportion of fall-related fractures among women,
whereas among men, upper trunk fracture was the second most frequent reason for fall-
related fractures EDs visits, representing an estimated 197,000 fractures.
The incidence of fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. After adjusting by age, the highest fall-related fracture rate was seen in whites, whereas Asians had the lowest rate. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians.

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 2).

As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.

Discussion
In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the US hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportion of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a previous investigation that reported two-fold higher fracture rates among women aged 65 years or older treated for unintentional fall-related injuries in hospital EDs in the U.S. [3]

Similarly, a recent study showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [12] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [13, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates. [14-15] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women's Health Initiative study, three risk factors common to all racial groups were older age, positive history of prior
fracture after the age of 55 years, and a positive history of two or more falls. [14, 16]

Falls are strongly associated with fractures, and a number of conditions predispose older Americans to falls, the most common of which are history of overall body weakness and fatigue, stroke, senile and organic psychotic conditions, Alzheimer’s disease and previous accidental falls. [17] Furthermore, a study reported that the incidence of a fall within three months after a clinical fracture was 18.5% and 6.5% in older women and men, respectively. Among those who had fallen, 11.9% resulted in a new fall-related fracture [18]. Consistent with other investigations [19-21], a study of Medicare beneficiaries also demonstrated that a history of typical osteoporotic fractures (hip, spine, and distal radius/ulna) was associated positively and consistently with the incidence of other fractures. Furthermore, prior non-hip and non-spine fractures in men and women were associated with the incidence of traditional fragility fracture incidence sites (hip, distal radius/ulna, and spine), as well as with fractures of the humerus and tibia/fibula. [17]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required hospitalization and the proportion of older adults hospitalized for these injuries increased during the 8-year study period. Although the present analysis was limited to fall-related fracture, these findings are consistent with a recent study that reported an increase by 50% in the estimated number of fall-related hospitalizations among older adults in the US between 2001 and 2008. Of these, hospitalizations for fractures accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the most common admitting diagnosis among persons aged 65 years or older hospitalized for fall-related injuries in the US between 1988 and 2005, representing 84% of the
admissions. [5] Moreover, fall-related injury hospitalization rates increased in both
genders during the 18-year period.

Overall, the number of fall-related fractures among older adults treated in EDs
increased between 2001 and 2008. After age adjustment, a non-significant upward
trend in fall-related fracture rates was seen among men. The precise reason for this
finding is unknown. However, differences in osteoporosis recommendations for
screening and prevention between men and women may account for increasing fall-
related fracture rates seen among men. [22] These results contrast with a previous
study among Medicare beneficiaries that reported a significant decrease in hip fracture

The increased proportion of older Americans with physical limitations (stooping,
lifting, reaching, grasping, and walking) over time may also partly explain these findings.
In fact, data from the Medicare Current Beneficiary Survey indicate that the age-
adjusted proportion of non-institutionalized adults aged 65 years and older with physical
limitations increased from 32.7% in 1992 to 38.4% in 2009. [23] Similarly, a recent
study using data from the National Health and Nutritional Examination Survey
demonstrated an increased prevalence of self-reported disability over time among older
Americans in basic activities of daily living, instrumental activities of daily living, and
mobility. [24] Disability of the lower extremities has been associated with increased risk
for falls among those aged 75 years or older living in the community and with fall-related
hip fracture in women. [25, 6] Moreover, adequate physical activity has been
associated with a reduced risk of fractures among fallers, possibly because physical
activity can increase physical functioning, maintain mobility, increase muscle strength
and balance, improve bone mineral density, and improve reaction time. [26]

Several limitations of this study must be mentioned in interpreting the present
findings. First, the number of fall-related fractures among older adults may be
underestimated because it includes only those persons who were treated in hospital
EDs; the NEISS-AIP does not include persons treated in a physician’s office or other
outpatient settings. Second, some fractures may have been missed because the
NEISS-AIP includes the principal diagnosis and primary body part noted during the
initial injury visit. In cases with multiple injuries, data for only the most severe injury are
recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the
primary body part affected and for the principal diagnosis relevant to consumer-product-
related injuries. ICD-9-CM diagnosis codes were not available in the medical records at
the time these data were collected; therefore, specific types of injuries (for example hip
fracture) could not be accurately identified. [3]

Despite these limitations, this study describes the demographic characteristics
and incidence of fall-related fractures nationwide among older adults treated in hospital
EDs. Since the population 65 years and older in the U.S. will increase by more than
double by 2050, rising from 39 million today to 89 million, these demographic changes
alone will increase the number of fall-related fractures unless interventions to prevent
falls among older adults are effectively implemented. [27]

In conclusion, the oldest old, women, and lower trunk fractures account for the
majority of fall-related fractures among persons aged 65 years or older treated in the
U.S. EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.

**Funding**

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

**Conflict of interest statement**

None declared

**Acknowledgments**

The author would like to thank Mrs. Patricia Gutierrez from UTHSC Laredo campus for librarian assistance.
References


10. United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS). Bridged-race population estimates, United States July1st resident population.


Figure 1. Fall-related fracture rates and 95% CI among older adults treated in U.S. EDs

254x190mm (96 x 96 DPI)
Figure 2. Trends in fall-related fracture rates treated in U.S. EDs, 2001-2008

254x190mm (96 x 96 DPI)
Figure 3. Disposition of older adults treated in US hospital EDs for fall-related fracture

- Treated and released
- Hospitalized
- Transferred

254x190mm (96 x 96 DPI)
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<tr>
<td></td>
<td>Cases</td>
<td>Estimates</td>
<td>Rates (95% CI)</td>
<td>Cases</td>
<td>Estimates</td>
<td>Rates (95% CI)</td>
</tr>
<tr>
<td>Head&lt;sup&gt;a&lt;/sup&gt;</td>
<td>116</td>
<td>5,000</td>
<td>4.6 (3.2-6.0)</td>
<td>134</td>
<td>7,000</td>
<td>4.4 (2.9-6.0)</td>
</tr>
<tr>
<td>Face</td>
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</tr>
<tr>
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<td>368</td>
<td>24,000</td>
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<tr>
<td>Upper trunk&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2,611</td>
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<td>161.0 (123.5-198.6)</td>
<td>3,975</td>
<td>303,000</td>
<td>177.5 (133.2-221.8)</td>
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<tr>
<td>Shoulder&lt;sup&gt;d&lt;/sup&gt;</td>
<td>912</td>
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<td>55.3 (42.7-68.0)</td>
<td>2,645</td>
<td>198,000</td>
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<tr>
<td>Elbow</td>
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<td>18.9 (14.3-23.5)</td>
<td>1,055</td>
<td>73,000</td>
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<tr>
<td>Upper arm&lt;sup&gt;e&lt;/sup&gt;</td>
<td>923</td>
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<td>295,000</td>
<td>172.8 (130.1-215.4)</td>
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<td>Lower arm&lt;sup&gt;f&lt;/sup&gt;</td>
<td>569</td>
<td>42,000</td>
<td>34.4 (25.0-43.7)</td>
<td>2,852</td>
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<tr>
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<tr>
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<td>255</td>
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<td>671</td>
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<td>748</td>
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<td>175,000</td>
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<tr>
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<td>38,000</td>
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<tr>
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<td>75,000</td>
<td>44.4 (34.1-54.8)</td>
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<tr>
<td>Toe</td>
<td>96</td>
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<td>311</td>
<td>22,000</td>
<td>30.4 (24.5-36.3)</td>
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</table>

<sup>a</sup>Parietal and occipital bones; <sup>b</sup>cervical spine; <sup>c</sup>thoracic spine, ribs, and sternum; <sup>d</sup>clavicle; <sup>e</sup>humerus; <sup>f</sup>ulna and distal radius; <sup>g</sup>lumbar spine, pelvis, and hip; <sup>h</sup>femur; <sup>i</sup>fibula and tibia.
Emergency department visits for fall-related fracture among older adults in the United States

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ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fracture among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition.

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was predominantly
seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year.

**Conclusions:** The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in US hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Article summary

Article focus

• To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

• An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.

• The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.

• EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

• The present study reports national estimates of fall-related fracture by gender and body part among older adults.

• ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the U.S. hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital. Data obtained on each case include age, race/ethnicity, gender, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (i.e., hospitalized, transferred, treated and released, observation, died), locale where the injury occurred, work-relatedness, and a narrative description of the injury circumstances. Also, major categories of external cause of injury (e.g., motor vehicle, falls, cut/pierce, poisoning, fire/burn) and of intent of injury (e.g., unintentional, assault, intentional self-harm, legal intervention). Trained, onsite hospital coders took data for injury-related cases from ED records at NEISS hospitals. The coders coded all data elements, except for cause of injury. These coded data and a narrative were electronically transmitted to Consumer Product Safety Commission (CPSC) headquarters. NEISS-AIP quality assurance coders at CPSC headquarters reviewed all of the data elements as well as a narrative (description) for each case from each of the 66 NEISS-AIP hospitals. Quality assurance coders then used the narrative and other data to assign codes for the precipitating and direct causes/mechanisms of injury for
each case. The present study included persons 65 years or older treated in the U.S. hospital EDs for unintentional fall-related fractures between 2001 and 2008. National estimates are considered unstable and potentially unreliable if the number of records is based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based on weighted data), or the coefficient of variation of the estimate is greater than 30%. The NEISS-AIP public use files were downloaded from the Inter-University Consortium for Political and Social Research. [9]

Statistical analysis

All statistical analyses were performed using SPSS Complex Sample software, version 17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to obtain unbiased, nationally representative estimates from the NEISS-AIP sampling design. The sample weight has been adjusted for hospital non-response within each NEISS-AIP sample stratum and changes in the number of ED visits annually in the sampling frame of US hospital EDs. Means and proportions were used to describe demographic and clinical characteristics of the study sample. The U.S. Census Bureau population estimates were used as the denominator to calculate fall-related fracture rates per 100,000 persons. [10] Fracture rates were then standardized by the direct method to the U.S. population for the year 2000 to account for changes in the age distribution of the population over time. Linear regression was used to examine the statistical significance of trends in fall-related fracture rates over the study period. The results are presented as the annual percentage change in rates and corresponding 95% confidence intervals (95% CI). The annual percentage change is one way to characterize trends over time in which the rates are assumed to change at a constant
percentage of the rate of the previous year. All analyses were performed by using Joinpoint software, version 3.5.0. [11]

Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age of 80.0 (SD 8.2) years were treated in the U.S. hospital EDs for unintentional fall-related fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of these cases and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Overall, 58.7% (95% CI, 54.0-63.3) of these injuries occurred at home. Moreover, after a fall-related fracture, 50.6% (95% CI, 47.7-53.5) of the patients were treated and released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip) represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the admissions, respectively.

The number, national estimates, and fall-related fracture rates according to gender and primary body part affected are shown in Table 1. In general, lower trunk fractures were the most frequently reported injuries in both genders, representing 37.3% (95% CI, 37.2-39.5) of fall-related fracture visits to EDs in the U.S. during the study period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum) accounted for a considerable proportion of fall-related fractures among women, whereas among men, upper trunk fracture was the second most frequent reason for fall-related fractures EDs visits, representing an estimated 197,000 fractures.
The incidence of fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. After adjusting by age, the highest fall-related fracture rate was seen in whites, whereas Asians had the lowest rate. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians.

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 2).

As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.

**Discussion**
In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the US hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportion of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a previous investigation that reported two-fold higher fracture rates among women aged 65 years or older treated for unintentional fall-related injuries in hospital EDs in the U.S. [3]

Similarly, a recent study showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [12] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [13, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates. [14-15] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study, three risk factors common to all racial groups were older age, positive history of prior
fracture after the age of 55 years, and a positive history of two or more falls. [14, 16]
Falls are strongly associated with fractures, and a number of conditions predispose
older Americans to falls, the most common of which are history of overall body
weakness and fatigue, stroke, senile and organic psychotic conditions, Alzheimer’s
disease and previous accidental falls. [17] Furthermore, a study reported that the
incidence of a fall within three months after a clinical fracture was 18.5% and 6.5% in
older women and men, respectively. Among those who had fallen, 11.9% resulted in a
new fall-related fracture [18] Consistent with other investigations [19-21], a study of
Medicare beneficiaries also demonstrated that a history of typical osteoporotic fractures
(hip, spine, and distal radius/ulna) was associated positively and consistently with the
incidence of other fractures. Furthermore, prior non-hip and non-spine fractures in men
and women were associated with the incidence of traditional fragility fracture incidence
sites (hip, distal radius/ulna, and spine), as well as with fractures of the humerus and
tibia/fibula. [17]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required
hospitalization and the proportion of older adults hospitalized for these injuries
increased during the 8-year study period. Although the present analysis was limited to
fall-related fracture, these findings are consistent with a recent study that reported an
increase by 50% in the estimated number of fall-related hospitalizations among older
adults in the US between 2001 and 2008. Of these, hospitalizations for fractures
accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the
most common admitting diagnosis among persons aged 65 years or older hospitalized
for fall-related injuries in the US between 1988 and 2005, representing 84% of the
admissions. [5] Moreover, fall-related injury hospitalization rates increased in both
genders during the 18-year period.

Overall, the number of fall-related fractures among older adults treated in EDs
increased between 2001 and 2008. After age adjustment, a non-significant upward
trend in fall-related fracture rates was seen among men. The precise reason for this
finding is unknown. However, differences in osteoporosis recommendations for
screening and prevention between men and women may account for increasing fall-
related fracture rates seen among men. [22] These results contrast with a previous
study among Medicare beneficiaries that reported a significant decrease in hip fracture

The increased proportion of older Americans with physical limitations (stooping,
lifting, reaching, grasping, and walking) over time may also partly explain these findings.
In fact, data from the Medicare Current Beneficiary Survey indicate that the age-
adjusted proportion of non-institutionalized adults aged 65 years and older with physical
limitations increased from 32.7% in 1992 to 38.4% in 2009. [23] Similarly, a recent
study using data from the National Health and Nutritional Examination Survey
demonstrated an increased prevalence of self-reported disability over time among older
Americans in basic activities of daily living, instrumental activities of daily living, and
mobility. [24] Disability of the lower extremities has been associated with increased risk
for falls among those aged 75 years or older living in the community and with fall-related
hip fracture in women. [25, 6] Moreover, adequate physical activity has been
associated with a reduced risk of fractures among fallers, possibly because physical
activity can increase physical functioning, maintain mobility, increase muscle strength
and balance, improve bone mineral density, and improve reaction time. [26]

Several limitations of this study must be mentioned in interpreting the present
findings. First, the number of fall-related fractures among older adults may be
underestimated because it includes only those persons who were treated in hospital
EDs; the NEISS-AIP does not include persons treated in a physician’s office or other
outpatient settings. Second, some fractures may have been missed because the
NEISS-AIP includes the principal diagnosis and primary body part noted during the
initial injury visit. In cases with multiple injuries, data for only the most severe injury are
recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the
primary body part affected and for the principal diagnosis relevant to consumer-product-
related injuries. ICD-9-CM diagnosis codes were not available in the medical records at
the time these data were collected; therefore, specific types of injuries (for example hip
fracture) could not be accurately identified. [3]

Despite these limitations, this study describes the demographic characteristics
and incidence of fall-related fractures nationwide among older adults treated in hospital
EDs. Since the population 65 years and older in the U.S. will increase by more than
double by 2050, rising from 39 million today to 89 million, these demographic changes
alone will increase the number of fall-related fractures unless interventions to prevent
falls among older adults are effectively implemented. [27]

In conclusion, the oldest old, women, and lower trunk fractures account for the
majority of fall-related fractures among persons aged 65 years or older treated in the
U.S. EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.

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**Conflict of interest statement**

None declared

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Emergency department visits for fall-related fracture among older adults in the United States

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ABSTRACT

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Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

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Main outcome measures: Fall-related fracture rates and EDs disposition.

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Conclusions: The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in US hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
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Article focus

To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.

The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.

EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

The present study reports national estimates of fall-related fracture by gender and body part among older adults.

ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
**Introduction**

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the U.S. hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital. Data obtained on each case include age, race/ethnicity, gender, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (i.e., hospitalized, transferred, treated and released, observation, died), locale where the injury occurred, work-relatedness, and a narrative description of the injury circumstances. Also, major categories of external cause of injury (e.g., motor vehicle, falls, cut/pierce, poisoning, fire/burn) and of intent of injury (e.g., unintentional, assault, intentional self-harm, legal intervention). Trained, onsite hospital coders took data for injury-related cases from ED records at NEISS hospitals. The coders coded all data elements, except for cause of injury. These coded data and a narrative were electronically transmitted to Consumer Product Safety Commission (CPSC) headquarters. NEISS-AIP quality assurance coders at CPSC headquarters reviewed all of the data elements as well as a narrative (description) for each case from each of the 66 NEISS-AIP hospitals. Quality assurance coders then used the narrative and other data to assign codes for the precipitating and direct causes/mechanisms of injury for
each case. The present study included persons 65 years or older treated in the U.S. hospital EDs for unintentional fall-related fractures between 2001 and 2008. National estimates are considered unstable and potentially unreliable if the number of records is based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based on weighted data), or the coefficient of variation of the estimate is greater than 30%.

The NEISS-AIP public use files were downloaded from the Inter-University Consortium for Political and Social Research. [9]

**Statistical analysis**

All statistical analyses were performed using SPSS Complex Sample software, version 17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to obtain unbiased, nationally representative estimates from the NEISS-AIP sampling design. The sample weight has been adjusted for hospital non-response within each NEISS-AIP sample stratum and changes in the number of ED visits annually in the sampling frame of US hospital EDs. Means and proportions were used to describe demographic and clinical characteristics of the study sample. The U.S. Census Bureau population estimates were used as the denominator to calculate fall-related fracture rates per 100,000 persons. [10] Fracture rates were then standardized by the direct method to the U.S. population for the year 2000 to account for changes in the age distribution of the population over time. Linear regression was used to examine the statistical significance of trends in fall-related fracture rates over the study period. The results are presented as the annual percentage change in rates and corresponding 95% confidence intervals (95% CI). The annual percentage change is one way to characterize trends over time in which the rates are assumed to change at a constant
percentage of the rate of the previous year. All analyses were performed by using
Joinpoint software, version 3.5.0. [11]

Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age
of 80.0 (SD 8.2) years were treated in the U.S. hospital EDs for unintentional fall-related
fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of
these cases and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white.
Overall, 58.7% (95% CI, 54.0-63.3) of these injuries occurred at home. Moreover, after a fall-related fracture, 50.6% (95% CI, 47.7-53.5) of the patients were treated and released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip) represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the admissions, respectively.

The number, national estimates, and fall-related fracture rates according to gender and primary body part affected are shown in Table 1. In general, lower trunk fractures were the most frequently reported injuries in both genders, representing 37.3% (95% CI, 37.2-39.5) of fall-related fracture visits to EDs in the U.S. during the study period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum) accounted for a considerable proportion of fall-related fractures among women, whereas among men, upper trunk fracture was the second most frequent reason for fall-related fractures EDs visits, representing an estimated 197,000 fractures.
The incidence of fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. After adjusting by age, fall-related fracture rate varies by race. The highest rates per 100,000 persons were 1,268.9 among non-Hispanic whites, whereas the lowest rates of 876.6 were seen among Asians. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians.

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 2).

As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.
Discussion

In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the U.S. hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportion of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a previous investigation that reported two-fold higher fracture rates among women aged 65 years or older treated for unintentional fall-related injuries in hospital EDs in the U.S. [3] Similarly, a recent study showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [12] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [13, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates. [14-15] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study,
three risk factors common to all racial groups were older age, positive history of prior 
fracture after the age of 55 years, and a positive history of two or more falls. [14, 16] 
Besides previous accidental falls, muscle weakness, stroke, senile and organic 
psychotic conditions, and Alzheimer’s disease are associated with increased risk of 
falling among older Americans. [17] A previous study reported that the incidence of a 
fall within three months after a clinical fracture was 18.5% and 6.5% in older women 
and men, respectively. Among those who had fallen, 11.9% resulted in a new fall-
related fracture [18] Consistent with other investigations [19-21], a study of Medicare 
beneficiaries demonstrated that a history of typical osteoporotic fracture was associated 
with the incidence of other fractures. Moreover, prior non-hip and non-spine fractures in 
both genders were associated with the incidence of traditional fragility fractures, as well 
as with fractures of the humerus and tibia/fibula. [17]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required 
hospitalization and the proportion of older adults hospitalized for these injuries 
increased during the 8-year study period. Although the present analysis was limited to 
fall-related fracture, these findings are consistent with a recent study that reported an 
increase by 50% in the estimated number of fall-related hospitalizations among older 
adults in the US between 2001 and 2008. Of these, hospitalizations for fractures 
accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the 
most common admitting diagnosis among persons aged 65 years or older hospitalized 
for fall-related injuries in the US between 1988 and 2005, representing 84% of the 
admissions. [5] Moreover, fall-related injury hospitalization rates increased in both 
genders during the 18-year period.
Overall, the number of fall-related fractures among older adults treated in EDs increased between 2001 and 2008. After age adjustment, a non-significant upward trend in fall-related fracture rates was seen among men. The precise reason for this finding is unknown. However, differences in osteoporosis recommendations for screening and prevention between men and women may account for increasing fall-related fracture rates seen among men. [22] These results contrast with a previous study among Medicare beneficiaries that reported a significant decrease in hip fracture rates among men and women between 1995 and 2005. [7]

The increased proportion of older Americans with physical limitations (stooping, lifting, reaching, grasping, and walking) over time may also partly explain these findings. In fact, data from the Medicare Current Beneficiary Survey indicate that the age-adjusted proportion of non-institutionalized adults aged 65 years and older with physical limitations increased from 32.7% in 1992 to 38.4% in 2009. [23] Similarly, a recent study using data from the National Health and Nutritional Examination Survey demonstrated an increased prevalence of self-reported disability over time among older Americans in basic activities of daily living, instrumental activities of daily living, and mobility. [24] Disability of the lower extremities has been associated with increased risk for falls among those aged 75 years or older living in the community and with fall-related hip fracture in women. [25, 6] Moreover, adequate physical activity has been associated with a reduced risk of fractures among fallers, possibly because physical activity can increase physical functioning, maintain mobility, increase muscle strength and balance, improve bone mineral density, and improve reaction time. [26]
Several limitations of this study must be mentioned in interpreting the present findings. First, the number of fall-related fractures among older adults may be underestimated because it includes only those persons who were treated in hospital EDs; the NEISS-AIP does not include persons treated in a physician’s office or other outpatient settings. Second, some fractures may have been missed because the NEISS-AIP includes the principal diagnosis and primary body part noted during the initial injury visit. In cases with multiple injuries, data for only the most severe injury are recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the primary body part affected and for the principal diagnosis relevant to consumer-product-related injuries. ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified. [3] Fourth, the present findings may be generalized to the U.S. population. However, regional or fracture rates by state cannot be determined. Finally, the NEISS-AIP does not evaluate health care services and medical outcomes after this type of injury.

Despite these limitations, this study describes the demographic characteristics and incidence of fall-related fractures nationwide among older adults treated in hospital EDs. Since the population 65 years and older in the U.S. will increase by more than double by 2050, rising from 39 million today to 89 million, these demographic changes alone will increase the number of fall-related fractures unless interventions to prevent falls among older adults are effectively implemented. [27] Although specific interventions on modifiable risk factors among older adults have shown to markedly decrease the prevalence of falls, health care providers, should recommend exercise or
physical therapy and vitamin D supplementation to prevent falls in community-dwelling older adults who are at increased risk of falling. [25, 28]

In conclusion, the oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in the U.S. EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.

**Funding**

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

**Conflict of interest statement**

None declared

**Acknowledgments**

The author would like to thank Mrs. Patricia Gutierrez from UTHSC Laredo campus for librarian assistance.
1 References

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13 January 30, 2012.


19 *Osteoporus Int* 2007;**18**: 585-91.


10. United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS). Bridged-race population estimates, United States July 1st resident population.


STROBE Statement—checklist of items that should be included in reports of observational studies

<table>
<thead>
<tr>
<th>Item No</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td><strong>Title and abstract</strong></td>
<td>1 yes (a) Indicate the study’s design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td></td>
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<tr>
<td>Background/rationale</td>
<td>2 yes Explain the scientific background and rationale for the investigation being reported</td>
</tr>
<tr>
<td>Objectives</td>
<td>3 yes State specific objectives, including any prespecified hypotheses</td>
</tr>
<tr>
<td><strong>Methods</strong></td>
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<tr>
<td>Study design</td>
<td>4 yes Present key elements of study design early in the paper</td>
</tr>
<tr>
<td>Setting</td>
<td>5 yes Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection</td>
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<tr>
<td>Participants</td>
<td>6 yes (a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants (b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case</td>
</tr>
<tr>
<td>Variables</td>
<td>7 Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable</td>
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<tr>
<td>Data sources/ measurement</td>
<td>8 For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group</td>
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<tr>
<td>Bias</td>
<td>9 Describe any efforts to address potential sources of bias</td>
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<td>Study size</td>
<td>10 Explain how the study size was arrived at</td>
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<tr>
<td>Quantitative variables</td>
<td>11 Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why</td>
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<tr>
<td>Statistical methods</td>
<td>12 yes (a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses</td>
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## Results

<table>
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<tr>
<th>Component</th>
<th>Score</th>
<th>Description</th>
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| Participants    | 13    | (a) Report numbers of individuals at each stage of study—e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed.  
(b) Give reasons for non-participation at each stage  
(c) Consider use of a flow diagram. |
| Descriptive data| 14    | (a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders.  
(b) Indicate number of participants with missing data for each variable of interest  
(c) Consider use of a flow diagram. |
| Outcome data    | 15    | (Co)hort study—Report numbers of outcome events or summary measures over time.  
Case-control study—Report numbers in each exposure category, or summary measures of exposure.  
Cross-sectional study—Report numbers of outcome events or summary measures. |
| Main results    | 16    | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included.  
(b) Report category boundaries when continuous variables were categorized.  
(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period. |
| Other analyses  | 17    | Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses. |

## Discussion

<table>
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<tr>
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<tbody>
<tr>
<td>Key results</td>
<td>18</td>
<td>Summarise key results with reference to study objectives.</td>
</tr>
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</table>
| Limitations     | 19    | Discuss limitations of the study, taking into account sources of potential bias or imprecision.  
Discuss both direction and magnitude of any potential bias. |
| Interpretation  | 20    | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence. |
| Generalisability| 21    | Discuss the generalisability (external validity) of the study results. |

## Other Information

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<tr>
<td>Funding</td>
<td>22</td>
<td>Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.</td>
</tr>
</tbody>
</table>

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

### Note:
Emergency department visits for fall-related fracture among older adults in the United States

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ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fracture among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition.

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was predominantly
seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year.

**Conclusions:** The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in US hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Article summary

Article focus

- To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

- An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.
- The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.
- EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

- The present study reports national estimates of fall-related fracture by gender and body part among older adults.
- ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
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As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.
Discussion

In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the U.S. hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportion of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a previous investigation that reported two-fold higher fracture rates among women aged 65 years or older treated for unintentional fall-related injuries in hospital EDs in the U.S. [3]

Similarly, a recent study showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [12] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [13, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates. [14-15] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study,
three risk factors common to all racial groups were older age, positive history of prior fracture after the age of 55 years, and a positive history of two or more falls. [14, 16] Besides previous accidental falls, muscle weakness, stroke, senile and organic psychotic conditions, and Alzheimer’s disease are associated with increased risk of falling among older Americans. [17] A previous study reported that the incidence of a fall within three months after a clinical fracture was 18.5% and 6.5% in older women and men, respectively. Among those who had fallen, 11.9% resulted in a new fall-related fracture [18] Consistent with other investigations [19-21], a study of Medicare beneficiaries demonstrated that a history of typical osteoporotic fracture was associated with the incidence of other fractures. Moreover, prior non-hip and non-spine fractures in both genders were associated with the incidence of traditional fragility fractures, as well as with fractures of the humerus and tibia/fibula. [17]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required hospitalization and the proportion of older adults hospitalized for these injuries increased during the 8-year study period. Although the present analysis was limited to fall-related fracture, these findings are consistent with a recent study that reported an increase by 50% in the estimated number of fall-related hospitalizations among older adults in the US between 2001 and 2008. Of these, hospitalizations for fractures accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the most common admitting diagnosis among persons aged 65 years or older hospitalized for fall-related injuries in the US between 1988 and 2005, representing 84% of the admissions. [5] Moreover, fall-related injury hospitalization rates increased in both genders during the 18-year period.
Overall, the number of fall-related fractures among older adults treated in EDs increased between 2001 and 2008. After age adjustment, a non-significant upward trend in fall-related fracture rates was seen among men. The precise reason for this finding is unknown. However, differences in osteoporosis recommendations for screening and prevention between men and women may account for increasing fall-related fracture rates seen among men. [22] These results contrast with a previous study among Medicare beneficiaries that reported a significant decrease in hip fracture rates among men and women between 1995 and 2005. [7]

The increased proportion of older Americans with physical limitations (stooping, lifting, reaching, grasping, and walking) over time may also partly explain these findings. In fact, data from the Medicare Current Beneficiary Survey indicate that the age-adjusted proportion of non-institutionalized adults aged 65 years and older with physical limitations increased from 32.7% in 1992 to 38.4% in 2009. [23] Similarly, a recent study using data from the National Health and Nutritional Examination Survey demonstrated an increased prevalence of self-reported disability over time among older Americans in basic activities of daily living, instrumental activities of daily living, and mobility. [24] Disability of the lower extremities has been associated with increased risk for falls among those aged 75 years or older living in the community and with fall-related hip fracture in women. [25, 6] Moreover, adequate physical activity has been associated with a reduced risk of fractures among fallers, possibly because physical activity can increase physical functioning, maintain mobility, increase muscle strength and balance, improve bone mineral density, and improve reaction time. [26]
Several limitations of this study must be mentioned in interpreting the present findings. First, the number of fall-related fractures among older adults may be underestimated because it includes only those persons who were treated in hospital EDs; the NEISS-AIP does not include persons treated in a physician’s office or other outpatient settings. Second, some fractures may have been missed because the NEISS-AIP includes the principal diagnosis and primary body part noted during the initial injury visit. In cases with multiple injuries, data for only the most severe injury are recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the primary body part affected and for the principal diagnosis relevant to consumer-product-related injuries. ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified. [3] Fourth, the present findings may be generalized to the U.S. population. However, regional or fracture rates by state cannot be determined. Finally, the NEISS-AIP does not evaluate health care services and medical outcomes after this type of injury.

Despite these limitations, this study describes the demographic characteristics and incidence of fall-related fractures nationwide among older adults treated in hospital EDs. Since the population 65 years and older in the U.S. will increase by more than double by 2050, rising from 39 million today to 89 million, these demographic changes alone will increase the number of fall-related fractures unless interventions to prevent falls among older adults are effectively implemented. [27] Although specific interventions on modifiable risk factors among older adults have shown to markedly decrease the prevalence of falls, health care providers, should recommend exercise or
physical therapy and vitamin D supplementation to prevent falls in community-dwelling older adults who are at increased risk of falling. [25, 28]

In conclusion, the oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in the U.S. EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.

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Conflict of interest statement
None declared

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References


10. United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS). Bridged-race population estimates, United States July1st resident population.


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<tr>
<th>Body Part</th>
<th>Cases</th>
<th>Estimates</th>
<th>Rates (95% CI)</th>
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\(^a\) Parietal and occipital bones; \(^b\) cervical spine; \(^c\) thoracic spine, ribs, and sternum; \(^d\) clavicle; \(^e\) humerus; \(^f\) ulna and distal radius; \(^g\) lumbar spine, pelvis, and hip; \(^h\) femur; \(^i\) fibula and tibia.

* National estimates of fall-related fractures.
Figure 1. Fall-related fracture rates and 95% CI among older adults treated in U.S. EDs

254x190mm (96 x 96 DPI)
Figure 2. Trends in fall-related fracture rates treated in U.S. EDs, 2001-2008

254x190mm (96 x 96 DPI)
Figure 3. Disposition of older adults treated in US hospital EDs for fall-related fracture

- Treated and released
- Hospitalized
- Transferred

254x190mm (96 x 96 DPI)
# Emergency department visits for fall-related fractures among older adults in the United States

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Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

Emergency department visits for fall-related fractures among older adults in the United States

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Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fractures among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition.

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was predominantly
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year.

Conclusions: The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in US hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

Article summary

Article focus

- To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

- An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.

- The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.

- EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

- The present study reports national estimates of fall-related fracture by gender and body part among older adults.

- ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3% of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the U.S. hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital. Data obtained on each case include age, race/ethnicity, gender, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (i.e., hospitalized, transferred, treated and released, observation, died), locale where the injury occurred, work-relatedness, and a narrative description of the injury circumstances. Also, major categories of external cause of injury (e.g., motor vehicle, falls, cut/pierce, poisoning, fire/burn) and of intent of injury (e.g., unintentional, assault, intentional self-harm, legal intervention). Trained, onsite hospital coders took data for injury-related cases from ED records at NEISS hospitals. The coders coded all data elements, except for cause of injury. These coded data and a narrative were electronically transmitted to Consumer Product Safety Commission (CPSC) headquarters. NEISS-AIP quality assurance coders at CPSC headquarters reviewed all of the data elements as well as a narrative (description) for each case from each of the 66 NEISS-AIP hospitals. Quality assurance coders then used the narrative and other data to assign codes for the precipitating and direct causes/mechanisms of injury for
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

each case. The present study included persons 65 years or older treated in the U.S.

hospital EDs for unintentional fall-related fractures between 2001 and 2008. National

estimates are considered unstable and potentially unreliable if the number of records is

based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based

on weighted data), or the coefficient of variation of the estimate is greater than 30%.

The NEISS-AIP public use files were downloaded from the Inter-University Consortium

for Political and Social Research. [9]

Statistical analysis

All statistical analyses were performed using SPSS Complex Sample software, version

17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to

obtain unbiased, nationally representative estimates from the NEISS-AIP sampling

design. The sample weight has been adjusted for hospital non-response within each

NEISS-AIP sample stratum and changes in the number of ED visits annually in the

sampling frame of US hospital EDs. Means and proportions were used to describe

demographic and clinical characteristics of the study sample. The U.S. Census Bureau

population estimates were used as the denominator to calculate fall-related fracture

rates per 100,000 persons. [10] Fracture rates were then standardized by the direct

method to the U.S. population for the year 2000 to account for changes in the age

distribution of the population over time. Linear regression was used to examine the

statistical significance of trends in fall-related fracture rates over the study period. The

results are presented as the annual percentage change in rates and corresponding 95%

confidence intervals (95% CI). The annual percentage change is one way to

characterize trends over time in which the rates are assumed to change at a constant
Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age of 80.0 (SD 8.2) years were treated in the U.S. hospital EDs for unintentional fall-related fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of these cases and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Overall, 58.7% (95% CI, 54.0-63.3) of these injuries occurred at home. Moreover, after a fall-related fracture, 50.6% (95% CI, 47.7-53.5) of the patients were treated and released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip) represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the admissions, respectively.

The number, national estimates, and fall-related fracture rates according to gender and primary body part affected are shown in Table 1. In general, lower trunk fractures were the most frequently reported injuries in both genders, representing 37.3% (95% CI, 37.2-39.5) of fall-related fracture visits to EDs in the U.S. during the study period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum) accounted for a considerable proportion of fall-related fractures among women, whereas among men, upper trunk fracture was the second most frequent reason for fall-related fractures EDs visits, representing an estimated 197,000 fractures.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

The incidence of fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. After adjusting by age, fall-related fracture rate varies by race. The highest rates per 100,000 persons were 1,268.9 among non-Hispanic whites, whereas the lowest rates of 876.6 were seen among Asians. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians.

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 2).

As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

Discussion

In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the U.S. hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportions of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a report from the Healthcare Cost and Utilization Project Nationwide Emergency Department Sample on EDs injury visits among older adults in which women were more likely to have EDs visits for upper extremity and hip fractures than older men. In addition, women were two to three times more likely than men to have a fall-related EDs visit for most types of fracture. Overall, hospitalization occurred in 51.3% of older adults with a fall-related fracture ED visit. [12] Similarly, a recent study using data from the NEISS-AIP showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [13] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [14, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

[15-16] Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study, three risk factors common to all racial groups were older age, positive history of prior fracture after the age of 55 years, and a positive history of two or more falls. [14, 17] Among fallers, an increasing amount of leisure-time physical activity and wearing proper shoes with low, wide heels that cover and stay on the foot in the event of a fall have been associated with decreased risk of fractures at the foot, distal forearm, proximal humerus, pelvis, and shaft of the tibia/fibula compared with fallers who do not fracture.

[18] Moreover, among older white women, walking for exercise, reducing caffeine intake, quitting smoking, avoiding long-acting sedatives agents, treating impaired vision and preserving bone mass were reported to reduce the risk of hip fractures. [19]

Several studies have reported that fractures of the hip, spine, or wrist are predictors of subsequent fractures. [20-23] Recently, investigators have demonstrated that besides typical osteoporotic fractures, prior non-hip and non-spine fractures in both genders are associated with the incidence of traditional fragility fractures, as well as with fractures of the humerus and tibia/fibula. [20]. Moreover, prior rib and upper leg fracture fractures are associated with increased risk of subsequent vertebral and hip fracture, respectively. Among women, a history of ankle fracture increased the risk of future fracture of a weight-bearing bone. [21]

Of interest, 44.2% of patients treated in EDs for fall-related fracture required hospitalization and the proportion of older adults hospitalized for these injuries increased during the 8-year study period. Although the present analysis was limited to
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

fall-related fractures, these findings are consistent with a recent study that reported an increase by 50% in the estimated number of fall-related hospitalizations among older adults in the US between 2001 and 2008. Of these, hospitalizations for fractures accounted for sixty three percent of the diagnoses. [4] Similarly, fractures were the most common admitting diagnosis among persons aged 65 years or older hospitalized for fall-related injuries in the US between 1988 and 2005, representing 84% of the admissions. [5] Moreover, fall-related injury hospitalization rates increased in both genders during the 18-year period.

Overall, the number of fall-related fractures among older adults treated in EDs increased between 2001 and 2008. After age adjustment, a non-significant upward trend in fall-related fracture rates was seen among men. The precise reason for this finding is unknown. However, differences in osteoporosis recommendations for screening and prevention between men and women may account for increasing fall-related fracture rates seen among men. [24] These results contrast with a previous study among Medicare beneficiaries that reported a significant decrease in hip fracture rates among men and women between 1995 and 2005. [7]

The increased proportion of older Americans with physical limitations (stooping, lifting, reaching, grasping, and walking) over time may also partly explain these findings. In fact, data from the Medicare Current Beneficiary Survey indicate that the age-adjusted proportion of non-institutionalized adults aged 65 years and older with physical limitations increased from 32.7% in 1992 to 38.4% in 2009. [25] Similarly, a recent study using data from the National Health and Nutritional Examination Survey demonstrated an increased prevalence of self-reported disability over time among older
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

Americans in basic activities of daily living, instrumental activities of daily living, and mobility. [26] Disability of the lower extremities has been associated with increased risk for falls among those aged 75 years or older living in the community and with fall-related hip fracture in women. [27, 6] Moreover, adequate physical activity has been associated with a reduced risk of fractures among fallers, possibly because physical activity can increase physical functioning, maintain mobility, increase muscle strength and balance, improve bone mineral density, and improve reaction time. [18]

Several limitations of this study must be mentioned in interpreting the present findings. First, the number of fall-related fractures among older adults may be underestimated because it includes only those persons who were treated in hospital EDs; the NEISS-AIP does not include persons treated in a physician’s office or other outpatient settings. Second, some fractures may have been missed because the NEISS-AIP includes the principal diagnosis and primary body part noted during the initial injury visit. In cases with multiple injuries, data for only the most severe injury are recorded. Third, the NEISS-AIP coding system has a fixed number of categories for the primary body part affected and for the principal diagnosis relevant to consumer-product-related injuries. ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified. [3] Fourth, the present findings may be generalized to hospital ED visits for fall-related injuries among older adults in the U.S. However, regional or fracture rates by state cannot be determined. Finally, the NEISS-AIP does not evaluate health care services and medical outcomes after this type of injury.
Despite these limitations, this study describes the demographic characteristics and incidence of fall-related fractures nationwide among older adults treated in hospital EDs. Since the population 65 years and older in the U.S. will increase by more than double by 2050, rising from 39 million today to 89 million, these demographic changes alone will increase the number of fall-related fractures unless interventions to prevent falls among older adults are effectively implemented. [28] Although specific interventions on modifiable risk factors among older adults have shown to markedly decrease the prevalence of falls, health care providers should recommend exercise or physical therapy and vitamin D supplementation to prevent falls in community-dwelling older adults who are at increased risk of falling. [27, 29]

In conclusion, the oldest old, women, and lower trunk fractures account for the majority of fall-related fractures hospital EDs visits among persons aged 65 years or older in the U.S. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
Table 1. Emergency Department fall-related fracture estimates and incidence rates according to gender and body part, NEISS-AIP 2001-2008

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References


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10. United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS). Bridged-race population estimates, United States July1st resident population.


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<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Estimates*</td>
</tr>
<tr>
<td>Head</td>
<td>116</td>
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<td>Ankle</td>
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<tr>
<td>Toe</td>
<td>96</td>
<td>6,000</td>
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1 Parietal and occipital bones; b cervical spine; c thoracic spine, ribs, and sternum; d clavicle; e humerus; f ulna and distal radius; g lumbar spine, pelvis, and hip; h femur; i fibula and tibia.

3 * National estimates of ED visits for fall-related fractures.

4 ¶ Rates per 100,000 population.
Emergency department visits for fall-related fractures among older adults in the United States

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Fax: (956) 712-3555
corces07@yahoo.com
ABSTRACT

Objectives: To describe the demographic characteristics and incidence of unintentional fall-related fractures among older adults treated in the US hospital emergency departments (EDs).

Design: Retrospective observational study

Settings: Hospitals EDs participants in the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)

Participants: The NEISS-AIP was used to generate national estimates of hospital EDs visits for unintentional fall-related fracture among adults aged 65 years or older between 2001 and 2008. Census population estimates were used as the denominator to calculate age-specific and age-adjusted fracture rates per 100,000 persons.

Main outcome measures: Fall-related fracture rates and EDs disposition.

Results: On the basis of 70,199 cases, an estimated 4.05 million older adults were treated in US hospital EDs for fall-related fracture during the 8-year period. Two-thirds of the injuries occurred at home and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Fall-related fracture rates increased gradually with age and were on average two-fold higher among women. Of those hospitalized, women and fractures of the lower trunk represented 75.2% and 65.1% of the admissions, respectively. The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 714,800 in 2008, a 24.4% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was predominantly
seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates
among women remained stable at 0.9% (95% CI -0.7-2.5) per year.

Conclusions: The oldest old, women, and lower trunk fractures account for the
majority of fall-related fractures among persons aged 65 years or older treated in US
hospital EDs. Increasing EDs visits and hospitalizations for fall-related fracture among
older adults deserve further research.
Article summary

Article focus

- To aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in the US hospital EDs.

Key messages

- An estimated 4.05 million older adults were treated in hospital EDs for fall-related fracture between 2001 and 2008.
- The oldest old, women, and lower trunk fractures account for the majority of fall-related fractures among persons aged 65 years or older treated in EDs.
- EDs visits and hospitalizations for fall-related fracture among older adults increased in the US during the study period.

Strength and limitations of the study

- The present study reports national estimates of fall-related fracture by gender and body part among older adults.
- ICD-9-CM diagnosis codes were not available in the medical records at the time these data were collected; therefore, specific types of injuries (for example hip fracture) could not be accurately identified.
Introduction

One-third of people over the age of 65 years who live in the community fall each year; this proportion increases to 50% by the age of 80 years. [1] Although not all falls of older persons are injurious, about 5% of them result in a fracture, and other serious injuries occur in 5% to 10% percent of falls. [2] In 2001, an estimated 1.64 million older adults were treated in hospital emergency departments (EDs) for unintentional fall-related injuries in the United States (U.S.). Of these, fractures accounted for 37.8% of women’s and 28.3 % of men’s injuries. [3]

Between 2001 and 2008, fractures were the most frequent primary diagnosis (63%) among older adults hospitalized after being treated in hospital EDs for fall-related injuries. [4] Similarly, a prior study showed that fractures accounted for 84% of hospitalizations for fall-related injuries among older adults in the US between 1988 and 2005. Moreover, hip fracture was the leading diagnosis in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the 18-year study period. [5]

About 1% to 14% of falls in women result in hip fracture and over 90% of hip fractures are the result of a fall [6]. Although hip fracture rates and subsequent mortality are declining in the U.S., information is scarce about the epidemiology of other fall-related fractures nationwide among older adults. [7-8] Thus, the aim of this study was to describe the demographic characteristics and incidence of unintentional fall-related fracture among persons aged 65 years or older treated in hospital EDs between 2001 and 2008.
Methods

The National Electronic Injury Surveillance System All Injury Program (NEISS-AIP) is designed to provide national incidence estimates of all types and external causes of non-fatal injuries and poisonings treated in the U.S. hospital EDs. Data on injury-related visits were obtained from a national sample of 66 out of 100 NEISS hospitals, which were selected as a stratified probability sample of hospitals in the US with a minimum of six beds and 24-hour EDs. Data are weighted by the inverse of the probability of selection to produce national estimates. The sample includes separate strata for very large, large, medium, and small hospitals, defined by the number of annual ED visits per hospital. Data obtained on each case include age, race/ethnicity, gender, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (i.e., hospitalized, transferred, treated and released, observation, died), locale where the injury occurred, work-relatedness, and a narrative description of the injury circumstances. Also, major categories of external cause of injury (e.g., motor vehicle, falls, cut/pierce, poisoning, fire/burn) and of intent of injury (e.g., unintentional, assault, intentional self-harm, legal intervention). Trained, onsite hospital coders took data for injury-related cases from ED records at NEISS hospitals. The coders coded all data elements, except for cause of injury. These coded data and a narrative were electronically transmitted to Consumer Product Safety Commission (CPSC) headquarters. NEISS-AIP quality assurance coders at CPSC headquarters reviewed all of the data elements as well as a narrative (description) for each case from each of the 66 NEISS-AIP hospitals. Quality assurance coders then used the narrative and other data to assign codes for the precipitating and direct causes/mechanisms of injury for
each case. The present study included persons 65 years or older treated in the U.S. hospital EDs for unintentional fall-related fractures between 2001 and 2008. National estimates are considered unstable and potentially unreliable if the number of records is based on fewer than 20 NEISS-AIP cases, national estimates fewer than 1200 (based on weighted data), or the coefficient of variation of the estimate is greater than 30%.

The NEISS-AIP public use files were downloaded from the Inter-University Consortium for Political and Social Research. [9]

Statistical analysis
All statistical analyses were performed using SPSS Complex Sample software, version 17 (SPSS Inc., Chicago, IL) and incorporated population-based sampling weights to obtain unbiased, nationally representative estimates from the NEISS-AIP sampling design. The sample weight has been adjusted for hospital non-response within each NEISS-AIP sample stratum and changes in the number of ED visits annually in the sampling frame of US hospital EDs. Means and proportions were used to describe demographic and clinical characteristics of the study sample. The U.S. Census Bureau population estimates were used as the denominator to calculate fall-related fracture rates per 100,000 persons. [10] Fracture rates were then standardized by the direct method to the U.S. population for the year 2000 to account for changes in the age distribution of the population over time. Linear regression was used to examine the statistical significance of trends in fall-related fracture rates over the study period. The results are presented as the annual percentage change in rates and corresponding 95% confidence intervals (95% CI). The annual percentage change is one way to characterize trends over time in which the rates are assumed to change at a constant
percentage of the rate of the previous year. All analyses were performed by using Joinpoint software, version 3.5.0. [11]

Results

On the basis of 70,199 cases, an estimated 5.04 million adults with a mean age of 80.0 (SD 8.2) years were treated in the U.S. hospital EDs for unintentional fall-related fracture between 2001 and 2008. Women accounted for 75.2% (95% CI, 74.2-76.2) of these cases and 69.5% (95% CI, 59.7-77.8) of the affected individuals were white. Overall, 58.7% (95% CI, 54.0-63.3) of these injuries occurred at home. Moreover, after a fall-related fracture, 50.6% (95% CI, 47.7-53.5) of the patients were treated and released from the ED and 44.2% (95% CI, 40.9-47.7) required hospitalization. Of those hospitalized, women and fractures of the lower trunk (lumbar spine, pelvis and hip) represented 75.2% (95% CI, 73.9-76.5) and 65.1% (95% CI, 62.0-68.1) of the admissions, respectively.

The number, national estimates, and fall-related fracture rates according to gender and primary body part affected are shown in Table 1. In general, lower trunk fractures were the most frequently reported injuries in both genders, representing 37.3% (95% CI, 37.2-39.5) of fall-related fracture visits to EDs in the U.S. during the study period. Moreover, wrist and upper trunk fractures (thoracic spine, ribs, and sternum) accounted for a considerable proportion of fall-related fractures among women, whereas among men, upper trunk fracture was the second most frequent reason for fall-related fractures EDs visits, representing an estimated 197,000 fractures.
The incidence of fall-related fracture rates increased with advancing age and were on average two-fold higher among women (figure 1). In fact, compared with those in the age group 65 to 69 years, fracture rates in the age group 85 years or older were four-fold higher among women and five-fold higher among men. After adjusting by age, fall-related fracture rate varies by race. The highest rates per 100,000 persons were 1,268.9 among non-Hispanic whites, whereas the lowest rates of 876.6 were seen among Asians. Blacks and American Indians had rates that were similar but intermediate between those of whites and Asians.

The estimated number of fall-related fractures treated in EDs increased from 574,500 in 2001 to 715,000 in 2008, a 24.4% increase. However, the population of older adults also increased by 9.8% in the U.S. during the same period. After age adjustment, fall-related fracture rates increased from 1618.7 in 2001 to 1789.4 per 100,000 persons in 2008, a 10.5% increase. By gender, a non-significant upward trend in age adjusted fall-related fracture rates was seen among men at an annual rate of 1.9% (95% CI -0.1-4.0), whereas fracture rates among women remained stable at 0.9% (95% CI -0.7-2.5) per year (figure 2).

As shown in figure 3, the proportion of patients hospitalized for fall-related fracture increased from 43.5% (95 CI, 42.4-44.5) in 2001 to 48.4% (95 CI, 47.4-49.3) in 2008, with a corresponding decrease in the proportion of patients released from EDs from 53.4% (95 CI, 52.3-54.5) to 48.7% (95 CI, 47.7-49.7) during the same period. The proportion of patients transferred to other facilities remained stable over time.
Discussion

In this nationally representative sample, an estimated 5.04 million older adults were treated for fall-related fractures in the U.S. hospital EDs between 2001 and 2008. Fall-related fracture rates increased gradually with advancing age and were on average two-fold higher among women. The gender differences in fall-related fracture rates were mainly attributed to higher proportions of upper extremity and lower trunk fractures (lumbar spine, pelvis and hip) among women. In fact, lower trunk fractures in women accounted for twenty eight percent of all fall-related fractures among older adults treated in EDs during the 8-year period. The present findings are consistent with a report from the Healthcare Cost and Utilization Project Nationwide Emergency Department Sample on EDs injury visits among older adults in which women were more likely to have EDs visits for upper extremity and hip fractures than older men. In addition, women were two to three times more likely than men to have a fall-related EDs visit for most types of fracture. Overall, hospitalization occurred in 51.3% of older adults with a fall-related fracture ED visit. [12] Similarly, a recent study using data from the NEISS-AIP showed that fall-related forearm and wrist fracture rates among persons 50 years or older treated in hospital EDs nationwide were on average 3.3 higher in women than those rates in men. [13] Possible explanations for the marked gender differences in fractures are the higher prevalence of osteopenia and osteoporosis among women and the 40% to 60% higher fall-related injury rates reported among women. [14, 3]

The racial differences in fall-related fracture rates found in this study are also consistent with results from previous investigations in which white women had the highest fracture rates, whereas black and Asian women had the lowest fracture rates.
Although many risk factors for fracture have been identified in white women, less is known about risk factors for fracture in non-white women. In a prospective study of 159,579 women aged 50 to 79 years enrolled in the Women’s Health Initiative study, three risk factors common to all racial groups were older age, positive history of prior fracture after the age of 55 years, and a positive history of two or more falls. [14, 17] Among fallers, an increasing amount of leisure-time physical activity and wearing proper shoes with low, wide heels that cover and stay on the foot in the event of a fall have been associated with decreased risk of fractures at the foot, distal forearm, proximal humerus, pelvis, and shaft of the tibia/fibula compared with fallers who do not fracture [18] Moreover, among older white women, walking for exercise, reducing caffeine intake, quitting smoking, avoiding long-acting sedatives agents, treating impaired vision and preserving bone mass were reported to reduce the risk of hip fractures. [19]

Several studies have reported that fractures of the hip, spine, or wrist are predictors of subsequent fractures. [20-23] Recently, investigators have demonstrated that besides typical osteoporotic fractures, prior non-hip and non-spine fractures in both genders are associated with the incidence of traditional fragility fractures, as well as with fractures of the humerus and tibia/fibula. [20]. Moreover, prior rib and upper leg fracture fractures are associated with increased risk of subsequent vertebral and hip fracture, respectively. Among women, a history of ankle fracture increased the risk of future fracture of a weight-bearing bone. [21]

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Overall, the number of fall-related fractures among older adults treated in EDs increased between 2001 and 2008. After age adjustment, a non-significant upward trend in fall-related fracture rates was seen among men. The precise reason for this finding is unknown. However, differences in osteoporosis recommendations for screening and prevention between men and women may account for increasing fall-related fracture rates seen among men. [24] These results contrast with a previous study among Medicare beneficiaries that reported a significant decrease in hip fracture rates among men and women between 1995 and 2005. [7]

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Despite these limitations, this study describes the demographic characteristics and incidence of fall-related fractures nationwide among older adults treated in hospital EDs. Since the population 65 years and older in the U.S. will increase by more than double by 2050, rising from 39 million today to 89 million, these demographic changes alone will increase the number of fall-related fractures unless interventions to prevent falls among older adults are effectively implemented. [28] Although specific interventions on modifiable risk factors among older adults have shown to markedly decrease the prevalence of falls, health care providers should recommend exercise or physical therapy and vitamin D supplementation to prevent falls in community-dwelling older adults who are at increased risk of falling. [27, 29]

In conclusion, the oldest old, women, and lower trunk fractures account for the majority of fall-related fractures hospital EDs visits among persons aged 65 years or older in the U.S. Increasing EDs visits and hospitalizations for fall-related fracture among older adults deserve further research.
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3 **Conflict of interest statement**

4 None declared

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Figure 1. Fall-related fracture rates and 95% CI among older adults treated in U.S. EDs

Rates per 100,000 persons

Age group, yrs

65-69 70-74 75-79 80-84 85+

men women

119x90mm (300 x 300 DPI)
Figure 2. Trends in fall-related fracture rates treated in U.S. EDs, 2001-2008

119x90mm (300 x 300 DPI)
Figure 3. Disposition of older adults treated in US hospital EDs for fall-related fracture

- Treated and released
- Hospitalized
- Transferred

119x90mm (300 x 300 DPI)
STROBE Statement—checklist of items that should be included in reports of observational studies

<table>
<thead>
<tr>
<th>Item No</th>
<th>Recommendation</th>
</tr>
</thead>
</table>
| **Title and abstract** | (a) Indicate the study’s design with a commonly used term in the title or the abstract  
(b) Provide in the abstract an informative and balanced summary of what was done and what was found |
| **Introduction** | Explain the scientific background and rationale for the investigation being reported |
| **Objectives** | State specific objectives, including any prespecified hypotheses |
| **Methods** | Present key elements of study design early in the paper |
| **Participants** | (a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up  
Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls  
Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants  
(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed  
Case-control study—For matched studies, give matching criteria and the number of controls per case |
| **Variables** | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable |
| **Data sources/measurement** | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group |
| **Bias** | Describe any efforts to address potential sources of bias |
| **Study size** | Explain how the study size was arrived at |
| **Quantitative variables** | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why |
| **Statistical methods** | (a) Describe all statistical methods, including those used to control for confounding  
(b) Describe any methods used to examine subgroups and interactions  
(c) Explain how missing data were addressed  
(d) Cohort study—If applicable, explain how loss to follow-up was addressed  
Case-control study—If applicable, explain how matching of cases and controls was addressed  
Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy  
(e) Describe any sensitivity analyses |

Continued on next page
### Results

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<td>Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed</td>
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<tr>
<td><strong>(b)</strong></td>
<td>Give reasons for non-participation at each stage</td>
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<tr>
<td><strong>(c)</strong></td>
<td>Consider use of a flow diagram</td>
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<td><strong>(a)</strong></td>
<td>Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders</td>
<td></td>
</tr>
<tr>
<td><strong>(b)</strong></td>
<td>Indicate number of participants with missing data for each variable of interest</td>
<td></td>
</tr>
<tr>
<td><strong>(c)</strong></td>
<td><em>Cohort study</em>—Summarise follow-up time (eg, average and total amount)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome data</th>
<th>15</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cohort study</strong></td>
<td>Report numbers of outcome events or summary measures over time</td>
<td></td>
</tr>
<tr>
<td><strong>Case-control study</strong></td>
<td>Report numbers in each exposure category, or summary measures of exposure</td>
<td></td>
</tr>
<tr>
<td><strong>Cross-sectional study</strong></td>
<td>Report numbers of outcome events or summary measures</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main results</th>
<th>16</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(a)</strong></td>
<td>Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included</td>
<td></td>
</tr>
<tr>
<td><strong>(b)</strong></td>
<td>Report category boundaries when continuous variables were categorized</td>
<td></td>
</tr>
<tr>
<td><strong>(c)</strong></td>
<td>If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period</td>
<td></td>
</tr>
</tbody>
</table>

| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses |

### Discussion

<table>
<thead>
<tr>
<th>Key results</th>
<th>18</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summarise key results with reference to study objectives</strong></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Limitations</th>
<th>19</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>20</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Generalisability | 21 | Discuss the generalisability (external validity) of the study results |

### Other Information

<table>
<thead>
<tr>
<th>Funding</th>
<th>22</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.*