# The impact of decreasing U.S. hip fracture rates on future hip fracture estimates

**J. A. Stevens** and **R. A. Rudd**

National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Mailstop F-62, Atlanta, GA 30341, USA

## Abstract

**Summary—**We examined age- and sex-specific hip fracture hospitalization rates among people aged 65 and older using 1990–2010 National Hospital Discharge Survey data. Trends calculated using Joinpoint regression analysis suggest that future increases in hip fractures due to the aging population will be largely offset by decreasing hip fracture rates among women. However, this trend will be counterbalanced by rising numbers of hip fractures among men.

**Introduction—**From 1990 to 2006, age-adjusted U.S. hip fracture rates among people aged 65 years and older declined significantly. We wanted to determine whether decreasing age group-specific hip fracture rates might offset increases in hip fractures among the aging population over the next two decades.

**Methods—**This study used data from the National Hospital Discharge Survey, a national probability survey of inpatient discharges from nonfederal U.S. hospitals, to analyze hip fracture hospitalizations, defined as cases with first diagnosis coded ICD-9 CM 820. We analyzed trends in rates by sex and 10-year age groups using Joinpoint analysis software and used the results and projected population estimates to obtain the expected number of hip fractures in 2020 and 2050.

**Results—**Based on current age- and sex-specific trends in hip fracture hospitalization rates, the number of hip fractures is projected to rise 11.9 %—from 258,000 in 2010 to 289,000 (Projection Interval [PI] =193,000–419,000) in 2030. The number of hip fractures among men is expected to increase 51.8 % (PI=15.9–119.4 %) while the number among women is expected to decrease 3.5 % (PI=–44.3–37.3 %). These trends will affect the future distribution of hip fractures among the older population.

**Conclusions—**Although the number of older people in the U.S.A. will increase appreciably over the next 20 years, the expected increase in the total number of hip fractures will be largely offset by decreasing hip fracture rates among women. However, this trend will be counterbalanced by rising numbers of hip fractures among men.

jas2@cdc.gov.
R. A. Rudd, rvr2@cdc.gov

**Conflicts of interest** None.

## Introduction

Hip fractures are a threat to the health, mobility, and independence of older adults as well as a burden on the U.S. health care system. In 2010, approximately 258,000 people aged 65 years and older in the U.S.A. were hospitalized for hip fractures [1]. These injuries are very costly, averaging $35,800 (including inpatient, outpatient, and long-term care) in the first year alone [2]. Hip fractures also are associated with significant mortality. Compared to people of similar age, hip fracture patients are two to three times more likely to die within a year following their injury [3].

Like many developed countries, the U.S. population is aging and the number of hip fractures is expected to increase. The U.S. Census Bureau predicts that by 2030, there will be 70.3 million people aged 65 and older [4]. In a recent study using data from the National Hospital Discharge Survey (NHDS) [1], Brown et al. [5] estimated that based on current population trends, the annual number of hip fractures could reach 666 million by 2030.

While the older population has been increasing, hip fracture rates in the U.S.A. have been decreasing [6]. In a previous study of trends in U.S. hip fracture rates among people aged 65 years and older using NHDS data, we reported that age-adjusted rates for both men and women declined significantly from 1990 to 2006 [6]. When stratified by age, this decline was significant among women aged 75 to 84 and among men and women aged 85 and older. Researchers in other countries also have reported declining hip fracture rates [7–10].

We undertook this study to determine the extent to which declining age group-specific hip fracture rates in women aged 75 to 84 and in men and women aged 85 and older might offset the estimated increase in the number of hip fractures due to population growth over the next two decades.

## Methods

This study used data from the National Hospital Discharge Survey (NHDS) [1], a national probability survey of inpatient discharges from nonfederal, short-stay hospitals in the U.S.A. Conducted by the National Center for Health Statistics (NCHS), the NHDS collects data annually from approximately 270,000 inpatient records obtained from a nationally representative sample of about 500 hospitals. Only hospitals with an average length of stay of fewer than 30 days for all patients, general hospitals, or children's general hospitals are included in the survey.

Because of the complex multistage design of the NHDS, the survey data are weighted to produce national estimates. The estimation procedure produces essentially unbiased national estimates and has three basic components: inflation by reciprocals of the probabilities of sample selection, adjustment for nonresponse, and population weighting ratio adjustments [11].

Estimates of hip fracture hospitalizations from the NHDS were obtained using Health Data Interactive (HDI), a webbased application providing access to national estimates of public health measures cross tabulated by a common set of variables [12]. Hip fracture

hospitalizations were cases with a first listed diagnosis coded 820, according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) [13]. For 1990 to 2010 (the most recent data available), the estimated number of hip fractures for people aged 65 and older, rates per 10,000 (age-adjusted by 10-year age groups to the 2000 U.S. population), and standard errors were derived by the NCHS using SUDAAN, a program that takes into account the complex sampling design. These data are available at www.cdc.gov/nchs/hdi.htm.

We extended our earlier analyses [6] by including hip fracture data from 1990 to 2010 (from approximately 2,000 of the inpatient records sampled each year), and analyzed the trend in rates during this time period for men and women aged 65 years and older by 10-year age groups (65 to 74 years, 75 to 84 years, and 85 years and older) using Joinpoint analysis software. The Joinpoint regression program tests whether a multi-segmented line fits the data better than a straight line (Joinpoint Regression Program, version 3.3, National Cancer Institute). The models incorporated both the estimated annual hospitalization rates as well as the standard error of the estimated rates. The rates were modeled on the log of the rate in order to obtain the annual percentage change (APC) from the trend line. The log-linear model assumes change at a constant percentage of the rate of the previous year. Therefore, as rates decrease, the absolute amount of annual change also will decrease. This gradual decrease seemed logically to fit hip fracture trends. The tests of significance of the Joinpoint models used a Monte Carlo permutation method.

The results of the trend analyses were used to estimate projected hip fracture rates by applying the following formula:

$$e^{bt+\ln(\text{initial rate})}=\text{Future rate}$$

where the ln(initial rate) is the intercept of the Joinpoint regression line, $b$=slope of the Joinpoint regression line from either 1990–2010 or from the inflection point (estimated peak rate) to 2010, and $t$=year.

We applied the projected rate to sex- and age-specific population projections for 2020 and 2050 [4] and summed the results to obtain the expected number of hip fractures for men and women aged 65 and older for these 2 years. Upper and lower bounds were calculated using prediction intervals (PI) that are equivalent to confidence intervals around a future predicted point. PIs take into account the variability of the slope and intercept of the estimated regression line as well as the variability of the future observation.

## Results

From 1990 to 2010, most age-adjusted hip fracture hospitalization rates for men and women aged 65 and older declined. Rates for men fell from 54.6 per 10,000 population to 44.2 per 10,000 in 2010 (APC = −1.2, [95 % CI = −1.8 to −0.6], $p<0.001$). Rates for women aged 65 and older did not change significantly from 1990 to 1996, after which rates declined from 125.1 per 10,000 population to 72.3 per 10,000 in 2010 (APC=−3.2, [95 % CI=−4.0 to

−2.5], $p<0.001$). However, differences emerged when rates were stratified by 10-year age groups. Among men, the APC was significant only among those aged 75 to 84 and 85 and older; rates declined steadily during the entire time period (APC=−1.4, [95 % CI=−2.4 to −0.4], p=0.012; and APC=−2.0, [95 % CI=−2.9 to −1.1], $p<0.001$, respectively). Among women, the APC was significant for all age groups. A steady decline during the entire time period was seen for women aged 65 to 74 and 75 to 84 (APC=−1.4, [95 % CI=−2.4 to −0.3], p=0.012, APC=−2.8, [95 % CI=−3.6 to −2.0], $p<0.001$, respectively), while, for women in the oldest group, rates peaked in 1996 and declined significantly thereafter (APC=−3.3, [95 % CI=−4.2 to −2.3], $p<0.001$).

Table 1 shows the projected number of hip fractures among people aged 65 and older. The number of hip fractures is expected to rise from 258,000 in 2010 to 289,000 in 2030 (PI =193,000–419,000). This 11.9 % increase (PI=−34.3–58.1 %) is the result of two conflicting trends. From 2010 to 2030, the number of hip fractures among men is expected to increase 51.8 % (PI=−15.9–119.4 %) while the number among women is expected to decrease 3.5 % (PI=−44.3–37.3 %). These trends also will affect the distribution of hip fractures in the older population. Whereas men sustained 27.9 % of hip fractures in 2010, by 2030 this proportion is expected to rise to 37.8 %.

## Discussion

The U.S. population is aging rapidly. By 2030, the number of people aged 65 and older will increase by over 80 % [4]. We found that although the older population will increase appreciably over the next 20 years, a corresponding increase in the number of hip fractures may be greatly offset by decreasing hip fracture rates among women. This especially will impact women aged 85 and older who comprise the fastest-growing segment of the older population and who have the highest hip fracture rates. In contrast, the number of hip fractures among men is projected to increase almost 52 %.

This study confirmed and expanded our previous findings that hip fracture rates of men and women aged 75 to 84 and 85 and older were declining [6]. We also found that hip fracture rates among women aged 65 to 74 were declining. Assuming these trends continue, we estimated that older adults will sustain about 289,000 hip fractures in 2030. Although this represents almost a 12 % increase, it is considerably lower than previous estimates. In 1990, Schneider and Guralnik [14] predicted that in 2040, there would be 530,000 to 840,000 hip fractures, and in 1999, the World Health Organization estimated that by 2050, the U.S.A. would have 650,000 hip fractures [15]. More recently, Brown et al. estimated that by 2030, the U.S.A. could expect 451,000 to 666,000 hip fractures [5].

Our lower estimates can be explained by the methods and time periods we used for our projections. Our trends were based on 10-year age group-specific hospitalization rates using data as recent as 2010. Other researchers have had to rely on older data or have used larger age groups in their analyses, both of which can result in different trend estimates. Additionally, our analysis method identified changes in trends during the 1990 to 2010 time period. When a change occurred, we used the most recent trend segment to project future

rates and, in conjunction with population projections, to estimate the number of future hip fractures.

It should be noted that NHDS collects data from a sample of inpatient records acquired from a national sample of hospitals, not from a patient registry. Because persons with multiple discharges during the year may be sampled more than once, estimates are for discharges, not persons. Hip fracture diagnoses are confirmed by x-ray so it is unlikely that this injury would have been incorrectly coded. However, there are no studies validating the coverage and accuracy of hip fracture data in the NHDS. In addition, because federal, military, and Department of Veterans Affairs hospitals; hospital units of institutions; and hospitals with fewer than six patient beds are excluded, these hip fracture rates may be somewhat underestimated.

We assumed that hip fracture rates will continue to decline by a constant annual percentage, but there is uncertainty in this extrapolation. The U.S. population is aging rapidly. The fastest-growing segment of the population is people aged 80 and over, and this group has the highest hip fracture rate. Over 95 % of hip fractures are caused by falling [16], usually by falling sideways onto the hip [17] from a standing height. While it is possible that current rates will level off or even increase, it is also possible that rates will decline faster due to broad implementation of fall prevention strategies and/or improved screening and treatment of osteoporosis. Osteoporosis, a metabolic disease that makes bones porous, greatly increases the chances of a hip fracture if a person falls [18]. The National Osteoporosis Foundation estimates that more than 10 million people over age 50 in the U.S.A. have osteoporosis and another 34 million are at risk for the disease [19]. However, Looker et al. has reported that bone mineral density (BMD) of the femoral neck has improved in the U.S.A., especially among older white women [20]; these changes may be due to cohort effects in diet or other health behaviors. Continuing improvements in BMD would support a corresponding decline in hip fractures.

Reducing serious fall injuries, including hip fractures, will necessitate expanding efforts by healthcare providers to improve screening and treatment for osteoporosis, to educate patients about the importance of diet and exercise for bone health, and to incorporate fall risk assessment, treatment, and referral into routine clinical practice, as recommended by the American and British Geriatrics Societies [21] and the U.S. Preventive Services Task Force [22]. It will also require widespread adoption of effective community-based fall prevention programs, such as exercise programs that emphasize balance and strength training and multifactorial fall prevention programs that include exercise, education about fall risks, medication review, vision enhancement and environmental modification [23].

## Conclusion

Although the population of older adults will continue to grow in the coming decades, it appears that much of the expected increase in the number of hip fractures may be offset by decreasing hip fracture rates among women. To bolster this trend, it is essential that we implement effective fall prevention strategies, especially among older men who will sustain a greater proportion of future hip fractures.

## Acknowledgment

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**Table 1**

Actual and projected annual numbers of hip fractures among men and women aged 65 and older, U.S.A., 2010–2030

| Year | Men | | | Women | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hip fractures | Lower PI[a] | Upper PI[a] | Hip fractures | Lower PI | Upper PI | Hip fractures | Lower PI | Upper PI | % Change per decade[b] |
| 2010 | 72 | 51 | 92 | 186 | 136 | 236 | 258 | 191 | 324 | – |
| 2020 | 89 | 59 | 124 | 175 | 131 | 234 | 264 | 191 | 358 | 2.3 % |
| 2030 | 109 | 68 | 162 | 179 | 126 | 257 | 289 | 193 | 419 | 9.4 % |
| Overall % change | 51.8 % | –15.9 % | 119.4 % | –3.5 % | –44.3 % | 37.3 % | 11.9 % | –34.3 % | 58.1 % | |

Actual and projected annual numbers are in thousands

Hip fractures: NCHS, ICD-9 820, first listed diagnosis

[a] Confidence interval for 2010, prediction interval for 2020 and 2030 (equivalent to a confidence interval around a future predicted point)

[b] Percentage change calculated using unrounded numbers