

**Fall-related traumatic brain injury deaths and hospitalizations among older adults—United States, 2005**

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Key words: Traumatic brain injury, elderly, fall

DOI: [doi:10.1016/j.jsr.2008.05.001](https://doi.org/10.1016/j.jsr.2008.05.001)

## **Abstract**

**Problem:** Among older adults, both unintentional falls and traumatic brain injuries (TBI) result in significant morbidity and mortality; however, only limited national data on fall-related TBI are available.

**Method:** To examine the relationship between older adult falls and TBI deaths and hospitalizations, CDC analyzed 2005 data from the National Center for Health Statistics' National Vital Statistics System and the Agency for Healthcare Research and Quality's Nationwide Inpatient Sample.

**Results:** In 2005, among adults  $\geq 65$  years, there were 7,946 fall-related TBI deaths and an estimated 56,423 hospitalizations for nonfatal fall-related TBI in the United States. Fall-related TBI accounted for 50.3% of unintentional fall deaths and 8.0% of nonfatal fall-related hospitalizations.

**Summary:** These findings underscore the need for greater dissemination and implementation of evidence-based fall prevention interventions.

## **Problem**

Unintentional falls are the leading cause of injury-related deaths and emergency department visits for U.S. adults aged  $\geq 65$  years (CDC, 2005). Older adults also have the highest rates of traumatic brain injury (TBI) deaths and hospitalizations (Rutland-Brown, Langlois, Thomas & Xi, 2006). CDC examined the relationship between older adult falls and TBI deaths and hospitalizations using 2005 data, the most recent year of data available, from the National Center for Health Statistics' (NCHS) National Vital Statistics System (NVSS) and the Agency for Healthcare Research and Quality's (AHRQ) Nationwide Inpatient Sample (NIS).

## **Method**

Death data were obtained from the Mortality Multiple Cause of Death File from the NCHS NVSS. The NVSS provides a complete enumeration of all deaths in the United States (NCHS, 2008). For this report, we included all deaths that occurred among U.S. residents that had an underlying cause of death listed as an unintentional fall (International Classification of Diseases, Tenth Revision [ICD-10] codes W00-W19) and that included one of the ICD-10 codes contained in CDC's TBI mortality case definition\* in any of the 20 multiple cause of death condition fields (Marr & Coronado, 2004). While NVSS is a complete census of all deaths and is not subject to sampling error, confidence intervals were calculated to account for random error (NCHS, 2008).

Hospitalization data were obtained from the Healthcare Cost and Utilization Project (HCUP) 2005 NIS, sponsored by AHRQ (AHRQ, 2007). The NIS is a stratified probability sample of hospitals from the states that submit data to HCUP (37 states in

2005), which is weighted to provide national estimates. In 2005, discharge data were reported for 1,054 hospitals, which represent approximately 20% of the hospitals in the United States. Cases were identified if one of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes E880-E886 or E888 were in any one of the four external cause-of-injury fields and if one of the ICD-9-CM codes contained in the CDC's TBI morbidity case definition<sup>†</sup> was present in 1 of the 15 diagnosis fields (Marr & Coronado, 2004). Patients who died while hospitalized were excluded. Estimates were based on weighted data for 11,554 nonfatal fall-related TBI hospitalizations. Confidence intervals were calculated using SAS PROC SURVEYMEANS to account for the sample weights and complex sample design. Rates were calculated using population estimates from the U.S. Census Bureau (2007).

## **Results**

In 2005 there were 7,946 fall-related TBI deaths among people aged  $\geq 65$  years, which accounted for 50.3% of all fall-related deaths in this age group (Table 1). Death rates for fall-related TBI were higher among men than women (26.9 per 100,000 and 21.6 per 100,000, respectively). For both men and women, death rates increased with age (Figure).

Also, there were an estimated 56,423 hospitalizations for nonfatal fall-related TBI, which accounted for 8.0% of fall-related hospitalizations (Table 1). Rates for fall-related TBI hospitalizations were similar among men and women (146.3 per 100,000 and 158.3 per 100,000, respectively). Like death rates, hospitalization rates for fall-related

TBI generally increased with age. However, the highest hospitalization rates for both sexes were among the 90-94 year old age group (Figure, Table 1).

The majority of patients were hospitalized with a fall-related nonfatal TBI for two to six days (54.9% for men, 61.5% for women; Table 2), although 10.0% of men and 6.0% of women were hospitalized for two weeks or longer. Upon discharge, 46.0% of men and 51.5% of women were transferred to another facility (e.g., skilled nursing facility, intermediate care), while 36.6% of men and 31.1% of women were discharged home. The median total charges for TBI hospitalizations were \$19,191 for men and \$16,006 for women (Table 2).

## **Discussion**

This report confirms that fall-related TBI contribute substantially to mortality and morbidity among older adults. Half of unintentional fall deaths and 8% of hospitalizations for nonfatal falls were attributable to TBI. These injuries often result in long-term cognitive, emotional, and functional impairments (Rutland-Brown et al., 2006). With the aging of the U.S. population, and without intervention, the number of these injuries will likely increase.

The numbers and rates of TBI deaths and nonfatal hospitalizations in this study were higher than those previously reported, which were based on averaged 1995-2001 data (Langlois, Rutland-Brown, & Thomas, 2006). Others have reported an increase in fall-related TBI death rates among people 80 years and older (Stevens & Adekoya, 2001) as well as an increasing trend in fall death rates among adults aged  $\geq 65$  years (CDC, 2007). The hospitalization rates in the current study were higher than those previously

reported (Langlois et al., 2006). There are several possible explanations. First, the earlier report averaged seven years of data so increases during that time period would be obscured. Second, in the 2006 study, the percentage of TBI discharges with an unknown external cause of injury was quite high (43.7%), so the number of fall-related TBI was likely underestimated. In the current study, a smaller percentage (17.1%) of these data had missing external cause of injury, so the estimates were more accurate. Finally, there is good reason to believe that fall-related TBI hospitalization rates among older adults have increased. A preliminary analysis of 1995-2004 National Hospital Discharge Survey data suggests that nonfatal TBI hospitalization rates from all causes have increased during this 10 year period (unpublished data). Additional analyses are needed to understand the observed increases in both death and hospitalization rates.

The age and gender patterns in this study were similar to patterns reported previously. The increases in fall-related TBI death and nonfatal hospitalization rates with age were similar to the results seen previously for fall-related deaths and injuries (Stevens & Sogolow, 2005) and for fall-related TBI deaths and hospitalizations (Langlois et al., 2006). It has previously been reported that both fall death rates (CDC, 2007) and TBI death rates (Langlois et al., 2006) were higher among men, and it is reasonable that the fall-related TBI deaths reported here were also higher among men. However, although fall-related hospitalization rates are higher among women (Stevens & Sogolow, 2005), TBI hospitalization rates are generally higher for men (Langlois et al., 2006). The combination of higher TBI rates among men and higher fall hospitalization rates among women likely resulted in fall-related TBI hospitalization rates that were similar for both sexes.

These findings are subject to at least two limitations. First, the number of hospitalizations was likely underestimated because 17.1% of the TBI cases were missing an external cause of injury. Since falls are a major cause of TBI in older adults (Langlois et al., 2006), it is likely that many of these cases were actually fall-related. Finally, the incidence of fall-related TBI would have been underestimated because the analysis did not include persons who were treated and discharged from emergency departments, who sought care in outpatient clinics and physician offices, and who did not seek medical care.

## **Summary**

CDC has developed three new resources to help prevent falls and TBI among older adults. Each incorporates four evidence-based fall prevention strategies--encouraging exercise, having medicines reviewed, having vision checked, and making homes safer. The first resource, *Help Seniors Live Better, Longer: Prevent Brain Injury* (CDC, 2008) is an initiative to raise awareness among children of older adults and other caregivers about ways to prevent, recognize, and respond to fall-related TBI in adults 75 years and older. The initiative features easy-to-use English- and Spanish-language materials and event and media guides for organizations interested in raising awareness ([www.cdc.gov/BrainInjuryinSeniors](http://www.cdc.gov/BrainInjuryinSeniors)). The second publication, *Preventing Falls: What Works. A Compendium of Effective Community-based Interventions from Around the World*, describes 14 randomized controlled studies of effective fall interventions. The third publication, *Preventing Falls: How to Develop Community-based Fall Prevention Programs for Older Adults*, provides guidelines for community-based organizations

interested in developing, implementing, and evaluating fall prevention programs. These two new publications and related resources (e.g., Podcasts, factsheets) are available at <http://www.cdc.gov/ncipc/PreventingFalls/>. These resources can be used by public health and aging network programs and will provide new information and tools needed to address falls and TBI among older adults. All of the materials are available online for download at no cost. For more information, visit [www.cdc.gov/injury](http://www.cdc.gov/injury).

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\*The following ICD-10 diagnosis codes were used to identify TBI-related deaths:

S01.0–S01.9, S02.0, S02.1, S02.3, S02.7–S02.9, S04.0, S06.0–S06.9, S07.0, S07.1,

S07.8, S07.9, S09.7–S09.9, T01.0, T02.0, T04.0, T06.0, T90.1, T90.2, T90.4, T90.5, T90.8, and T90.9. Although included in the case definition, T01.0, T02.0, T04.0, and T06.0 are considered invalid codes in the United States.

†TBI-related hospitalizations were identified using the following ICD-9-CM diagnosis codes: 800.0–801.9, 803.0–804.9, 850.0–854.1, 950.1–950.3, 959.01, and 995.55.

Table 1: Numbers\* and rates† of fall-related traumatic brain injury deaths and nonfatal hospitalizations among older adults, by sex and age group--United States, 2005

|              | Deaths       |             |                     | Nonfatal hospitalizations |              |                      |
|--------------|--------------|-------------|---------------------|---------------------------|--------------|----------------------|
|              | Number       | Rate        | 95% CI <sup>§</sup> | Estimate                  | Rate         | 95% CI               |
| <b>Men</b>   |              |             |                     |                           |              |                      |
| 65-69        | 381          | 8.1         | (7.3-8.9)           | 2,883                     | 61.1         | (54.2-67.9)          |
| 70-74        | 532          | 14.0        | (12.8-15.1)         | 3,521                     | 92.4         | (82.2-102.6)         |
| 75-79        | 822          | 26.3        | (24.5-28.1)         | 4,706                     | 150.8        | (137.0-164.6)        |
| 80-84        | 1,070        | 49.5        | (46.6-52.5)         | 5,170                     | 239.3        | (215.8-262.8)        |
| 85-89        | 867          | 79.6        | (74.3-84.9)         | 3,904                     | 358.5        | (322.4-394.7)        |
| 90-94        | 375          | 93.6        | (84.1-103.0)        | 1,921                     | 479.3        | (416.0-542.6)        |
| 95+          | 103          | 98.8        | (79.7-117.8)        | 438                       | 419.6        | (322.8-516.6)        |
| <b>Total</b> | <b>4,150</b> | <b>26.9</b> | <b>(26.1-27.8)</b>  | <b>22,542</b>             | <b>146.3</b> | <b>(135.0-157.6)</b> |
| <b>Women</b> |              |             |                     |                           |              |                      |
| 65-69        | 199          | 3.7         | (3.2-4.2)           | 2,454                     | 45.4         | (40.2-50.5)          |
| 70-74        | 362          | 7.7         | (6.9-8.5)           | 3,706                     | 78.8         | (71.6-85.9)          |
| 75-79        | 609          | 14.2        | (13.0-15.3)         | 6,031                     | 140.3        | (128.7-151.9)        |
| 80-84        | 902          | 25.9        | (24.2-27.6)         | 8,297                     | 238.4        | (218.3-258.4)        |
| 85-89        | 908          | 42.9        | (40.1-45.7)         | 7,422                     | 350.5        | (319.3-381.7)        |
| 90-94        | 598          | 59.4        | (54.6-64.1)         | 4,502                     | 446.9        | (409.4-484.4)        |
| 95+          | 218          | 60.8        | (52.7-68.9)         | 1,430                     | 398.8        | (343.7-454.0)        |
| <b>Total</b> | <b>3,796</b> | <b>17.8</b> | <b>(17.2-18.3)</b>  | <b>33,842</b>             | <b>158.3</b> | <b>(147.6-169.0)</b> |
| <b>TOTAL</b> | <b>7,946</b> | <b>21.6</b> | <b>(21.1-22.1)</b>  | <b>56,423</b>             | <b>153.4</b> | <b>(142.9-163.8)</b> |

\*Numbers might not sum to totals because of rounding.

†Per 100,000 population.

§Confidence interval.

**Figure: Fall-related traumatic brain injury deaths and nonfatal hospitalizations among older adults, by age and sex--United States, 2005**

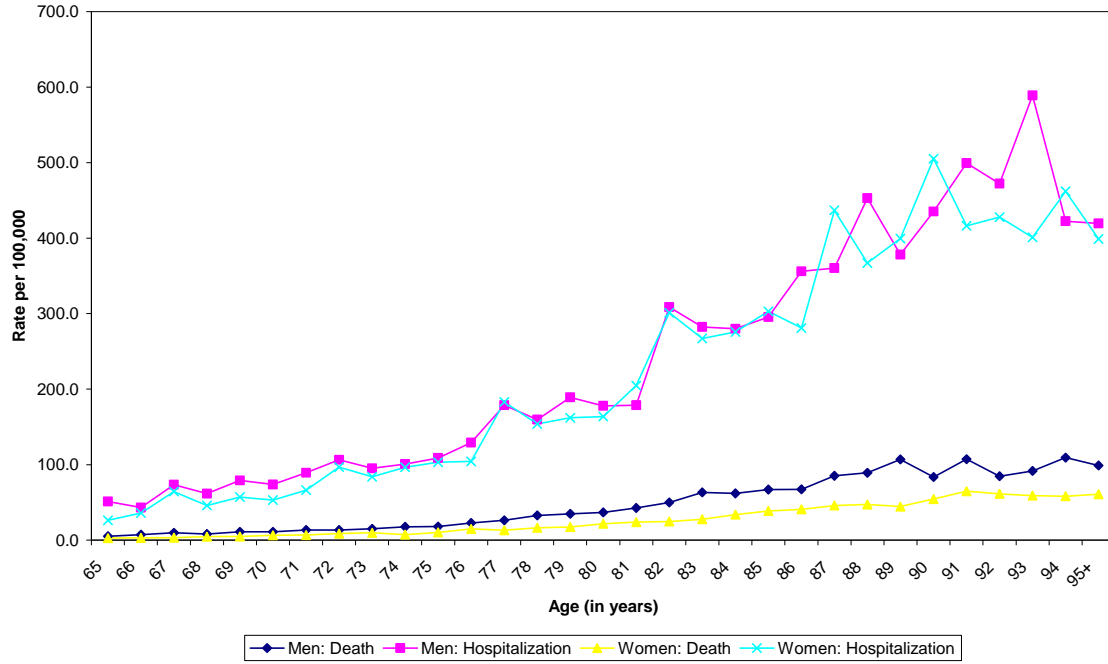


Table 2: Estimates\* of fall-related nonfatal traumatic brain injury hospitalizations among older adults, by sex and selected characteristics--United States, 2005

|                            | Men              |                     |       | Women            |                 |       |
|----------------------------|------------------|---------------------|-------|------------------|-----------------|-------|
|                            | Estimate         | 95% CI <sup>†</sup> | %     | Estimate         | 95% CI          | %     |
| Length of stay             |                  |                     |       |                  |                 |       |
| 0-1 days                   | 2,853            | (2,551-3,154)       | 12.7  | 4,007            | (3,602-4,413)   | 11.8  |
| 2-3 days                   | 6,001            | (5,452-6,551)       | 26.6  | 10,372           | (9,575-11,169)  | 30.6  |
| 4-6 days                   | 6,370            | (5,783-6,956)       | 28.3  | 10,457           | (9,624-11,290)  | 30.9  |
| 7-13 days                  | 5,067            | (4,596-5,538)       | 22.5  | 6,980            | (6,371-7,589)   | 20.6  |
| 14+ days                   | 2,245            | (1,938-2,552)       | 10.0  | 2,025            | (1,763-2,288)   | 6.0   |
| Unknown                    | 7 <sup>¶</sup>   | (0-20)              | 0.0   | 0 <sup>¶</sup>   | ---             | 0.0   |
| Discharge disposition      |                  |                     |       |                  |                 |       |
| Routine                    | 8,252            | (7,517-8,987)       | 36.6  | 10,530           | (9,719-11,341)  | 31.1  |
| Transfer to short stay     | 921              | (759-1,084)         | 4.1   | 860              | (705-1,015)     | 2.5   |
| Transfer other facility    | 10,363           | (9,430-11,297)      | 46.0  | 17,432           | (16,057-18,807) | 51.5  |
| Home health                | 2,788            | (2,464-3,112)       | 12.4  | 4,866            | (4,392-5,339)   | 14.4  |
| Other/unknown <sup>§</sup> | 218              | (148-288)           | 1.0   | 154              | (97-212)        | 0.5   |
| Total charges              |                  |                     |       |                  |                 |       |
| \$0-\$9,999                | 5,620            | (4,994-6,245)       | 24.9  | 9,992            | (8,990-10,993)  | 29.5  |
| \$10,000-\$19,999          | 5,838            | (5,275-6,400)       | 25.9  | 9,779            | (8,918-10,641)  | 28.9  |
| \$20,000-\$29,999          | 3,143            | (2,793-3,494)       | 13.9  | 4,916            | (4,473-5,360)   | 14.5  |
| \$30,000-\$49,999          | 3,343            | (2,930-3,756)       | 14.8  | 4,568            | (4,068-5,067)   | 13.5  |
| \$50,000 +                 | 4,212            | (3,567-4,856)       | 18.7  | 4,148            | (3,498-4,798)   | 12.3  |
| Unknown                    | 386 <sup>¶</sup> | (0-786)             | 1.7   | 439 <sup>¶</sup> | (41-836)        | 1.3   |
| TOTAL                      | 22,542           | (20,804-24,280)     | 100.0 | 33,841           | (31,550-36,133) | 100.0 |

\*Numbers might not sum to totals because of rounding.

<sup>†</sup>Confidence interval.

<sup>§</sup>Includes those discharged against medical advice.

<sup>¶</sup>Estimate may be unstable because the coefficient of variation >30%.