Declining hip fracture rates in the United States

SIR—Unintentional falls are a common occurrence among older adults, affecting ~30% of persons aged 65 years and older annually [1]. One of the most serious fall outcomes is hip fracture, an injury that often results in long-term functional impairment, nursing home admission and increased mortality [2]. More than 90% of hip fractures are caused by falls [3], usually by falling onto the hip [4]. In 2006 there were ~293,000 hospital admissions for hip fracture [5]. Osteoporosis, a metabolic disease characterised by low bone mineral density (BMD) and bone structure deterioration, greatly increases the chances that a person who falls will sustain a hip fracture [6]. The National Osteoporosis Foundation estimates that more than 10 million people over age 50 in the United States have osteoporosis and another 34 million have low BMD and are at risk for the disease [7].

Extending an earlier and less comprehensive analysis [8], this study used hospital discharge data to analyse the national trends in hip fracture rates from 1990 to 2006 for people aged 65 years and older by both sex and 10-year age groups.

Methods

This study used data from the National Hospital Discharge Survey (NHDS) [5], a national probability survey of inpatient discharges from nonfederal, short-stay hospitals in the United States. Conducted by the National Center for Health Statistics (NCHS), the NHDS collects data annually from a sample of ~270,000 inpatient records obtained from a national sample of ~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. Federal, military and Department of Veterans Affairs hospitals, as well as hospital units of institutions (such as prison hospitals), and hospitals with fewer than six beds staffed for patient use, are excluded.

Because of the complex multistage design of the NHDS, the survey data is weighted in order 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 [9].

Hip fracture hospitalisations were defined as cases with a first-listed diagnosis coded 820, according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) [10]. The estimated number of hip fractures for men and women aged 65 and older, rates per 10,000 (age-adjusted to the 2000 US population) and standard errors were derived by the NCHS using SUDAAN, which takes into account the complex sampling design. These data are available at www.cdc.gov/nchs/hdi.htm. Trend analyses were conducted with Joinpoint software. The Joinpoint regression programme 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 hospitalisation rates as well as the standard error of the estimated rates. The tests of significance used a Monte Carlo permutation method. A P-value ≤0.05 was considered statistically significant.

Results

Age-adjusted hip fracture rates for both men and women declined significantly from 1990 to 2006 (Table 1). (Please see Table 2 with rates and standard errors in Ap-

Table 1. Age-adjusted[a] and age-specific hip fracture[b] rates[c] for men and women aged 65 years and older—United States, 1990–2006

	Year																
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Men																	
65+	54.6	59.6	58.6	54.9	56.8	56.4	55.7	60.5	64.3	50.2	52.8	51.1	50.7	55.6	52.8	47.1	48.8[d]
65–74	15.3	17.8	14.9	16.6	17.7	18.2	14.0	13.2	21.4	16.4	20.0	20.1	16.2	14.6	16.7	16.8	13.6
75–84	53.7	66.1	67.5	58.8	62.4	66.5	65.5	76.2	63.9	53.1	68.6	53.1	52.7	76.0	58.8	54.0	58.5
85+	224.4	218.6	218.9	206.8	207.6	190.0	205.3	216.6	248.1	185.6	146.5	177.0	191.7	170.8	189.6	156.5	170.7[d]
Women																	
65+	108.4	109.4	99.0	114.4	107.0	106.0	125.1	109.8	102.6	106.3	98.9	99.1	93.9	85.7	92.0	82.9	91.7[d]
65–74	35.7	28.8	34.3	35.8	33.8	28.5	47.7	30.8	35.3	30.7	31.7	34.1	32.5	28.3	34.1	29.6	28.2
75–84	152.4	143.3	126.3	146.5	136.8	138.7	151.9	144.1	119.8	121.0	118.8	113.4	109.2	104.6	109.6	101.2	125.0[d]
85+	291.0	352.0	295.7	356.5	332.6	341.4	377.0	346.7	339.4	385.3	327.9	334.0	310.8	275.2	287.9	256.7	266.0[d]

[a]Age adjusted by 10-year age groups to the 2000 US population.
[b]First listed diagnosis = ICD-9 CM 820.
[c]Rates per 10,000 population.
[d]Test for trend, $P < 0.05$.

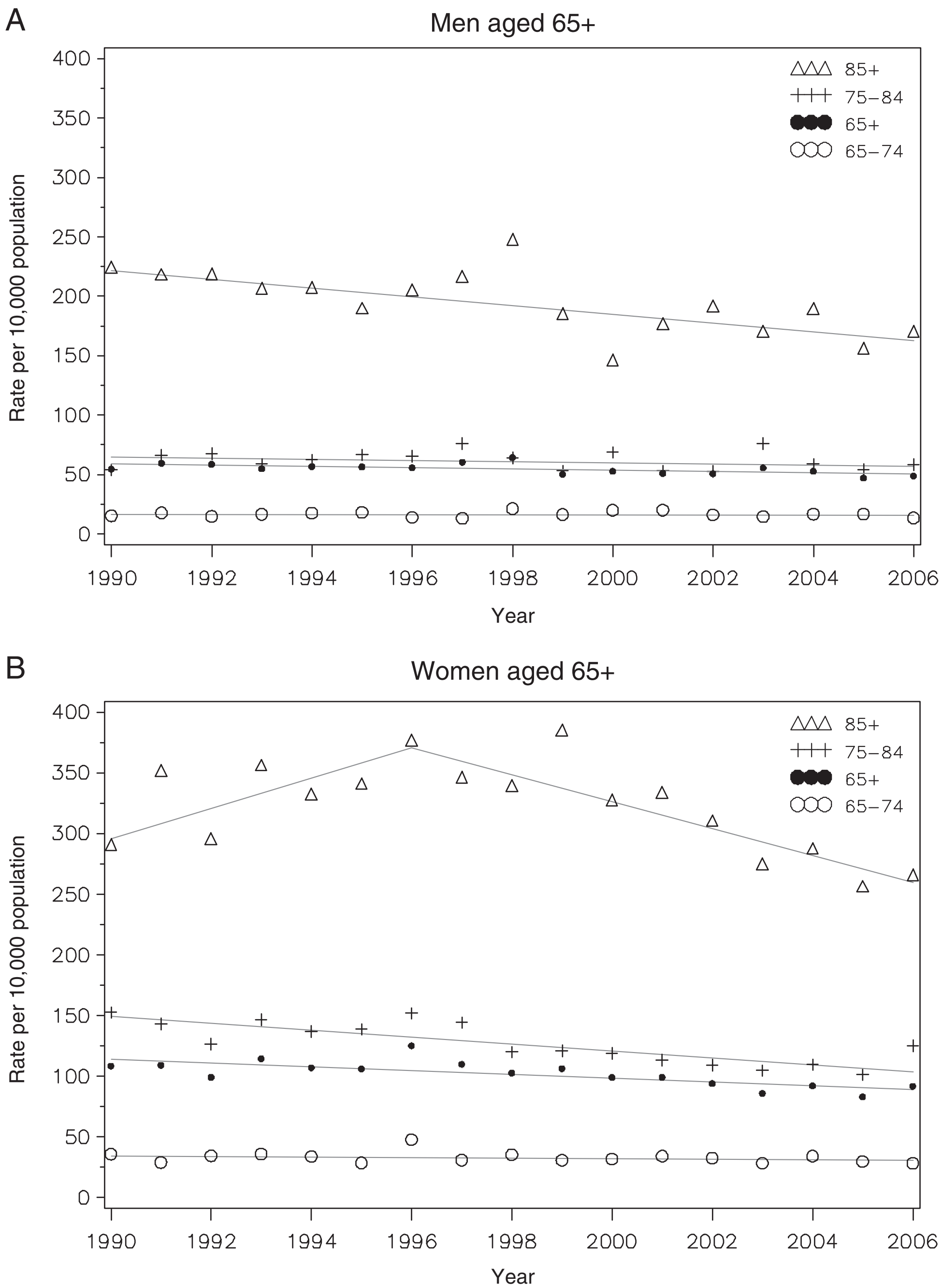

Figure 1. Trends in age-adjusted hip fracture rates for men and women aged 65 years and older—United States, 1990–2006.

pendix 1 in the Supplementary data available in *Age and Ageing* online.) Men's rates fell from 54.6 per 10,000 population in 1990 to 48.8 per 10,000 in 2006 (test for trend, $P=0.007$) (Figure 1). However, this trend was only significant among men aged 85 and older (test for trend, $P=0.005$). Rates for women fell from 108.4 per 10,000 in 1990 to 91.7 per 10,000 in 2006 (test for trend, $P<0.001$). Examination by 10-year age groups found that the decline was significant only among women aged 75–84 (test for trend, $P<0.001$) and aged 85 and older (test for trend, $P=0.001$). For women in the oldest age group, rates peaked in 1997 and declined thereafter.

Discussion

This study found that the age-adjusted hip fracture hospitalisation rates for both men and women in the United States declined significantly from 1990 to 2006. These findings are consistent with our earlier study [8]. Similar trends have been observed in other countries. Kannus *et al.* [11] reported that national age-adjusted hip fracture rates in Finland for people aged 50 and older peaked in 1997 and declined 20% for women and 6% for men from 1997 to 2004. We found a similar pattern but only among women aged 85 and older. Smaller studies in Sweden [12], Norway [13], Denmark [14] and Canada [15] have also reported declines in hip fracture rates.

We considered a number of possible explanations. Although BMD screening and osteoporosis treatment can reduce hip fractures [16, 17], low screening rates among Medicare beneficiaries [18] and patients' underuse of bisphosphonates [19, 20] suggest that other factors are contributing to the declining hip fracture rates. Improvements in functional abilities among older adults [21] could be helping to reduce falls and subsequent hip fractures. Although exercise that improves balance and lower body strength is effective in reducing falls [22, 23], such exercise programmes are not readily available in the United States. Other possible explanations include a cohort effect of a healthier ageing population, improved nutrition, decreased use of psychoactive drugs to decrease fall risk and the protective effect of increased average body weight and body mass index [24]. Finally, it is likely that some of the observed decrease is due to unknown protective factors. Additional research is needed to identify factors contributing to declining hip fracture rates, both in the United States and in other countries, in order to maintain this trend.

The pattern of hip fracture rates among women aged 85 and older deserves comment. Peak bone mass is achieved during young adulthood [25]. The women who sustained hip fractures from 1990 to 1996 were young adults in the 1930s, when food shortages and poor nutrition would have resulted in lower peak bone mass and greater susceptibility to hip fracture later in life. Improved nutrition among subsequent cohorts may account for the decrease in hip fracture rates after 1997.

A limitation of this study is 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.

The US population is ageing rapidly. There are now 35 million people aged 65 and older and by 2030 this number will exceed 71 million. People over age 85 are the fastest growing segment of the older population and have the highest hip fracture rate. Over time, the absolute number of hip fractures will increase. Primary and secondary prevention efforts remain important strategies for reducing falls and resulting hip fractures. For high-risk older men and women, hip fracture prevention involves increased osteoporosis screening and treatment. For the general older adult population, prevention must include education about osteoporosis risk factors, the value of adequate dietary intake of calcium and vitamin D and the importance of weight bearing exercise; access to accessible and affordable BMD screening programmes; and dissemination and implementation of effective community-based fall prevention programmes [23].

Key points

- Age-adjusted hip fracture hospitalisation rates in the United States declined significantly from 1990 to 2006.
- Possible factors include improvements in functional abilities, decreased use of psychoactive drugs and increased body weight.
- Additional research is needed to identify contributing factors in order to maintain this trend.
- Primary and secondary prevention efforts remain important strategies for reducing falls and resulting hip fractures.

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Conflicts of interest

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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References

1. Hausdorff JM, Rios DA, Edelberg HK. Gait variability and fall risk in community-living older adults: a 1-year prospective study. Arch Phys Med Rehabil 2001; 82: 1050–6.

2. Stevens JA. Falls among older adults—risk factors and prevention strategies. In: Falls Free: Promoting a National Falls Prevention Action Plan: Research Review Papers. NCOA Center for Healthy Aging 2005; 3–18.
3. Nyberg L, Gustafson Y, Berggren D, Brännström B, Bucht G. Falls leading to femoral neck fractures in lucid older people. J Am Geriatr Soc 1996; 44: 156–60.
4. Hayes WC, Myers ER, Morris JN, Gerhart TN, Yett HS, Lipsitz LA. Impact near the hip dominates fracture risk in elderly nursing home residents who fall. Calcif Tissue Int 1993; 52: 192–8.
5. National Hospital Discharge Survey (NHDS). National Center for Health Statistics. Available at www.cdc.gov/nchs/hdi.htm (2 February 2009, date last accessed).
6. Greenspan SL, Myers ER, Maitland LA *et al.* Trochanteric bone mineral density is associated with type of hip fracture in the elderly. J Bone Miner Res 1994; 9: 1889–94.
7. National Osteoporosis Foundation (NOF). Clinician's Guide to Prevention and Treatment of Osteoporosis. Available at www.nof.org/professionals/NOF_Clinicians_Guide.pdf (6 May 2010, date last accessed).
8. Stevens JA, Ryan G, Kresnow M. Fatalities and injuries from falls among older adults—United States, 1993–2003 and 2001–2005. MMWR 2006; 55: 1222–4.
9. Dennison CF, Pokras R. Design and Operation of the National Hospital Discharge Survey: 1988 Redesign. Vital and Health Stat 1(39). 2000. Available at www.cdc.gov/nchs/data/series/sr_01/sr01_039.pdf (25 March 2010, date last accessed).
10. The International Classification of Diseases. 9th revision, Clinical Modification: ICD-9-CM. (2003). Available at www.cdc.gov/nchs/icd/icd9cm.htm (5 May 2010, date last accessed).
11. Kannus P, Niemi S, Parkkari J, Palvanen M, Vuori I, Järvinen M. Nationwide decline in incidence of hip fracture. J Bone Miner Res 2006; 21: 1836–8.
12. Rogmark C, Sernbo I, Johnell O, Nilsson J-Å. Incidence of hip fractures in Malmo, Sweden, 1992–1995. Acta Orthop Scand 1999; 70: 19–22.
13. Lofthus CM, Osnes EK, Falch JA *et al.* Epidemiology of hip fractures in Oslo, Norway. Bone 2001; 29: 413–8.
14. Nymark T, Lauritsen JM, Ovesen O, Röck ND, Jeune B. Decreasing incidence of hip fracture in the Funen County, Denmark. Acta Orthop Scand 2006; 77: 109–13.
15. Jaglal SB, Weller I, Mamdani M *et al.* Population trends in BMD testing, treatment, and hip and wrist fracture rates: are the hip fracture projections wrong? J Bone Miner Res 2005; 20: 898–905.
16. Kern LM, Powe NR, Levine MA *et al.* Association between screening for osteoporosis and the incidence of hip fracture. Ann Intern Med 2005; 142: 173–81.
17. Álvarez MJM, Díaz-Curiel M. Pharmacological treatment of osteoporosis for people over 70. Aging Clin Exp Res 2007; 19: 246–54.
18. Curtis JR, Carbone L, Cheng H *et al.* Longitudinal trends in use of bone mass measurement among older Americans, 1999–2005. J Bone Miner Res 2008; 23: 1061–7.
19. Siris ES, Harris ST, Rose CJ *et al.* Adherence to bisphosphonate therapy and fracture rates in osteoporotic women: relationship to vertebral and nonvertebral fractures from 2 US claims databases. Mayo Clin Proc 2006; 81: 1013–22.
20. Tosteson ANA, Grove MR, Hammond CS *et al.* Early discontinuation of treatment for osteoporosis. Am J Med 2003; 115: 209–16.
21. Freedman VA, Martin LG, Schoeni RF. Recent trends in disability and functioning among older adults in the United States: a systematic review. JAMA 2002; 288: 3137–46.
22. Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JCT. Effective exercise for the prevention of falls: a systematic review and meta-analysis. J Am Geriatr Soc 2008; 56: 2234–43.
23. Stevens JA, Sogolow ED. Preventing Falls: What Works. A CDC Compendium of Effective Community-Based Interventions from Around the World. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Available at www.cdc.gov/HomeandRecreationalSafety/Falls/preventfalls.html#Compendium 2008 (1 February 2010, date last accessed).
24. Ford ES, Mokdad AH, Giles WH. Trends in waist circumference among U.S. adults. Obesity Res 2003; 11: 1223–31.
25. Sandler RB, Slemenda CW, LaPorte RE *et al.* Postmenopausal bone density and milk consumption in childhood and adolescence. Am J Clin Nutr 1985; 42: 270–4.

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Associations between drug burden index and physical function in older people in residential aged care facilities

SIR–The functional decline seen in older people results in a need for increased support from carers, health care services and residential aged care facilities (RACFs) [1]. Impaired physical function in older people predicts nursing home placement and death [2]. While advances in medical management have aided in managing many diseases, certain classes of medications have adverse effects on physical function in older adults [3–5]. Expert consensus panels have compiled criteria for drugs that are potentially inappropriate for older people [5–8]. Anticholinergic and sedative drugs occur frequently in these criteria; however, the effects of cumulative exposure are not addressed.

Studies of community-dwelling older people have found associations between increasing anticholinergic [4, 9] and sedative [9] exposure and poor physical function measures. Research conducted in RACFs has shown associations between polypharmacy, adverse drug reactions and inappropriate drug use but not functional decline [10–12].

The drug burden index (DBI) is a measure of an individual's total exposure to anticholinergic and sedative drugs, using the principles of dose–response and maximal effect. Increasing DBI is associated with impairments in measures of physical and cognitive function in community-dwelling older people, cross-sectionally in American [3] and Australian [13] populations and longitudinally in the USA [14]. This relationship has not been examined in older people living in RACFs who are frequently excluded from epidemiological studies [11]. We hypothesised that increasing