

FALLS in older people

Risk factors and strategies for prevention

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Epidemiology of falls and fall-related injuries

In this chapter, we examine the epidemiology of falls in older people. We review the major studies that have described the incidence of falls, the locations where falls occur and falls sequelae. We also examine the costs and services required to treat and manage falls injuries. Before looking at the above, however, it is helpful to discuss briefly two important methodological considerations that are pertinent to all research studies of falls in older people. First, how falls are defined, and second, how falls are counted.

The definition of a fall

In 1987 the Kellogg International Working Group on the prevention of falls in the elderly defined a fall as ‘unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure’ [1]. Since then, many researchers have used this or very similar definitions of a fall. Depending on the focus of study, however, some researchers have used a broader definition of falls to include those that occur as a result of dizziness and syncope. The Kellogg definition is appropriate for studies aimed at identifying factors that impair sensorimotor function and balance control, whereas the broader definition is appropriate for studies that also address cardiovascular causes of falls such as postural hypotension and transient ischaemic attacks.

Although falls are often referred to as accidents, it has been shown statistically that falls incidence differs significantly from a Poisson distribution [2]. This implies that causal processes are involved in falls and that they are not merely random events.

Falls ascertainment

The earliest published studies on falls were retrospective in design in that they asked subjects whether and/or how many times they fell in a past period – usually 12

months. This approach has limitations because subjects have only limited accuracy in remembering falls over such a long period [3]. More recent studies have used prospective designs, in which subjects are followed up for a period, again usually 12 months, to determine more accurately the incidence of falling. Not surprisingly, these studies have usually reported higher rates of falling. In community studies, the only feasible method of ascertaining falls is by self-report and a number of methods have been used to record falls in prospective follow-up periods. These include monthly or bi-monthly mail-out questionnaires [4, 5], weekly [6] or monthly falls calendars [7], and monthly telephone interviews [8].

Each method has advantages and disadvantages in terms of accuracy, cost and researcher time commitment. Calendars have an advantage in that subjects are requested to indicate daily whether or not they have fallen. However, specific details about the circumstances of any falls cannot be ascertained until the diary is returned at the end of the month. Monthly questionnaires have an advantage in that all relevant details can be gained from a single form. A sample of a monthly questionnaire is shown in Figure 1.1. Telephone interviews gain the same information as mail-out questionnaires, but may require many calls to contact active older people. However, even with the most rigorous reporting methodology, it is quite likely that falls are underreported and that circumstances surrounding falls are sometimes incomplete or inaccurate. After a fall, older people are often shocked and distressed and may not remember the predisposing factors that led to the fall. Denial is also a factor in underreporting, as it is common for older people to lay the blame on external factors for their fall, and not count it as a 'true' one. Simply forgetting falls leads to further underreporting, especially in those with cognitive impairments.

In institutional settings, the use of falls record books maintained by nursing staff can provide an ancillary method for improving the accuracy of recording falls. In a study of intermediate care (hostel) residents in Sydney, we found that systematic recording of falls by nurses increased the number of falls reported by 32% [4].

The incidence of falls in older people

Community-dwellers

In 1977, Exton-Smith examined the incidence of falls in 963 people over the age of 65 years. He found that in women, the proportion who fell increased with age from about 30% in the 65–69 year age group to over 50% in those over the age of 85 years. In men, the proportion who fell increased from 13% in the 65–69 year age group to levels of approximately 30% in those aged 80 years and over [9].

Retrospective community studies undertaken since Exton-Smith's work have reported similar findings: that about 30% of older persons experience one or more

FALLS STUDY OCTOBER FOLLOW-UP

1. HAVE YOU HAD ANY FALLS IN THE MONTH OF OCTOBER?

I have not fallen

Once

Twice

Three or more times

If you have had no falls please stop here, otherwise please continue

2. WHERE HAVE YOU FALLEN?

Inside:

On the one level	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Getting out of bed	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Getting out of a chair	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Using the shower/bath	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Using the toilet	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Walking up or down stairs	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Home entrances or in the garden:

Walking up or down a step/stairs		
On the one level (e.g. pathway)	Yes <input type="checkbox"/>	No <input type="checkbox"/>
In the garden	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Away from home:

On the footpath	Yes <input type="checkbox"/>	No <input type="checkbox"/>
On a kerb / gutter	Yes <input type="checkbox"/>	No <input type="checkbox"/>
In a public building	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Getting out of a vehicle	Yes <input type="checkbox"/>	No <input type="checkbox"/>
In another person's home	Yes <input type="checkbox"/>	No <input type="checkbox"/>

Falls not described above (Please specify)

3. HOW DID YOU FALL?
(Tick more than one if necessary)

I tripped

I slipped

I lost my balance

My legs gave way

I felt faint

I felt giddy / dizzy

I am not sure

4. AS A RESULT OF THIS FALL OR FALLS DID YOU SUFFER ANY INJURIES?

Yes No

5. IF YES WHAT TYPE OF INJURIES DID YOU SUFFER?

Bruises

Cuts/grazes

Broken wrist

Broken hip

Broken ribs

Back pain

Thank you very much for your co-operation. Please return the questionnaire to us by using the enclosed envelope

Fig. 1.1. Example of a monthly falls questionnaire.

falls per year [10–12]. For example, Campbell et al. [10] analysed a stratified population sample of 533 subjects aged 65 years and over and found that 33% experienced one or more falls in the past year. Blake et al. [12] reported a similar incidence (35%) in their study of 1042 subjects aged 65 years and over. In a large study of 2793 subjects aged 65 years and over, Prudham and Evans [11] estimated an annual incidence for accidental falls of 28%, a figure identical to that found in the Dubbo osteoporosis epidemiology study of 1762 older people aged 60 years and over [13].

More recent prospective studies undertaken in community settings have found slightly higher falls incidence rates. In the Randwick falls and fractures study conducted in Australia, we found that 39% of 341 community-dwelling women reported one or more falls in a 1-year follow-up period [14]. In a large study of 761 subjects aged 70 years and over undertaken in New Zealand, Campbell et al. [15] found that 40% of 465 women and 28% of 296 men fell at least once in the study period of 1 year, an overall incidence rate of 35%.

In the USA, Tinetti et al. [7] found an incidence rate of one or more falls of 32% in 336 subjects aged 75 years and over. Similar rates have been reported in Canada by O’Loughlin et al. [8] in a 48-week prospective study of a random sample of 409 community-dwelling people aged 65+ years (29%), and in Finland by Luukinen et al. [16] in 833 community-dwelling people aged 70+ years from five rural districts (30%). Falling rates also increase beyond the age of 65 years. Figure 1.2 shows the proportion of women who took part in the Randwick falls and fractures study [14] who reported falling, once, twice, or three or more times in a 12-month period.

The prospective studies that have reported the incidence of multiple or recurrent falls are also in good agreement. The reported rates from five studies for two or more falls in follow-up year average 15% and range from 11% to 21%. The three studies that report data for three or more falls all report an incidence of 8%.

Residents of long-term care institutions

Studies on the prevalence of falls have also been conducted in institutions, where the reported frequency of falling is considerably higher than among those living in their own homes. For example, Luukinen et al. [17] estimate that among people aged 70 and over in Finland, the rate of falling in the institutionalized population is three times higher than that among those living independently in the community.

The prospective studies conducted in nursing homes have found 12-month falls incidence rates ranging from 30% to 56%. In an early study, Fernie et al. [18] studied 205 nursing home residents for 12 months and found 30% of the men and 42% of the women had one or more falls. More recently, two studies have reported higher falls incidence rates in institutionalized older people. Lipsitz et al. [19] found

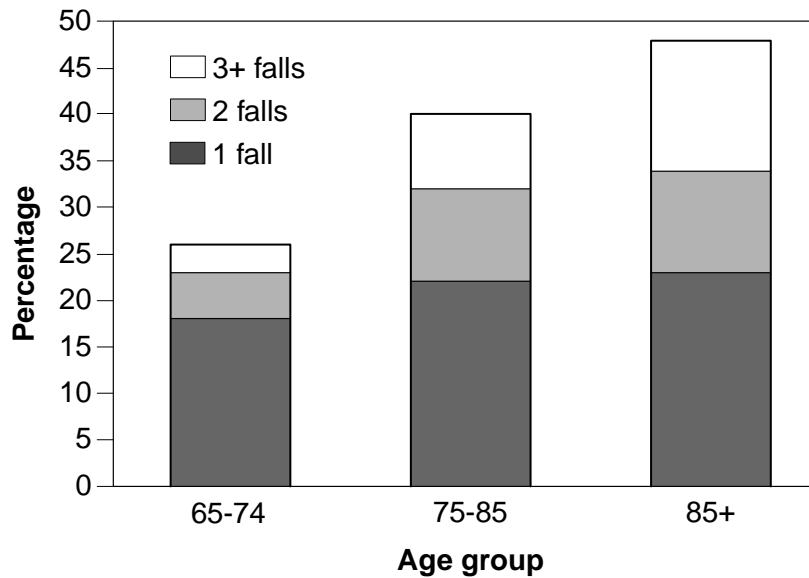


Fig. 1.2. Proportion of older women who took part in the Randwick Falls and Fractures Study who reported falling, once, twice or three or more times in a 12-month period. Diagram adapted from: Lord SR, Ward JA, Williams P, Anstey KJ. An epidemiological study of falls in older community-dwelling women: the Randwick falls and fractures study. *Australian Journal of Public Health* 1993;17(3):240–5.

that 40% of 901 ambulatory nursing home residents fell two or more times in 6 months and Yip and Cumming [20] found that 56% of 126 nursing home residents fell at least once in a year.

Two other studies have calculated falls incidence rates across a number of nursing homes. Rubenstein et al. [21] summarized the findings from five published and two unpublished studies on the incidence of falls in long-term care institutions. They calculated that the incidence rate ranged between 60% to 290% per bed, with a mean fall incidence rate of 170% or 1.7 falls per person per year. Thapa et al. [22] conducted a 12-month prospective study in 12 nursing homes involving 1228 residents. They reported that during the 1003 person-years of follow-up, 548 residents suffered 1585 falls.

Falling rates are also high in residents living in intermediate (hostel) care institutions and retirement villages. We found a yearly falls incidence rate for one or more falls of 52%, and for two or more falls of 39% in a hostel population of older people [4]. Tinetti et al. [23] also found a high incidence of falling in 79 persons admitted consecutively to intermediate care facilities: 32% fell two or more times in a 3-month period. In the one study that has been conducted in a retirement village to date, Liu et al. [24] found that 61% of 96 subjects fell over a 12-month period.

Particular groups

Older people who have suffered a fall are at increased risk of falling again. In a prospective study of 325 community-dwelling persons who had fallen in the previous year, Nevitt et al. [6] found that 57% experienced at least one fall in a 12-month follow-up period and 31% had two or more falls. Not surprisingly, falling is also more prevalent in frailer older people than vigorous ones, in those who have difficulties undertaking activities of daily living, and in those with particular medical conditions that affect posture, balance and gait. Northridge et al. [25] reported that when community-dwelling persons were classified as either frail or vigorous, frailer people were more than twice as likely to fall as vigorous people. Similarly, Speechley and Tinetti [26] reported 52% of a frail group fell in a 1-year prospective period compared with only 17% of a vigorous group.

With regard to medical conditions, Mahoney et al. [27] found that 14% of older patients fell in the first month after discharge from hospital following a medical illness. Falling rates are also increased in those with stroke and Parkinson's disease. Forster and Young [28] found that 73% of elderly stroke patients fell within 6 months after hospital discharge. Koller et al. [29] and Paulson et al. [30] report falling yearly incidence rates of 38% and 53% respectively in elderly people with idiopathic Parkinson's disease. Kroller et al. [29] also noted that very frequent falling was a problem in this group, with 13% reporting falling more than once a week. Falls incidence is also high in older people following lower limb amputation. Kulkarni [31] found that 58% of people with a unilateral amputation had at least one fall within a 12-month period before their survey.

Increased falls incidence is also evident in persons with cognitive impairments and other neurological conditions, arthritis and diabetes, although few studies have reported specific falls incidence rates in these groups. In one study that examined falls incidence in persons with Alzheimer's disease, only 17% were reported to fall within a prospective period of 3 years [32]. This would appear to be an underestimate, as cognitive impairment has been found to be an independent risk factor for falling in many subsequent prospective studies (see Chapter 4).

Falls location

In independent older community-dwelling people, about 50% of falls occur within their homes and immediate home surroundings (Figure 1.3) [16, 33]. Most falls occur on level surfaces within commonly used rooms such as the bedroom, living-room and kitchen. Comparatively few falls occur in the bathroom, on stairs or from ladders and stools. While a proportion of falls involve a hazard such as a loose rug or a slippery floor, many do not involve obvious environmental hazards [33]. The remaining falls occur in public places and other people's homes. Commonly

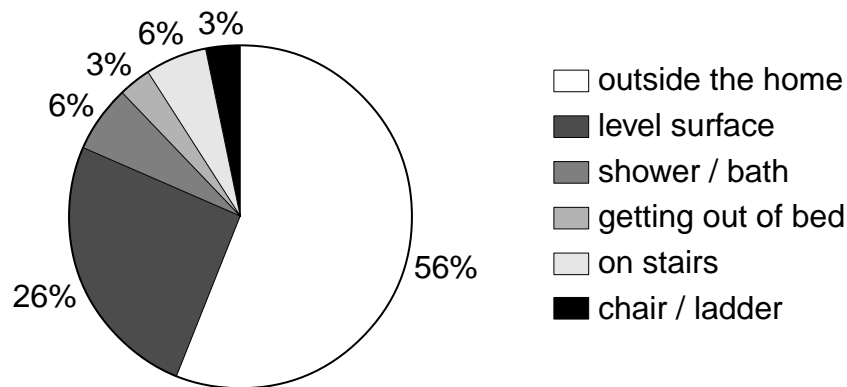


Fig. 1.3. Location of falls. 56% of falls occur outside the home (in the garden, street, footpath or shops), with the remainder (44%) occurring at various locations in the home. Adapted from: Lord SR, Ward JA, Williams P, Anstey KJ. Physiological factors associated with falls in older community-dwelling women. *Australian Journal of Public Health* 1993;17(3):240-5.

reported environmental factors involved in falls in public places include pavement cracks and misalignments, gutters, steps, construction works, uneven ground and slippery surfaces.

The location of falls is related to age, sex and frailty. In community-dwelling older women, we found that the number of falls occurring outside the home decreased with age, with a corresponding increase in the number of falls occurring inside the home on a level surface (Figure 1.4) [14]. Campbell et al. [33] found that fewer men than women fell inside the home (44% versus 65%) and more men fell in the garden (25% versus 11%). Also as would be expected, frailer groups with limited mobility suffer most falls within the home. These findings indicate that the occurrence of falls is strongly related to exposure, that is, they occur in situations where older people are undertaking their usual daily activities. Furthermore, most falls occur during periods of maximum activity in the morning or afternoon, and only about 20% occur between 9 p.m. and 7 a.m. [33].

Consequences of falls

Falls are the leading cause of injury-related hospitalization in persons aged 65 years and over, and account for 4% of all hospital admissions in this age group [34]. In Australia we found that hospital admissions resulting from falls are uncommon in young adulthood but with advancing age, the incidence of fall-related admissions increases at an exponential rate. Beyond 40 years, the admission rate due to falls increases consistently by 4.5% per year for men (doubling every 15.7 years) and by 7.9% per year for women (doubling every 9.1 years) [35] (Figure 1.5). In those aged

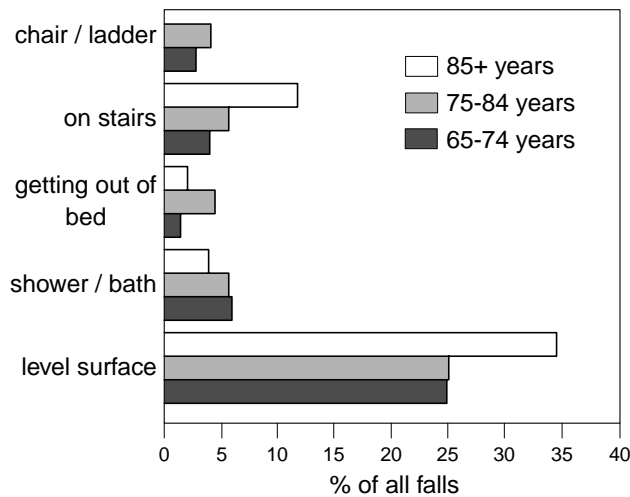


Fig. 1.4. Indoor falls location according to age. Adapted from: Lord SR, Ward JA, Williams P, Anstey KJ. An epidemiological study of falls in older community-dwelling women: the Randwick falls and fractures study. *Australian Journal of Public Health* 1993;17(3):240–5.

85 years and over, the levels have reached 4% per annum in men and 7% per annum in women. Falls also account for 40% of injury-related deaths, and 1% of total deaths in this age group [36].

Depending on the population under study, between 22% and 60% of older people suffer injuries from falls, 10–15% suffer serious injuries, 2–6% suffer fractures and 0.2–1.5% suffer hip fractures. The most commonly self-reported injuries include superficial cuts and abrasions, bruises and sprains. The most common injuries that require hospitalization comprise femoral neck fractures, other fractures of the leg, fractures of radius, ulna and other bones in the arm and fractures of the neck and trunk [1, 26, 35].

In terms of morbidity and mortality, the most serious of these fall-related injuries is fracture of the hip. Elderly people recover slowly from hip fractures and are vulnerable to postoperative complications. In many cases, hip fractures result in death and of those who survive, many never regain complete mobility. Marottoli et al. [37] analysed the outcomes of 120 patients from a cohort study who suffered a hip fracture over a 6-year period. They found that before their fractures, 86% could dress independently, 75% could walk independently and 63% could climb a flight of stairs. Six months after their injuries, these percentages had fallen to 49%, 15% and 8%, respectively.

Another consequence of falling is the ‘long lie’, i.e. remaining on the ground or floor for more than an hour after a fall. The long lie is a marker of weakness, illness and social isolation and is associated with high mortality rates among the

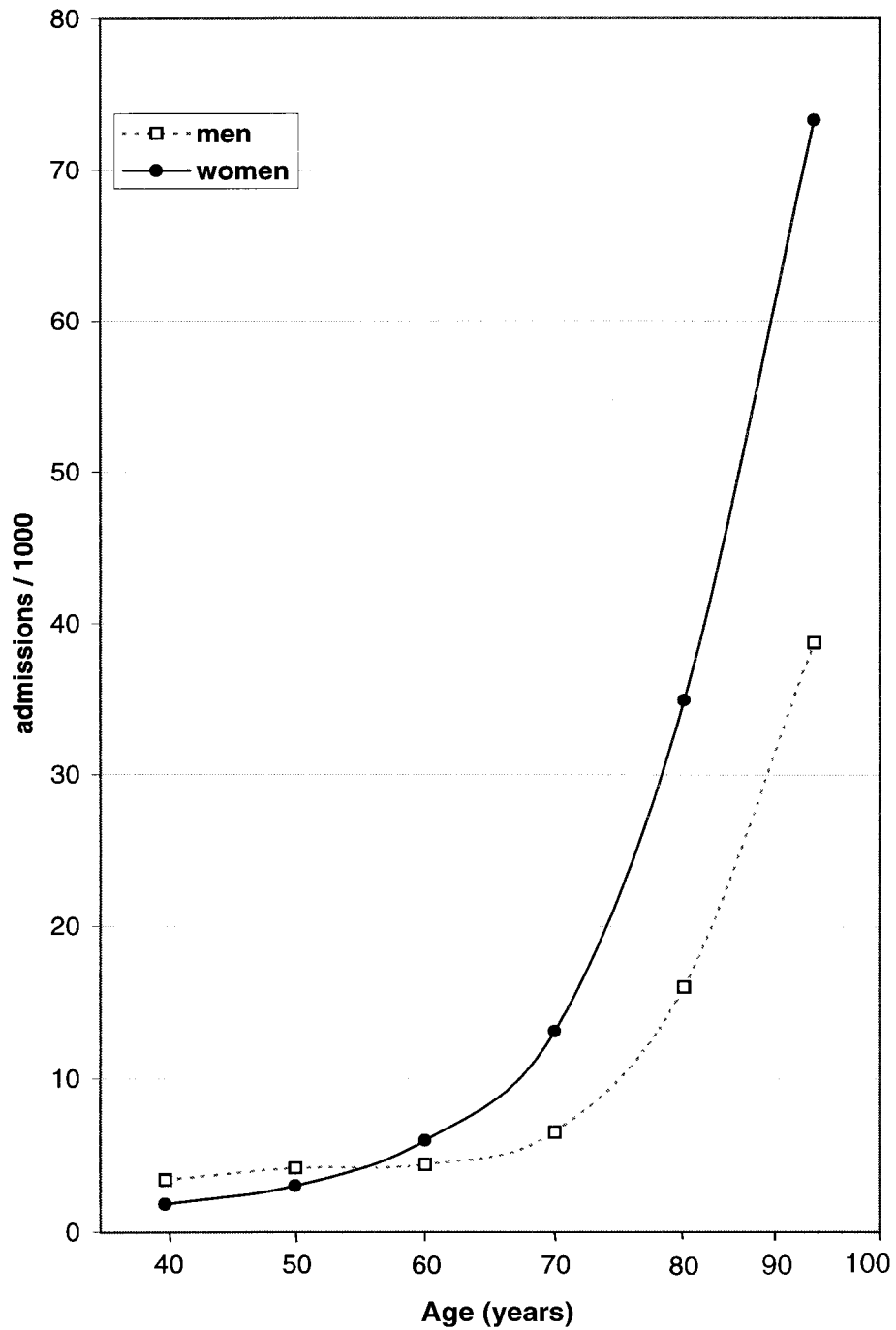


Fig. 1.5. Hospital admissions for falls according to age and gender. Adapted from: Lord SR. Falls in the elderly: admissions, bed use, outcome and projections. *Medical Journal of Australia* 1990;153:117-18.

elderly. Time spent on the floor is associated with fear of falling, muscle damage, pneumonia, pressure sores, dehydration and hypothermia [6, 38, 39]. Wild et al. [40] found that half of those who lie on the floor for an hour or longer die within 6 months, even if there is no direct injury from the fall. Vellas [41] suggests that long lies are not uncommon. He found that more than 20% of patients admitted to hospital because of a fall had been on the ground for an hour or more. Such a figure could be expected as Tinetti et al. [42] found that up to 47% of non-injured fallers are unable to get up off the floor without assistance.

Falls can result in restriction of activity and fear of falling, reduced quality of life and independence. Even falls that do not result in physical injuries can result in the 'post-fall syndrome'; a loss of confidence, hesitancy, tentativeness, with resultant loss of mobility and independence. It has been found that after falling, 48% of older people report a fear of falling and 25% report curtailing activities [6, 43]. Tinetti et al. [43] have also found that 15% of nonfallers also report avoiding activities due to a fear of falling.

Finally, falls can also lead to disability and decreased mobility which often results in increased dependency on others and hence an increased probability of being admitted to an institution. Falls are commonly cited as a contributing reason for an older person requiring admission to a nursing home [42, 44].

The cost of falls

As indicated above, falls in older people are common and can lead to numerous disabling conditions, extensive hospital stays and death. It is not at all surprising, then, that falls constitute a significant health care cost. Fall-related costs can include the direct costs, which include doctor visits, acute hospital and nursing home care, outpatient clinics, rehabilitation stays, diagnostic tests, medications, home care, home modifications, equipment and institutional care. Indirect costs include carer and patient morbidity and mortality costs. The literature on the total cost of falls is scarce, however, as there are many difficulties and limitations involved in estimating the economic cost of any disease or condition. Problems exist because cost data are only estimates, and many costs are only relevant to the country in which they are incurred. Furthermore, because of inflation and other economic and health care factors, costs are outdated soon after they are published.

A number of researchers have estimated the hospital costs of an injurious fall in absolute terms and as a proportion of health budgets [35, 45–49]. In a detailed report to the US Congress in 1989, Rice and MacKenzie [48] calculated that in 1985, nearly \$10 billion of the \$158 billion or 6% of the lifetime economic cost of injury in the United States was attributable to falls in older people. Furthermore, falls account for 70% of all injury-related costs in elderly people. The cost per injured

person in 1985 was \$4226, which was nearly double that of the average cost per injured person for all age groups. Englander et al. [49] updated the costs of falls as presented by Rice and MacKenzie [48] from 1985 US dollars to 1994 US dollars. They projected the cost of falls in 1994 to total \$20.2 billion, with a cost per injured person being \$7399. The authors further extrapolated these figures to the year 2020 and estimated the cost of falls injuries at \$32.4 billion.

Conclusion

Despite the disparate methodologies of falls ascertainment used in the above studies, the incidence rates reported are remarkably similar. Approximately one third of older people living in the community fall at least once a year, with many suffering multiple falls. Falling rates are higher in older women (40%) than in older men (28%) and continue to increase with age above 65 years. The incidence of falls is increased in people living in retirement villages, hostels and nursing homes, in those who have fallen in the past year and in those with particular medical conditions that affect posture, balance and gait. In community-dwelling older people, about 50% of falls occur within their homes and 50% in public places. Falls account for 4% of hospital admissions, 40% of injury-related deaths and 1% of total deaths in persons aged 65 years and over. The major injuries that result from falls include fractures of the wrist, neck, trunk and hip. Falls can also result in disability, restriction of activity and fear of falling, which can reduce quality of life and independence and contribute to an older person being admitted to a nursing home. Finally, as many fall-related injuries require medical treatment including hospitalization, falls constitute a condition requiring considerable health care expenditure.

REFERENCES

- 1 Gibson MJ, Andres RO, Isaacs B, Radebaugh T, Worm-Petersen J. The prevention of falls in later life. A report of the Kellogg International Work Group on the prevention of falls by the elderly. *Danish Medical Bulletin* 1987;34(Suppl 4):1–24.
- 2 Grimley-Evans J. Fallers, non-fallers and Poisson. *Age and Ageing* 1990;19:268–9.
- 3 Cummings SR, Nevitt MC, Kidd S. Forgetting falls. The limited accuracy of recall of falls in the elderly. *Journal of the American Geriatrics Society* 1988;36:613–16.
- 4 Lord SR, Clark RD, Webster IW. Physiological factors associated with falls in an elderly population. *Journal of the American Geriatrics Society* 1991;39:1194–200.
- 5 Lord SR, Ward JA, Williams P, Anstey KJ. Physiological factors associated with falls in older community-dwelling women. *Journal of the American Geriatrics Society* 1994;42:1110–17.
- 6 Nevitt MC, Cummings SR, Kidd S, Black D: Risk factors for recurrent nonsyncopal falls. A prospective study. *Journal of the American Medical Association* 1989;261:2663–8.

- 7 Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine* 1988;319:1701–7.
- 8 O’Loughlin JL, Robitaille Y, Boivin JF, Suissa S. Incidence of and risk factors for falls and injurious falls among the community-dwelling elderly. *American Journal of Epidemiology* 1993;137:342–54.
- 9 Exton-Smith AN. Functional consequences of ageing: clinical manifestations. In Exton-Smith AN, Grimley Evans J editors. *Care of the elderly: meeting the challenge of dependency*. London: Academic Press, 1977.
- 10 Campbell AJ, Reinken J, Allan BC, Martinez GS. Falls in old age: a study of frequency and related clinical factors. *Age and Ageing* 1981;10:264–70.
- 11 Prudham D, Evans JG. Factors associated with falls in the elderly: a community study. *Age and Ageing* 1981;10:141–6.
- 12 Blake A, Morgan K, Bendall M, et al. Falls by elderly people at home: prevalence and associated factors. *Age and Ageing* 1988;17:365–72.
- 13 Lord SR, Sambrook PN, Gilbert C, et al. Postural stability, falls and fractures in the elderly: results from the Dubbo osteoporosis epidemiology study. *Medical Journal of Australia* 1994;160:684–5, 688–91.
- 14 Lord SR, Ward JA, Williams P, Anstey KJ. An epidemiological study of falls in older community-dwelling women: the Randwick falls and fractures study. *Australian Journal of Public Health* 1993;17:240–5.
- 15 Campbell AJ, Borrie MJ, Spears GF. Risk factors for falls in a community-based prospective study of people 70 years and older. *Journal of Gerontology* 1989;44:M112–17.
- 16 Luukinen H, Koski K, Laippala P, Kivela SL. Predictors for recurrent falls among the home-dwelling elderly. *Scandinavian Journal of Primary Health Care* 1995;13:294–9.
- 17 Luukinen H, Koski K, Hiltunen L, Kivela SL. Incidence rate of falls in an aged population in northern Finland. *Journal of Clinical Epidemiology* 1994;47:843–50.
- 18 Fernie GR, Gryfe CI, Holliday PJ, Llewellyn A. The relationship of postural sway in standing to the incidence of falls in geriatric subjects. *Age and Ageing* 1982;11:11–16.
- 19 Lipsitz LA, Jonsson PV, Kelley MM, Koestner JS. Causes and correlates of recurrent falls in ambulatory frail elderly. *Journal of Gerontology* 1991;46:M114–22.
- 20 Yip YB, Cumming RG. The association between medications and falls in Australian nursing-home residents. *Medical Journal of Australia* 1994;160:14–18.
- 21 Rubenstein LZ, Robbins AS, Schulman BL, Rosado J, Osterweil D, Josephson KR. Falls and instability in the elderly [clinical conference]. *Journal of the American Geriatrics Society* 1988;36:266–78.
- 22 Thapa PB, Brockman KG, Gideon P, Fought RL, Ray WA. Injurious falls in nonambulatory nursing home residents: a comparative study of circumstances, incidence, and risk factors. *Journal of the American Geriatrics Society* 1996;44:273–8.
- 23 Tinetti ME, Williams TF, Mayewski R. Fall risk index for elderly patients based on number of chronic disabilities. *American Journal of Medicine* 1986;80:429–34.
- 24 Liu BA, Topper AK, Reeves RA, Gryfe C, Maki BE. Falls among older people: relationship to medication use and orthostatic hypotension. *Journal of the American Geriatrics Society* 1995;43:1141–5.

- 25 Northridge ME, Nevitt MC, Kelsey JL, Link B. Home hazards and falls in the elderly: the role of health and functional status. *American Journal of Public Health* 1995;85:509–15.
- 26 Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. *Journal of the American Geriatrics Society* 1991;39:46–52.
- 27 Mahoney J, Sager M, Dunham NC, Johnson J. Risk of falls after hospital discharge. *Journal of the American Geriatrics Society* 1994;42:269–74.
- 28 Forster A, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. *British Medical Journal* 1995; 311:83–6.
- 29 Koller WC, Glatt S, Vetere-Overfield B, Hassanein R. Falls and Parkinson's disease. *Clinical Neuropharmacology* 1989;12:98–105.
- 30 Paulson GW, Schaefer K, Hallum B. Avoiding mental changes and falls in older Parkinson's patients. *Geriatrics* 1986;41:59–62.
- 31 Kulkarni J, Toole C, Hirons R, Wright S, Morris J. Falls in patients with lower limb amputations: prevalence and contributing factors. *Physiotherapy* 1996;82:130–6.
- 32 Buchner DM, Larson EB. Falls and fractures in patients with Alzheimer-type dementia. *Journal of the American Medical Association* 1987;257:1492–5.
- 33 Campbell AJ, Borrie MJ, Spears GF, Jackson SL, Brown JS, Fitzgerald JL. Circumstances and consequences of falls experienced by a community population 70 years and over during a prospective study. *Age and Ageing* 1990;19:136–41.
- 34 Baker SP, Harvey AH. Fall injuries in the elderly. *Clinics in Geriatric Medicine* 1985; 1:501–12.
- 35 Lord SR. Falls in the elderly: admissions, bed use, outcome and projections. *Medical Journal of Australia* 1990;153:117–18.
- 36 New South Wales Health Department: The epidemiology of falls in older people in NSW. Sydney: New South Wales Health Department, 1994.
- 37 Marottoli RA, Berkman LF, Cooney LM Jr. Decline in physical function following hip fracture. *Journal of the American Geriatrics Society* 1992;40:861–6.
- 38 Mallinson W, Green M. Covert muscle injury in aged persons admitted to hospital following falls. *Age and Ageing* 1985;14:174–8.
- 39 King MB, Tinetti ME. Falls in community-dwelling older persons. *Journal of the American Geriatrics Society* 1995;43:1146–54.
- 40 Wild D, Nayak US, Isaacs B. How dangerous are falls in old people at home? *British Medical Journal (Clinical Research)* 1981;282:266–8.
- 41 Vellas B, Cayla F, Bocquet H, de Pemille F, Albarede JL. Prospective study of restriction of activity in old people after falls. *Age and Ageing* 1987;16:189–93.
- 42 Tinetti ME, Liu WL, Claus EB. Predictors and prognosis of inability to get up after falls among elderly persons. *Journal of the American Medical Association* 1993;269:65–70.
- 43 Tinetti ME, Mendes de Leon CF, Doucette JT, Baker DI. Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. *Journal of Gerontology* 1994;49:M140–7.
- 44 Lord SR. Predictors of nursing home placement and mortality of residents in intermediate care. *Age and Ageing* 1994;23:499–504.
- 45 Alexander BH, Rivara FP, Wolf ME. The cost and frequency of hospitalization for fall-related injuries in older adults. *American Journal of Public Health* 1992;82:1020–3.

- 46 Covington DL, Maxwell JG, Clancy TV. Hospital resources used to treat the injured elderly at North Carolina trauma centers. *Journal of the American Geriatrics Society* 1993;41:847–52.
- 47 Sjogren H, Bjornstig U. Unintentional injuries among elderly people: incidence, causes, severity, and costs. *Accident Analysis and Prevention* 1989;21:233–42.
- 48 Rice DP, MacKenzie EJ. *Cost of injury in the United States: a report to Congress*. San Francisco: Institute for Health and Ageing, University of California, 1989.
- 49 Englander F, Hodson TJ, Terregrossa RA. Economic dimensions of slip and fall injuries. *Journal of Forensic Sciences* 1996;41:733–46.