Part I

Epidemiology and risk factors for falls

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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 and fall-related injuries. Before addressing these issues, however, it is helpful to briefly discuss four important methodological considerations that are pertinent to all research studies of falls in older people: how falls are defined, how falls are counted, how injurious falls are defined and what constitutes an older person.

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. The Kellogg definition is appropriate for studies aimed at identifying factors that impair sensorimotor function and balance control, whereas broader definitions that include dizziness and loss of consciousness are appropriate for studies that also address cardiovascular and neurological causes of falls such as syncope, postural hypotension and transient ischaemic attacks. More recently, the Prevention of Falls Network Europe (ProFaNE) collaborators, in conjunction with international experts in the field and using consensus methodology, have adopted a simpler definition to include falls that occur from all causes, i.e. 'an unexpected event in which the participant comes to rest on the ground, floor or lower level' [2]. A comparable definition has also been adopted by the World Health Organization.[1] This simple definition is appropriate for

[1] www.who.int/violence_injury_prevention/unintentional_injuries/falls/falls1/en/

multi-centre studies requiring a core data set or for situations where details of falls are unrecorded (routine surveillance data/accident records), or where a high proportion of subjects cannot provide reliable information about their falls (i.e. those with delirium or cognitive impairment).

Although falls are often referred to as accidents, it has been shown statistically that falls incidence differs significantly from a Poisson distribution [3]. 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 had fallen over in a defined period of time – usually 12 months. This approach has limitations in that subjects have limited accuracy in remembering falls over a prolonged period [4]. More recent studies have used prospective designs, in which subjects are followed up for a period, again usually 12 months, to more accurately determine 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 [5, 6], weekly [7] or monthly falls calendars [8] and monthly telephone interviews [9].

The ProFaNE collaborators recommend that falls should be recorded using prospective daily recording and a notification system with a minimum of monthly reporting [2]. Telephone or face to face interview should be used to chase missing data and to ascertain further details of falls and injuries. Specific information about the circumstances of any falls can also be ascertained with additional questions on the falls diary forms. An example of a monthly falls calendar is shown in Figure 1.1a, with additional questions in Figure 1.1b. Telephone interviews gain the same information as mail-out questionnaires and falls diaries, but may require many calls to contact active older people. In research studies, fall data should be summarized as: number of falls; number of fallers/non-fallers/frequent fallers; and fall rate per person years [2].

However, even with the most rigorous reporting methodology, it is quite likely that falls are under-reported and that data regarding 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 under-reporting, as it

SUN	MON	TUES	WED	THURS	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Fig. 1.1a Example of a monthly falls diary.

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 under-reporting, especially in those with cognitive impairment.

In residential aged care 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% [5]. In hospitals, falls incident forms are now commonly used.

The definition of a fall-related injury

The definitions of injurious falls have differed considerably in the literature, due primarily to whether or not minor injuries such as bruises, cuts and abrasions have been classified as fall-related injuries. The ProFaNE collaborators recommend that due to difficulties in standardizing definitions and classifications of fall injury type, the most rigorous definition of a serious fall-related injury is radiologically confirmed peripheral fracture, i.e. fractures of the limbs and limb girdles [2].

The definition of the older person

There is no consistency among studies as to what demographic group constitutes older people. The term is used for age-groups starting from as low as 50 years. However, the most frequently used definition is people aged 65 years and over. Within this age-band, commonly accepted subgroups are those aged 65–74 years, 75–84 years and 85 years and older.

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

1. WHERE HAVE YOU FALLEN?

Inside:

On the one level	Yes	[ ]	No	[ ]
Getting out of bed	Yes	[ ]	No	[ ]
Getting out of a chair	Yes	[ ]	No	[ ]
Using the shower/bath	Yes	[ ]	No	[ ]
Using the toilet	Yes	[ ]	No	[ ]
Walking up or down stairs	Yes	[ ]	No	[ ]

Home entrances or in the garden:

Walking up or down a step/stairs	Yes	[ ]	No	[ ]
On the one level (e.g. pathway)	Yes	[ ]	No	[ ]
In the garden	Yes	[ ]	No	[ ]

Away from home:

On the footpath	Yes	[ ]	No	[ ]
On a kerb/gutter	Yes	[ ]	No	[ ]
In a public building	Yes	[ ]	No	[ ]
Getting out of a vehicle	Yes	[ ]	No	[ ]
In another person's home	Yes	[ ]	No	[ ]

Falls not described above (please specify)

2. HOW DID YOU FALL?

(Tick more than one if necessary)

I tripped	[ ]
I slipped	[ ]
I lost my balance	[ ]
My legs gave way	[ ]

Fig. 1.1b (Cont.)

I felt faint [ ]

I felt giddy/dizzy [ ]

I am not sure [ ]

3. AS A RESULT OF THIS FALL OR FALLS DID YOU SUFFER ANY INJURIES? Yes [ ] No [ ]

4. 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 it to us by using the enclosed envelope

Fig. 1.1b Example of additional questions seeking specific information about the circumstances of falls.

The incidence of falls in older people

Community-dwelling older people

In 1977, Exton-Smith examined the incidence of falls in 963 people over the age of 65 years living in England [10]. He found that in women, the proportion that fell increased with age from 30% in the 65–9 year age group to over 50% in those over the age of 85. In men, the proportion that fell increased from 13% in the 65–9 year age group to levels of approximately 30% in those aged 80 years and over.

Retrospective community studies in primarily White populations undertaken since Exton-Smith's work have reported similar findings – that approximately 30% of older persons experience one or more falls per year [11–13]. Campbell *et al.* [11] analysed a stratified population sample of 533 subjects aged 65 years and over, and found that 33% experienced one or more falls in the previous year. Blake *et al.* [13] reported a similar incidence (35%) in a study of 1042 subjects aged 65 years and over. In a large study of 2793 subjects aged 65 years and over, Prudham and Grimley-Evans [12] estimated an annual incidence for accidental falls of 28%, a figure identical to that found in

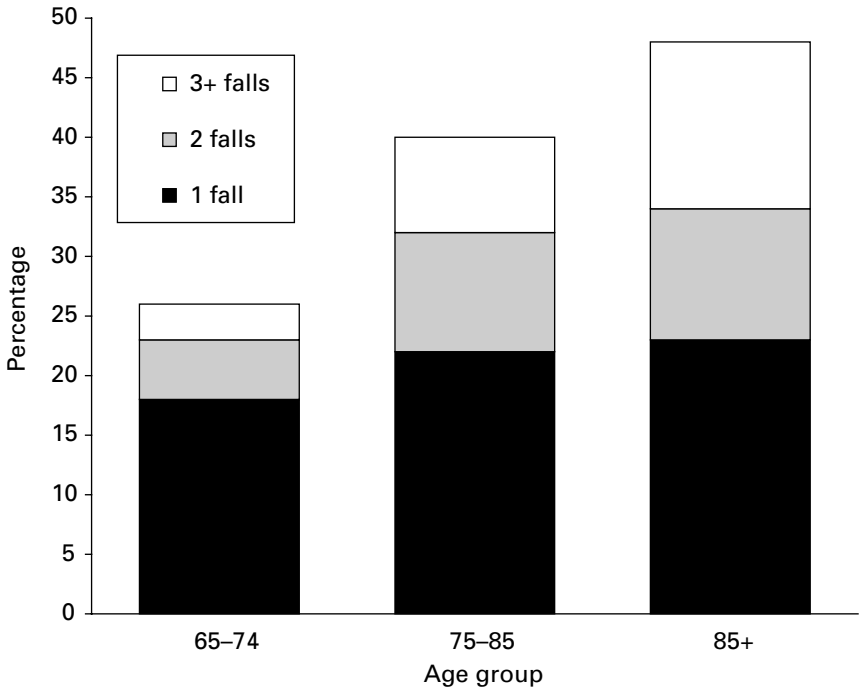

Fig. 1.2 Proportion of older women who took part in the Randwick Falls and Fractures Study who reported falling once, twice, or three or more times in a 12 month period. Diagram adapted from Lord *et al*. [15].

the Australian Dubbo Osteoporosis Epidemiology Study of 1762 older people aged 60 years and over [14].

More recent prospective studies undertaken in community settings have found higher falls incidence rates. In the Randwick Falls and Fractures Study conducted in Australia, we found that 39% of 341 community-dwelling women aged 65 years and over reported one or more falls in a one-year follow-up period [15]. In a large study of 761 subjects aged 70 years and over undertaken in New Zealand, Campbell *et al.* [16] found that 40% of the 465 women and 28% of the 296 men fell at least once in the study period of one year, an overall incidence rate of 35%. In the United States, Tinetti *et al.* [8] 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.* [9] in a 48-week prospective study of a random sample of 409 community-dwelling people aged 65 years and over (29%), and in Finland community-dwelling people aged 70 years and over by Luukinen *et al.* in 833 from five rural districts (30%) [17].

Fall 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 [15] 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 agreement. The incidence of two or more falls in a follow-up year reported in five studies ranges between 11% and 21% (average 15%). Three studies have reported data for three or more falls and all report an incidence of 8%.

Rigorous data regarding falls incidence in older people from non-White populations is limited. However, studies of fall rates in Japanese people living in both Japan and Hawaii reveal a contrasting picture to that of White populations. Aoyaga *et al.* [18] studied falls among 1534 (624 men, 910 women) community-dwelling people aged 65 years and over in Japan. They found that only 9% of the men and 19% of the women reported one or more falls in the previous year. Similarly low incidence rates have also been found in seven other large community studies undertaken in Japan [19]. As part of the Hawaii Osteoporosis Study, Davis *et al.* prospectively assessed falls incidence among older Japanese men and women living in Hawaii [20]. The falls incidence rates were 13.9 per 100 person years for men and 27.6 per 100 person years for women, representing about half the fall rates of comparable studies in predominantly White populations.

In a subsequent study, Davis *et al.* attempted to identify neuromuscular performance measures and functional disabilities that could account for such differences in fall rates [21]. They found that the Japanese women had faster walking speeds, chair stands and performed better on a series of balance tests. On the other hand, the White women had greater strength, particularly of the quadriceps, and faster hand and foot reaction times. After adjusting for the neuromuscular test results and the number of functional disabilities, the odds ratio for the risk of falls remained essentially the same. It is possible that the better performances in the more functional strength and balance tests that translate more directly to activities of daily living could explain the lower risk of falls among Japanese women.

Finally, Ellis and Trent compared risks for falls and their consequences among 104 902 people from four major race/ethnic groups who were admitted to non-federal hospitals in California from 1995 to 1997 [22]. Rates per 100 000 for the same level hospitalized fall injuries for Whites (161) were distinctively higher than for Blacks (64), Hispanics (43) and Asian/Pacific Islanders (35). Whites were also more likely to have suffered a fracture and to be discharged to long term care, suggesting poorer outcomes and greater injury severity. It is possible that differing levels of bone density, medical insurance and family support may account for some of these differences observed among the groups.

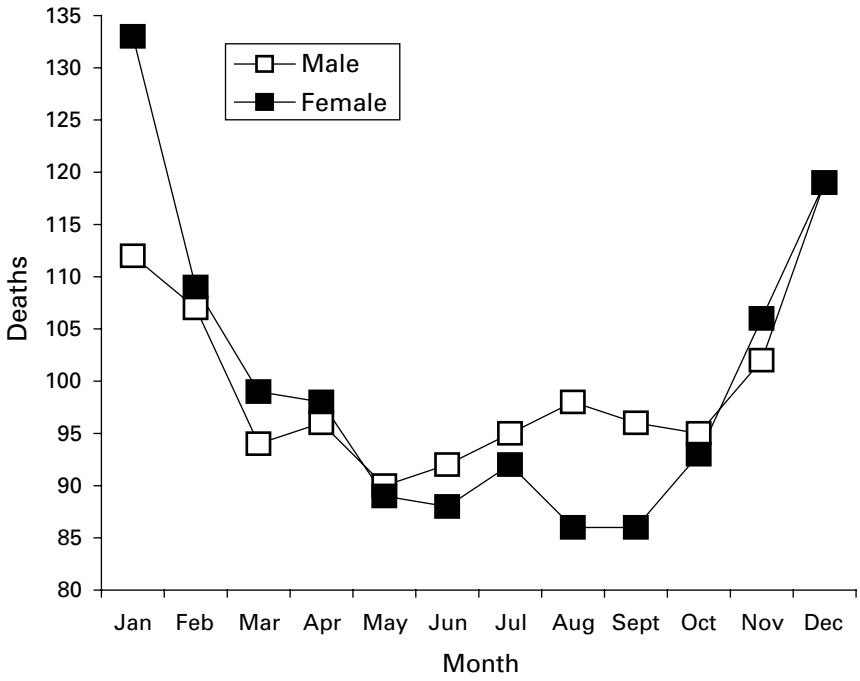

Fig. 1.3 Deaths from accidental falls – annualized monthly ratios; 1993–7 [23].

Seasonal variations in falls frequency

It is possible that the ambient temperature may lead to a seasonal variation in the incidence of falls. People tend to hurry more in colder weather, and mild hypothermia and slowed responses are more common. Equally, people tend to be less active in winter, the hours of daylight are shorter and vitamin D deficiency is more likely. There appears to be a seasonal variation in deaths from accidental falls as illustrated in Figure 1.3 which shows annualized monthly ratios in England and Wales for 1993–7 [23].

In a Finnish study, Luukinen *et al.* found that the incidence of outdoor falls was higher in periods of extreme cold [24]. However, there was no association between indoor falls and temperature which they attributed to adequately heated houses. A similar study in the UK found that apart from the presence of ground frost, there was no significant association between the prevailing weather conditions and the incidence of hip fractures [25]. The precise effect of seasonal change on the epidemiology of falls is therefore somewhat unclear.

Secular trends in falls injuries

Two recent studies have examined routinely collected fall injury data as a means of assessing secular trends in falls incidence. In Finland, Kannus *et al.* analysed

data from the National Hospital Discharge Register and found that the number of older people with fall-induced injuries increased between 1970 and 1995 at a rate that could not be explained simply by demographic changes [26]. The age-standardized incidence increased by 127% in women (from 648 in 1970 to 1469 in 1995) and by 124% in men (from 434 in 1970 to 972 in 1995). Secular changes in falls hospitalization rates have also been examined in the Australian states of Victoria and South Australia [27]. Between 1988 and 1997, age-standardized falls hospitalization rates increased significantly – by 32% in Victoria and 5% in South Australia. Such increases may partially account for the commonly found secular increases in hip and other fractures reported in several Western countries [28, 29].

Residents of residential aged care facilities

Studies on the prevalence of falls have also been conducted in residential aged care facilities, where the reported frequency of falling is considerably higher than among those living in their own homes. For example, Luukinen *et al.* [30] estimate that among people aged 70 and over in Finland, the rate of falling in the residential care population is three times higher than that among those living independently in the community.

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.* [31] monitored 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, studies have reported higher falls incidence rates in older people living in residential care facilities. Lipsitz *et al.* [32] found that 40% of 901 ambulatory nursing home residents fell two or more times in six months, and Yip and Cumming [33] 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.* [34] summarized the findings from five published and two unpublished studies on the incidence of falls in long term care facilities. 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.* [35] conducted a 12-month prospective study in 12 nursing homes involving 1228 residents. They report that during the 1003 person years of follow up, 548 residents suffered 1585 falls.

Fall rates are also high in residents living in intermediate-care hostels. 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 [5]. Tinetti *et al.* [36] also found a high incidence of falling in 79 persons admitted consecutively