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Epidemiology of falls

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Introduction

Falls in older people are a major public health concern in terms of morbidity, mortality and the cost to health and social services [1]. This epidemiological review of falls concentrates on four main components. Firstly, different ways of defining and classifying falls and fallers are outlined. The second section deals with the occurrence, including the prevalence, time and place of falls. We then examine the causes (risk factors) for falling, and finally we discuss the impact (consequences) of falls in the older population.

Definitions and classifications

In epidemiological and intervention studies of falls it is important to consider carefully the definition used for a fall as this may vary between studies. Most studies have required the fall to be 'unintentional' and for some form of contact with the ground. Most studies have also excluded falls caused by road accidents and violence. Some studies have excluded falls caused directly by syncope or an acute major intrinsic event such as a stroke, although other definitions have included such falls.

In the literature one of the early definitions was that a fall results 'when the vertical line which passes through the centre of mass of the human body comes to lie beyond the support base and correction does not take place in time' [2]. Whilst this definition describes the mechanical process occurring during a fall it is not a practical definition which can be used in fall studies. Tinetti in 1988 defined fall as 'an event which results in a person coming to rest unintentionally on the ground or other lower level, not as a result of a major intrinsic event (such as stroke) or overwhelming hazard' [3]. Nevitt's definition involved a person 'falling all the way down to the floor or ground, or falling and hitting an object like a chair or stair' [4].

The Frailty and Injuries: Co-operative Studies of Intervention Techniques (FICSIT) studies in the last decade defined a fall as 'unintentionally coming to rest on the ground, floor or other lower level' [5]. This definition was broad and could include some types of 'stumbles', and therefore some FICSIT centres also used other modified definitions in their studies. For example, the Atlanta group used the FICSIT definition as well as a narrower modified version, which excluded stumbles [6]. In their particular study of a 15-week Tai-Chi intervention, there was a significant reduction in falls (unadjusted) using the FICSIT definition but no significant reduction using the modified definition. This highlights the important point that a small alteration in the fall definition can alter the main resulting message from research studies. The definition which is consistent with The International Classification of Diseases (ICD 9) states that a 'fall is an unexpected event where a person falls to the ground from an upper level or the same level' [7]. A more recent definition of a fall defines the latter 'to be an unexpected descent from an upright, sitting or horizontal position, the descent height being $\leqslant 1$ metre' [8]. The diversity of these and other definitions means that it can be difficult to compare studies, and there is a need for a universally used standardised version.

Falls can also be classified in several ways. A fall can be explained (for example a simple trip or an intrinsic event such as syncope) or unexplained, where no apparent cause has been found. A fall can be intrinsic, where some event or condition affects postural control, or extrinsic, where an environmental factor is the main contributing reason for the fall. The concept of accidental versus non-accidental falls is sometimes used but this distinction can be misleading because the implication is that accidental falls are purely random events whereas other causal processes, including environmental factors and variables specific to the individual may also be involved. Another classification depends on whether the fall is injurious or non-injurious, and the distinction is important because the risk factors for these two types of falls may be different [4, 9]. It is also important to remember that there is an epidemiological overlap between falls and syncope and fallers may fail to recollect syncopal events.

Fallers can also be classified in different ways. A faller, as compared to a non-faller, is usually defined as someone who has fallen at least once over a defined time period, usually one year or 6 months. A recurrent faller is often defined as someone who has fallen twice or more during a defined time period, as compared to a 'once only faller'. However, some

evidence suggests that people who are 'once only fallers' are characteristically more closely related to non-fallers than 'twice or more fallers'. Lord *et al.* showed that the physiological parameters of visual contrast sensitivity, reaction time, body sway, quadriceps strength and vibration were similar in non-fallers and once-only fallers, but these parameters were significantly worse in multiple (2 or more) fallers [10]. Some researchers therefore define a faller as someone who has had 2 or more falls, and recurrent fallers are sometimes defined as those with 3 or more falls over a defined time period. The distinction between recurrent and non-recurrent fallers can be important in some contexts. Thus there is evidence that in some groups, recurrent fallers experience more 'minor' injuries, whereas non-recurrent fallers may be more prone to 'major' injuries as a consequence of a fall [9].

Occurrence

Numerous studies on the annual incidence of falls have been published. Inconsistencies in research methodologies, including selecting different populations and using different fall definitions explain some of the differences in the results. Another important problem is poor recall of falls in many subjects. Cummings *et al.* showed that compared to prospective studies, retrospective studies underestimate the incidence of falls by 13–32% depending on the time period of recall [11]. Even in prospective studies the methodology used in data collection can influence the incidence. A recent Japanese study showed that monitoring (postal questionnaire followed by telephone call) at different time intervals led to different incidence in three similar groups of older men [12]. Monthly and 3-monthly monitoring led to annual incidences of 20.5% and 15.9% respectively, whereas collecting falls data only once at the end of the year led to a significantly lower incidence of 6.4%. These differences were not found in women.

Despite these difficulties there are enough large well-designed population studies in the nineteen eighties and early nineties that have given us reliable estimates of the incidence of falls in community dwellers. The proportion of people sustaining at least one fall over a one-year period varies from 28–35% in the $\geqslant 65$ year age group [13–15] to 32–42% in the $\geqslant 75$ year age group [3, 16]. Even 'healthy' older people have an annual incidence of falls of 15% [17]. Previous fallers have a two-thirds chance of having a fall in the subsequent year [18], and over a half of residents in institutional care have had at least one fall over a one-year period [19]. More recent data from Australia has suggested that the annual incidence of falls in community dwellers in the over 70 age group may be 49% [20] and there is some evidence suggesting that that age-adjusted fall rates (as measured by fall-induced injuries) may be increasing with time [8]. About half of those who fall do so repeatedly [19, 21].

In those who fall, approximately 65% of women and 44% of men fall inside their usual residence and about 25% of men and 11% of women fall in their garden. In the home most falls occur in the most frequently used rooms—bedrooms, kitchen and dining room [22]. People aged <75 years are more likely to fall outdoors than those aged 75 years and over, and indoor falls are associated with frailty whilst outdoor falls are associated with compromised health status in more active people [23]. Most falls in the community occur during the day with only 20% occurring during the night [22]. Colder days and the winter season increase the rate of falls in women [24] and the incidence of fractures [25–27]. American studies suggest that fall rates are similar in different races [28, 29], although in Hawaii, Japanese women fall less often than other races [30].

Risk factors

Numerous studies have identified over 400 potential risk factors for falling [31], although there is no reliable and agreed classification. The Effective Health Care Bulletin classified the causes into five major categories: environmental (e.g. loose carpets, bathtubs without rails, poor lighting, unsafe stairs, ill-fitting shoes), medication (e.g. antidepressants, sedatives and hypnotics), medical conditions and changes associated with ageing (e.g. poor vision, cognitive impairment), nutritional (e.g. calcium and vitamin D deficiency) and lack of exercise [31].

One approach in elucidating the risk factors for falls is to study the causes of hip fracture, which is an important and serious consequence of falling. The Study of Osteoporotic Fractures in 9,516 white women identifies a number of risk factors, which were significantly associated with hip fracture [Table 1] [32]. The problem with this approach is that not all hip fracture risk factors are also fall-related risk factors with some being purely related to skeletal factors [Figure 1] [33]. The other approach is to study fall risk factors *per se*. Rubenstein and Josephson summarised the data

Table 1. Risk factors for hip fracture in 9,516 white women [32]

- Age
- Maternal hip fracture
- Height at age 25 years
- Lack of weight gain since 25 years
- Self related health
- Current benzodiazepines
- Current anticonvulsants
- Current caffeine intake
- Lack of walking for exercise
- On feet $\leqslant 4$ hours/day
- Inability to rise from chair
- Poor distant depth perception
- Impaired contrast sensitivity
- Resting pulse rate >80/min
- Any fracture since age 50 years
- Calcaneal bone density

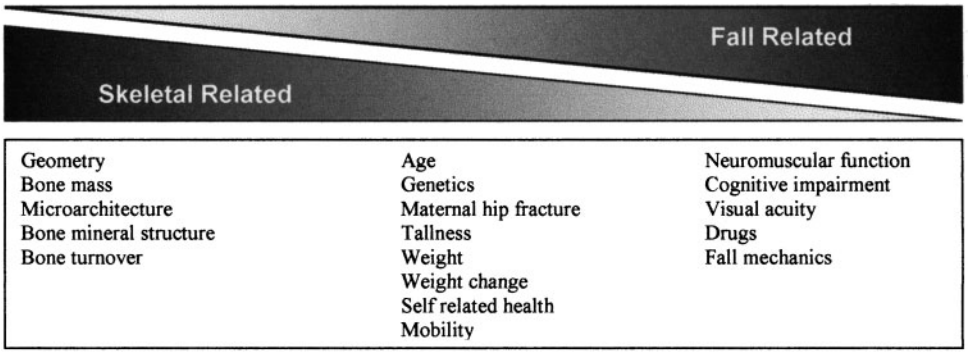

Figure 1. Diagram showing details of risk factors for hip fracture according to their 'skeletal' or 'fall' relationship [33].

Table 2. Summary of causes of falls in 12 studies that carefully evaluated elderly persons after a fall and specified a 'most likely' cause. Mean percentage calculated from a total of 3684 falls in the 12 studies. Ranges indicate the percentage reported in each of the 12 studies [34]

Most likely cause of fall	Mean %	Range
Accident/environment-related	31	(1–53)
Gait/balance disorders or weakness	17	(4–39)
Dizziness/vertigo	13	(0–30)
Drop attacks	9	(0–52)
Confusion	5	(0–14)
Postural hypotension	3	(0–24)
Visual disorder	2	(0–5)
Syncope	0.3	(0–3)
Other specified causes	15	(2–39)
Unknown	5	(0–21)

Table 3. Table showing important individual risk factors for falls in a summary of 16 controlled trials. The number of studies with significant associations is shown against the total number of studies looking at each factor [34]

Risk factor	Significant/total
Weakness	11/11
Balance deficit	9/9
Mobility limitation	9/9
Gait deficit	8/9
Visual deficit	5/9
Cognitive impairment	4/8
Impaired ADL	5/9
Postural hypotension	2/7

on risk factors from falls studies in community-dwelling and institutional-dwelling older people [Tables 2 and 3] [34]. Further data have suggested that stroke, depression and urinary incontinence are risk factors for falls [35–37].

A recent study has shown that ward design in hospitals can influence fall rates. Wards in which 85% of beds were visible from the nursing station had significantly lower falls when compared to the ward where only 15% of beds were visible from the nursing station [38]. Another recent study showed that bedrails do not significantly reduce either falls or total injury rates but may significantly increase injuries that were considered serious [39]. Stairs have also been associated with falls. Ten percent of fall-related deaths occur as a consequence of stair-related falls and 75% of falls on stairs occur during descent. The same intrinsic factors which apply to falls in general seem also to apply to stair-related falls and important extrinsic factors related to stair-related falls include the influence of stair design (e.g. stair angle and step height), stair maintenance, footwear and clothing, lighting and distracting events [40].

Impact

Around 40–60% of falls lead to injuries, with 30–50% being minor injuries, 5–6% major injuries excluding fractures and 5% being fractures [3, 14, 41, 42]. Up to 1% of falls in older people are said to result in a hip fracture [3, 41, 43] which has a significant morbidity, mortality and cost to health services. Recent data suggest that 80% of women would rather be dead than experience the loss of independence and quality of life that results from a bad hip fracture and subsequent admission to a nursing home [44]. A recent Finnish study has shown that the number of older persons with fall-induced injuries is increasing at a rate that cannot be explained simply by demographic changes [8]. Another study from the same cohort has shown that the age-adjusted severe fall-induced head injury rate dramatically increased from 1970 to 1995 [45].

Fall related accidents are predisposing factors in 40% of the events leading to long-term institutional care in older people [46]. Hospital admission rates from falls increase $>$6-fold from between the ages of 65–69 years to the over 85 years age group [47]. Injuries are the fifth commonest cause of death in an older population

[48] and falls are the commonest cause of injury-related death in persons over 75 years [49].

Around a third of older people develop a fear of falling after an incidental fall [50] and those with a fear of falling (low falls efficacy scale score) had an increased risk of falling, reduced activities of daily living, lower quality of life (Short-Form 36) and increased institutionalization [51]. Many older fallers are unable to get up again without assistance and any subsequent 'long lie' can lead to hypothermia, dehydration, bronchopneumonia and pressure sores [52].

Conclusion

Falls in older people are common and constitute an important public health problem. It is important to take note of definitions of falls, fallers and recurrent fallers when interpreting epidemiological studies. The method of collecting data on falls can influence incidence and prevalence rates. The incidence of falls varies widely between studies and depends heavily upon the definition employed. There are potentially over 400 risk factors for falling, which can be categorized in several ways, although they can broadly be divided into intrinsic and extrinsic causes. The important impact of falls includes significant morbidity, mortality, functional deterioration, hospitalization, institutionalization and expenditure to health and social services.

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