PATTERNS AND PREDICTORS OF FALLS AND THEIR CONSEQUENCES IN EXTREME OLD AGE

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SUMMARY ABSTRACT

BACKGROUND AND AIMS

Falls in old age can have serious consequences. The impact on health and social care is growing as the older population increases, but there are few data on falling amongst the "oldest old". This study aimed to provide much needed information on this fastest growing section of the population: the epidemiology of falls and their consequences, the prevalence of potential risk factors and their predictive value in extreme old age.

METHODS

This study added a special investigation of falling in advanced old age to the 2002–2003 interviews of 110 over-90-year-olds from the Cambridge City over-75s Cohort, a population-based longitudinal study of ageing. The survey (90 women, 20 men) comprised a standardised nurse-administered questionnaire with cognitive assessment, quantitative heel ultrasound scans and functional performance measures: Timed Unsupported Stand, Short Physical Performance Battery (standing balance tests, gait speed and chair rising),180° turn, functional reach and hand grip strength. Data collection also included a year's prospective monitoring of falls using a combination of weekly calendars and telephone follow-up, with reports from participants themselves and proxy informants.

KEY FINDINGS AND THEIR IMPLICATIONS

The study's description of a representative population aged over 90 is valuable to service planners preparing for demographic change, revealing high levels of many fall risk factors. Detailed characterisation of functional status showed close agreement between reported disability levels and performance measures.

This first population-based survey of skeletal fragility in the tenth decade found quantitative ultrasound measures markedly lower than in previous studies with younger old people. Skeletal fragility reflected weight-bearing functional test performance and reported current or past mobility.

This first prospective study of falling amongst people aged over 90 in a representative population-based sample found falls are even more common than previously reported for very old people a decade younger: 60% fell at least once during follow-up, 45% more than once. Incidence was 277 falls / 100 person-years.

The extent to which falls in advanced old age lead to serious consequences – both immediate and longer-term – has not previously been reported. In one year's follow-up 54% of fall reports described the participant as being found on the floor. 82% of falls occurred alone, 80% of those who fell were unable to get up after at least one fall, and 30% suffered long lies of an hour or more. Four out of five times when someone fell alone and could not get up they did not use available alarms to call help. More than half the falls reported to the study, and three in ten of the falls resulting in any injury, had not been reported to any health care professional. Findings also showed high levels of injuries (38% of falls but 68% of fallers) including fractures – one man and 1 in 8 of the women who fell. One in three people had at least one hospital admission, 2/3 of them at least partly due to falling, 2/3 of these directly prompted by a fall. Mean total length of stay of fallers was 6 times that of non-fallers. 1 in 7 of those not already living in long-term care had moved into homes within a year, 80% of these prompted at least in part by falling.

Falls, adverse consequences and skeletal fragility shared a pattern of strong associations with several key risk factors, particularly impaired mobility and characteristics typical of frailty. Fracture risk factors were also associated with skeletal ultrasound measures. Functional tests added no predictive value to reported clinical risk factors.

The implications of this research for policy and practice are fully discussed in relation to the current developing situation and future projections, setting these novel findings in the context of existing knowledge summarised in an extensive literature review.

DECLARATION

This dissertation is the result of my own work and is not the same as any submitted for another degree, diploma or other qualification at this or any other University.
My research is based on field epidemiology with a very old cohort of survivors from a longitudinal study of ageing, the Cambridge City over-75s Cohort (CC75C), for which I was the sole project nurse and study co-ordinator. Maintaining core measures already established in earlier stages of this study, I developed the protocol to encompass a specific focus for this survey on function, falls and fracture risk in advanced old age. After obtaining ethical approval from Cambridge Research Ethics Committee, my fieldwork involved tracing, contacting, and re-interviewing the cohort survivors for the latest survey (2002-3), and their next of kin or other proxy informants where necessary. Besides face-to-face interviews in the usual place of residence, which included cognitive assessments, the majority of study participants also agreed to additional measurements: I carried out all these functional performance tests and quantitative ultrasound heel scans. I set up and carried through the prospective phase of the study, monitoring falls, hospital admissions and moves into care for a year following each interview. I was responsible for cleaning and checking data, both the standard interview schedule data entered commercially and my own double data entry of additional measures collected specifically for this thesis on physical function, fall history and follow-up outcomes. Apart from seeking statistical advice, all the analyses and data graphics are my own work. I acknowledge the contribution of earlier researchers in the field to the development of my interest and ideas, but I declare that the presentation and interpretation of my research findings in this thesis are my own.

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1.1 Context and development of aims

Falls
Injuries
Other consequences
Advanced old age
Research questions

Relatively little is known about many aspects of extreme old age – the numerous studies of health and function amongst those aged at least 65 or 75 have rarely provided detailed information about those aged 90 or older. As this oldest section of the population rises, the need for accurate data is crucial both for understanding disease and normal ageing, and for planning health and social care[1;2].

Falls

Although it is as yet unclear whether increasing longevity will ultimately result in longer disease-free life expectancy or lengthier periods of disability, already health and social care systems are experiencing the impact of greater numbers of older old people. Of the many complex co-morbidities that can pose difficulties in old age, one of the most common is the problem of falling. The immediate consequences of a fall can range from the relatively minor to the literally life-threatening, and the longer-term effects on the individual, their social network, health and other care services, and society as a whole are major challenges that are receiving increasing recognition in the political and public health agenda.

Injuries

It is particularly encouraging that in recent years attention has focused on the links between falls and fracture prevention. Although only a minority of falls result in fractures, the vast majority of fractures in the elderly are due to falls. A succession of strategy documents from government departments and guidelines from professional bodies are highlighting the importance of "joined up thinking" between orthopaedics, osteoporosis, elderly care and fall services to prevent further unnecessary occurrence of this most devastating consequence of falling. Amongst frailer older people many less serious consequences that are often labelled "minor injuries" can be extremely debilitating, and an injury-free fall may nonetheless lead to such damaging consequences of a "long lie" as pressure sores, carpet burns and hypothermia.

Other consequences

A fall, with or without fracture, is often a turning point from which an older person marks their decreased function and independence, ranging from restriction of activity levels as a result of injury or fear of falling again through to moving into a more supported residential setting. For some a fall triggers a cycle of decline from which recovery is never made, although the obvious problems of defining "death as a consequence of a fall" make it difficult to measure fall-related mortality.

Advanced old age

The last decade or so has seen an explosion of research into older people's falls, both from observational epidemiology seeking to identify fall risk factors and intervention studies testing the application of these findings in falls prevention. However, despite the common observation that falling increases with age, there is a dearth of evidence regarding falls amongst the very old. One of the earlier pioneer studies of falls[3] reported the proportion of older people who recalled falling in the past year rose from 1 in 3 amongst over-65-year-olds to 1 in 2 of the over-85-year-olds, the latter group numbering only 72 of the 1,042 people in that study. In two decades of research since then few studies have included more than a small minority of participants over 80, let alone over 90.

Research questions

With the "oldest old" now the fastest growing section of most western populations, this is an information gap that urgently needs filling. The picture of health conditions affecting older old people is different from that for younger old age[4] so simple extrapolation cannot provide adequate estimates on which to plan for future demographic change. It is unknown whether the prevalence of falling continues to rise with increasing age, or whether falls incidence rates amongst those who do fall also increase. It might reasonably be hypothesised that the consequences of falling tend to be more serious for frailer older people, but to what extent this is so is unproven. Factors identified in earlier research as linked with increased risk of falling may be more common in extreme old age but most of these risk factors have rarely been quantified in populations of very old people. Crucially, it has not previously been established which, if any, of these risk factors remain applicable for identification of which oldest old people are at highest risk of falling. While it is arguable that advanced

old age of itself poses high risk, limited resources demand that the priority for prevention is to intervene on modifiable risk factors. It is therefore important that research investigates the relevance of "known" risk factors to this relatively "unknown" group.

This study addresses the research questions above with the three-fold aims shown in Box 1.1.1 towards an over-arching fourth aim of informing public health policy and planning for service provision. Whilst the ultimate goal of research into falling amongst older people is to lessen the devastating effects of falls by prevention, it is beyond the scope of this study to test preventive interventions.

The following section (1.2 Background) sets the context for this study with an overview of research to date relating to advanced old age, falls and the consequences of falls. The background described in this chapter provides the starting point from which this study's aims are translated into specific objectives (detailed in section 1.3). The following chapter provides background information specific to the origins and development of the current study (see Chapter 2 *Study Methodology*).

Box 1.1.1 Study aims

1) To describe the prevalence of risk factors for falls, fractures and other serious consequences of falls in extreme old age

2) To describe the epidemiology of falls and their consequences in extreme old age

3) To explore which predictors of falls, fractures and other serious consequences are applicable in extreme old age

4) To set the findings in the context of health policy and to assess their impact on public health policy and planning for service provision

1.2 Background: related research to date

1.2.1 Population ageing
1.2.2 Researching advanced old age
1.2.3 Researching falls: methodological issues
1.2.4 The epidemiology of falls and their consequences in old age
1.2.5 Risk factors for falls and their consequences in old age
1.2.6 Assessment of functional ability and prediction of falls risk
1.2.7 Assessment of bone fragility and prediction of fracture risk

This section provides a narrative review of the literature relevant to this study of over-90-year-olds so as to set the thesis in context. This first addresses, in the light of current trends in population ageing and other longitudinal studies that have included very old people, the significance of research into advanced old age and falls, and methodological challenges involved. There follows an overview of the enormous literature on falls, fractures and their sequelae, summarising epidemiological findings to date regarding prevalence and risk factors and introducing methods that have been used to predict fall and fracture risk by the assessment of functional ability and bone fragility. The next section (Chapter 1.3) highlights questions for research and practice, as yet unanswered by the literature, that inform the formulation of the study's aims into specific objectives.

It is beyond the scope of this study to undertake systematic reviews of the wide range of topics relevant to this thesis. The approach used took as starting points for each of the following sections the work of a number of centres for evidence synthesis, such as the Cochrane Collaboration, the NHS Centre for Reviews and Dissemination, and the WHO Health Evidence Network, to ensure the inclusion of grey literature from government and non-governmental organisation sources as well as academic publications found through Medline, Embase and CINHAL searches. The literature reviewed was guided initially by existing reviews in each field, in some cases with specific search strategies that were re-run to capture more recent publications that post-dated a review paper, with snowballing of references from key papers identified, and hand-searching of selected journals flagged for current awareness and retrospective searches, with the aim of giving a comprehensive if not exhaustive review of the issues covered. Each section references the key sources and, although this study does not directly address falls prevention, several sections have been informed by recent guidelines and, as well as epidemiological reviews, also by reviews on assessment, management and interventions to reduce falls, resultant injuries, disability and other longer-term consequences (see Appendices A and B).

1.2.1 Population ageing

1.2.1.1 Trends in increasing longevity
1.2.1.2 Uncertain implications
1.2.1.3 Information needs

1.2.1.1 Trends in increasing longevity

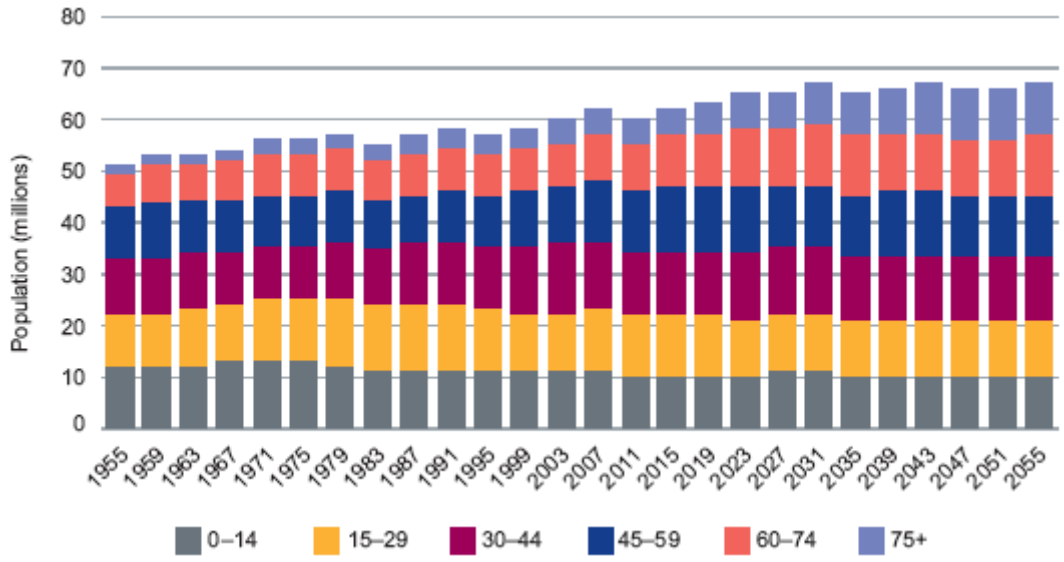
A quarter century ago the twentieth century conquest of "premature death" was already identified as enabling greater proportions of the population to live out a "natural lifespan" to the extent that population survival curves were becoming increasingly "rectangularised"[5]. Subsequent demography has described maximum life expectancy as following a steady linear increase from historical records to current data[6-9] and even suggested there is no reason this should not continue in future projections, implying there may be no such thing as reaching the limits of "natural lifespan"[10;11]. In the European Union the next twenty years will see a 30% increase in over-65-year-olds, with the numbers aged over 80 forecast to rise 39%[12]. Shifts in population age distribution towards the older end of the spectrum due to increasing life expectancy and falling fertility rates are most marked but not confined to the developed world[13-17].

Over the last century the total UK population rose by under 60% but in the same period (1901-2003) the number of people over 65-years-old rose five fold whilst the census data counts of the oldest old – 85-years-old or more – increased by a factor of eighteen. The oldest old by this definition made up 12% of the 65 and older group in 2003, four times the proportion of the same at the start of the twentieth century[2].

The projected rise in the UK population over the next half-century compared with the last 50 years is due almost entirely to the increasing proportion of older people (see Figure 1.2.1.1.1). Just over a tenth of the population was aged over 65 in 1950. Already this has risen to a sixth and the proportion is forecast to reach a quarter within the next 30 years[18;19]. Projections indicate that the working age population will barely increase over this period while the proportion of children will decrease. Within only two years people over State Pension Age in the UK will outnumber those aged less than 16 years old.

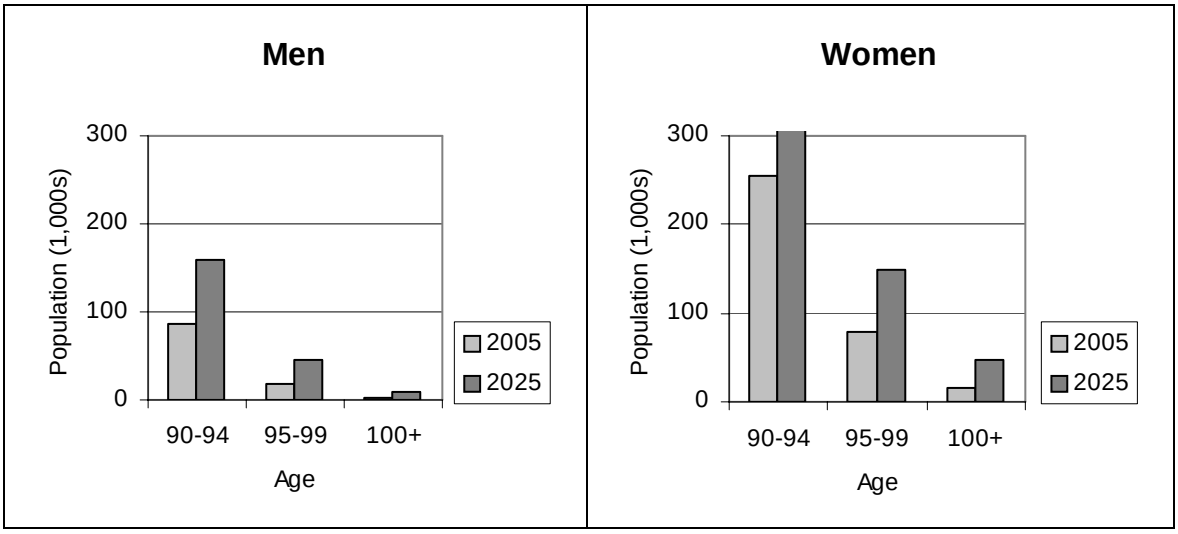
The fastest growing element of the population is the oldest group of older people. The term "oldest old" has been used loosely by many to refer to a various age-ranges from the broad "75 plus" age-band, often meaning 85 years and above - the highest categorisation readily available from census data, or sometimes taking decade cut-points such as "over 80s", "over 90s" and even centenarians. Throughout the 1980s the population of England and Wales aged 85 and over was rising 3.8% each year[20], while the number aged 90 or older had risen 58% by the end of the decade[21]. By 2051 the number of people in the UK aged 85 or older will have quadrupled to make up 6% of the population or about 4 million (GAD 2003) [18]. Even living to be 100 or more is no longer so very rare: there were approximately 2,500 centenarians a quarter century back[10;11], 10,000 now and official estimates expect this to rise to 136,000 by the middle of the 21st century[18]. Figure 1.2.1.1.2 illustrates the forecast rises in just twenty years for the population aged over 90-years-old.

Figure 1.2.1.1.1 UK age distribution 1955 – 2055



Government Actuary's Department (GAD), 2003 principal projections
and Office for National Statistics (ONS)

Figure 1.2.1.1.2 UK current and forecast population over 90 years old



Plotting data from U.S. Census Bureau, International Data Base, April 2005 version,
Government Actuary's Department (GAD) and Office for National Statistics (ONS)

1.2.1.2 Uncertain implications

The "greying" of the population is frequently portrayed as a threat to economic stability and a strain on the well-being of the population as a whole as the "dependency ratio" shifts[21;22]. Negative stereotypes abound, often phrased in terms of society bearing the burden of an impending demographic crisis. Quantifying the extent of this dependency is vital: attempts to estimate the current profile of disability and the resultant care needs of older people, for example in the UK's MRC- Cognitive Function and Ageing Study (MRC-CFAS), confirm high levels of physical, cognitive and combined disabilities especially amongst older old people[23]. However, whilst the very old and the cognitively impaired account for much of the demand for long term care, this study found large sections of even the most disabled elderly living outside the institutional care sector and maintaining their independence to a variable degree.

Even those who encourage positive views of ageing tend to be less positive about extreme old age. In his life course perspective on different social ages[24] Peter Laslett challenges the "self-evident nature of chronological age" but does not extend this challenge to what he terms "The Fourth Age". He originally described this stage as generally marked by "decline and decrepitude" though he subsequently modified this image[25].

However, the "oldest old" are not a homogeneous group and it should be stressed that age banding should not be taken to imply this[2;26;27]. Wide variations in the circumstances, well-being and attitudes of very old people are reported although most studies to date include too few very old people to be able to generalise about these differences.

It has been argued that longer lives will not inevitably mean extended periods of reduced health, with the same logic that proposed the "rectangularisation" of the mortality curve suggesting a similar effect in the compression of morbidity[5]. Whether longer survival will lead to compression or expansion of the number of years lived with disability or morbidity is still a matter of debate[12-14;28-36]. There is some evidence suggesting that older old people may often be the most "successful agers" who thus make fewer demands on support services[5;21;27;31]. There is also an alternative

suggestion that, whilst expectancy of life with severe disability may be declining, years of remaining life with light or moderate disability may be on the increase[4;37-40]. It has been estimated that by the age of 90 men can expect to suffer from at least two of three broad areas of disability (physical, functional and cognitive) for 30% of their remaining life expectancy, and for women the estimated proportion of remaining years with disability affecting two or more areas is double, 60%[41].

1.2.1.3 Information needs

These forecasts have major implications for planning services to meet the needs of an ageing older population. As the number of people living longer rises, research needs to capture data reflecting changes already happening to inform policy in the making now that will affect older people in the future.

Demographic transitions already underway will lead to inevitable changes that, to some extent, they also serve to mask at present. The "baby-boom" generation are currently in middle age, thus the older generation now have a larger supporting population than older people who follow them are likely to have[42-47]. The social ramifications of changing life and health expectancies are as important as the economic consequences, perhaps even more so[32;48-50]. There is a greater need than ever for research to provide answers to questions with enormous implications for resource use such as - How are living arrangements, social networks and the availability of formal care or informal support changing? Are the numbers of old people living alone rising? Who has family living nearby? What might longer lives mean for the prevalence of long-term disability, chronic disease, physical frailty and declining cognitive function? What will be the impact on social care and services, or on society as a whole?

The future is inevitably uncertain[43;51-53] but research into old age has a vital role to play in monitoring trends; attempting to interpret changes already happening now may help prepare for the future.

1.2.2 Researching advanced old age

1.2.2.1 Routine data sources
1.2.2.2 National cross-sectional surveys
1.2.2.3 Longitudinal cohorts
Age ranges
Studies of the oldest old
Themes
1.2.2.4 Ethics and logistics
Ethical issues
Practical issues
Attitudes of older people to research participation

Britain's "oldest old" population has already almost trebled in just over three decades (from 485,000 people age 85 or older in 1971 to over 1.1million in 2003) and is set to double again within the next quarter century[1], as the previous section reports in more detail. With rising numbers of people living to a very old age, the need for information about this section of the population is clear but gathering it is not straightforward. A variety of possible sources of such information exist already, all of which have their own particular difficulties.

1.2.2.1 Routine data sources

Routinely kept records on whole populations – for example mortality records, pensions and benefits data, the General Practice Research Database or hospital episodes statistics – have the advantage of avoiding the potential selection bias that besets any sub-sample selection. However, such sources are not designed to answer every question researchers may be seeking to address so it is often not possible to extract the data needed. Death certification is beset by well-recognised problems[54;55], the most pertinent to the aims of this present study being the uncertainties around the cause of death data. There is little standardisation of practice in reporting even hip fracture – a major precipitating event – as a contributory cause of death if, say, the primary cause is documented as a pulmonary embolism or pneumonia that developed post-operatively[56;57]. Even less likely is any mention of a fall that led to the fracture. Health service statistics pose problems especially related to timing and coding. Re-admissions and frequent moves between wards or specialists make even tracking length of stay difficult. Crucially for research on the very old, there has been no standard coding for

an accidental fall, although attempts are now underway to address this (see section 1.2.3).

1.2.2.2 National cross-sectional surveys

In many countries there are a variety of nationwide cross-sectional surveys, often government run but sometimes independent, that attempt to collect data regularly from across the whole population spectrum on a diverse range of themes from, say, diet to crime. Some of the major UK surveys are potentially sources of valuable information on the lives of older people, for example the General Household Survey (GHS), the British Social Attitudes Survey and the Expenditure and Food Survey. However, these samples include limited numbers of very old people, for example of the 3,000 people aged at least 65-years-old in the GHS only 300 are aged 85 or older[1]. The largest sample of very old people in such national surveys is 800 people out of 45,000 households in the Family Resources Survey, but this has one of the lower response rates (63% over-all in the latest survey)[58]. Even surveys specifically addressing old age, such as the Retirement Survey[59] and the new English Longitudinal Study of Ageing (ELSA)[60] which is starting to follow-up a panel from the cross-sectional Health Survey for England, are focusing on a younger section of the older population. Census data and the Samples of Anonymised Records[61] derived from the two most recent censuses are of course the most complete UK cross-sectional surveys, but their age-banding also imposes limitations. For historical reasons, dating from an era when the number of older old people was too small to warrant finer analysis categories, census data has traditionally grouped older people as 65-74 years, 75-84 years and 85 years or more if any breakdown at all is used.

1.2.2.3 Longitudinal cohorts

Age ranges
Studies of the oldest old
Themes

Given the limitations of routine data and cross-sectional surveys, even at a nationally co-ordinated level, researchers have sought to address many aspects of ageing through specific studies designed to investigate old age longitudinally. Following a specific

cohort over time provides greater opportunities to understand the complex processes that may be affecting the development of disability and frailty or contributing to successful ageing and increasing longevity. Unravelling questions of causation is impossible with single time-point surveys but, although longitudinal studies offer advantages over cross-sectional approaches, they also pose new methodological challenges, including how to reflect changes over considerable lengths of time with up-dated measures whilst preserving constant core instruments that are necessary to show time series data[62-65].

Over the last quarter century dozens of longitudinal ageing studies have begun worldwide; a few have been running even longer and many of them are still on-going.

Age ranges

The age-ranges included vary widely with the focus of enquiry and each country's circumstances, for example in the World Health Organisation's new Longitudinal Study of Aging in Africa[66] takes "50 plus" as old, but this is also the lower limit in the English Longitudinal Study of Ageing (ELSA)[60] as it seeks to examine transitions into retirement and the origins of later disability. For similar reasons as ELSA's, other studies have also focussed on middle-aged and younger old people: 55-85 years at baseline in both the Netherlands' Longitudinal Aging Study Amsterdam (LASA)[67] and Australia's Victoria Longitudinal Study on Aging (VLS)[68]. Other studies of ageing take a broad life-course approach[69], for example the Dutch Maastricht Aging Study[70] includes people aged from 20 to 80, and the Swedish Betula Project[71] sample are aged from 35 upwards. Over time naturally these younger cohorts will provide invaluable long-term data on the ageing process, for example one of the earliest studies, the Baltimore Longitudinal Study of Aging, recruited 3,000 people aged 20 to 100 in 1958, the youngest of whom are now all in retirement.

However, the majority of ageing studies have taken 60, 65 or 70-years-old as their starting ages and, generally speaking, the number of participants of advanced old age is very small. Sometimes deliberate design decisions to over-sample older age-bands attempt to strengthen analytical power in older groups, as was planned in the Medical Research Council's Cognitive Function and Ageing Study[23]. There is a growing move to link up data from several countries across a region, thus building sample sizes for

smaller groups such as the very old and enabling cross-national comparisons, the major European developments including SHARE[72;73], HALE[74], CLESA[75] and the ESS[76]. However, often these wider collaborations include countries with relatively limited proportions of the population reaching advanced old age, such as the Comparative Study of Aging and Health in Asia[77] and SABE – Salud, Beinestar y Envejecimiento – Survey on Health, Well-being and Aging in Latin America and the Caribbean[78].

Studies of the oldest old

A handful of studies have set out specifically to research the "oldest old", whilst a few more of the longer-running programmes that began with "older" samples of people aged 75 or more, now have survivor samples aged at least 85- or 90-years-old. Pioneering research into successful ageing and quality of life in advanced old age began almost two decades ago with surveys of over-85-year-old East Londoners, but follow-up lasted only a few years[79]. The largest yet – the Determinants of Healthy Longevity in China[80] – interviewed over 9,000 people aged at least 80 in 1998, including one octagenarian and one nonagenarian from the same district for every centenarian recruited, with more recent surveys rising to over 16,000 including survivors, replacement sampling and interviews with relatives. Europe also has a number of centenarian studies, for instance in Denmark, Sardinia and Italy[81;82], and Scandinavia in particular maintains a number of very old cohort studies: the Swedish NONA immune study[83], OCTO and OCTO-Twin studies[84], Danish Aging Twins[85] and the Danish 1905 Cohort Study[86]. Three "85-plus" studies that are currently active in northern Europe are worth noting because of some similarities with the Cambridge City over-75s Cohort (CC75C) on which the study for this thesis is based. The Dutch Leiden 85-plus Study[87] recruited almost a thousand people in the late 1980s by contacting every resident of the city as they turned 85, then a second cohort of nearly 600 85-year-olds a decade later. The smaller Umeå 85+ Study[88], which forms the oldest age arm of the Betula Project[71], enrolled almost 200 very old people from a random sample from half those aged 85, all those aged 90 and everyone aged 95 or more at the new millennium in one northern Swedish municipality. In the UK, the North East 85+ Study[89] is currently recruiting as many 85-year-old Newcastle residents as possible, with a planned 5-year follow-up.

Themes

The majority of these "old old" studies involve inter-disciplinary approaches to explore cross-dimensional aspects of inter-related processes that can affect extreme old age, for instance no study of health and disability would be complete without also considering, say, support networks, community/institutional care provision or economic inequalities. Even the studies that have had specialised areas of interest, for example the Swedish[90] Kungsholmen Project with its focus on dementia and cognitive functioning, examine these in the context of social interactions, independence and quality of life.

Some of these studies of advanced old age share some common themes with CC75C, but, by and large, the areas of overlap with the current study's focus are limited. Whilst most studies of advanced old age groups include assessments of cognition, and a fair number also take functional performance measurements [81;88;91;92], no publications from these were found in extensive searching to have included any measures of bone strength and only three have collected or are currently collecting data on falls in late old age: the three 85+ studies in Leiden, Umeå and Newcastle, none of which are using prospective falls data collection. At the time the survey for this thesis began none of these studies had published any of their data relevant to the research topic, though recent publications have included two on falls from Leiden's second wave cohort[93;94] and one from Umeå on past hip fractures that found no association with reported falls[95]. Indeed a surprisingly small fraction of ageing studies overall have examined falling – searching bibliographic databases and study websites of 52 other longitudinal ageing cohorts and collaborations revealed only nine have any publications relating to falls in old age (see Section 1.2.3). Most of these studies published falls data after the survey for this thesis began. Other UK studies are known to be still currently gathering data on recalled falls (ELSA, Melton-Mowbray and the new North East 85+) and, as this area of research continues to expand, others elsewhere may also be addressing this important topic. Section 1.2.3 addresses the particular problems that beset falls research and the sources of known falls data to date, after the following section 1.2.2.4 considers some of the difficulties that affect all areas of research into old age, and particularly advanced old age.

1.2.2.4 Ethics and logistics

Ethical issues
Practical issues
Attitudes of older people to research participation

Ethical issues

Old age research raises particular problems that must be addressed both for the well-being of old people who may participate and for the integrity of the research itself. Not only are there formidable practical hurdles to surmount but, especially with the very old, the ethical context of research is crucial[96-99]. The current legislative and research governance environment rightly lays great emphasis on the protection of potentially vulnerable groups, and clearly ageing studies of cognitive impairment, frailty and end of life issues involve participants who require special consideration[100;101]. However, it has been argued that, in the name of preserving research standards and individual rights, by treating all the elderly as potentially vulnerable and insisting on excessive safeguards, some research ethics committees now err on the side of over-protection and unwittingly deprive competent older people of their voice and compromise the validity of research[102;103]. For example, confidentiality concerns often put GPs in the position of "gate-keepers" to the extent that reduced study enrolment produces an unrepresentative sample.

The long-standing ethical debate over consent to take part in research is now broadening to consider, conversely, the ethics of *not* including older people in studies, and of research not addressing issues of major importance for older people. There is increasing recognition of the problems that stem from the almost total exclusion of older people from clinical research trials to date[104-106]. As a result of the many practical issues that make research involving older people difficult, and the impossible goal of recruiting only those rare "pure" patients with, say, a disease of interest and no confounding co-morbidity, most trial patients are atypical of the majority of older people who are likely to be considered for the treatment under development[107;108]. Recent calls for more trials and other studies to include older people[103;109] and to consider appropriate design considerations[110;111] are pertinent to all studies of ageing, especially with the frail[108;110], cognitively impaired and those approaching the end of life[112]

Practical issues

There are many acknowledged difficulties in researching advanced old age, from study design, gaining access to potential participants, recruitment, data collection, retention, to data handling and analysis.

When first seeking to enrol very old people in a research study, there are considerable problems of even contacting them, as sensory, mobility or cognitive impairment may pose obstacles to recruitment channels used with younger age-groups[113]. Family members may view research participation as too burdensome for an older relative and seek to restrict access. There are additional procedures to be dealt with when trying to include long-term care residents, usually involving the institution's administration, care staff and, possibly distant, relatives[114]. For those living in the community, especially those living alone, there can be different obstacles arising from the older person's concerns about what research might involve. This could include wariness of strangers, particular fears about impostors and crime, embarrassment about home conditions or perhaps their own disabilities, worry about not being able to hear or answer questions, anxieties about what an interview may cover or even uncover, particularly pertinent to questions about functional capabilities that some people suspect might mask a hidden agenda – the assessment of inability to cope. Research ethics demands that investigators guarantee the minimisation of harm to participants and, if hoping to maximise participation, researchers need to be aware of older people's perceptions of all such potentially negative aspects of joining a study[100]. If a low response rate cannot be avoided, the resultant incomplete coverage of the population raises serious sampling error and validity issues[115].

Sensory and cognitive impairment can pose challenges, both the obvious communication difficulties and the ethical issues of competence to grant fully informed consent[108;116]. It has been reported that requesting written consent reduces participation compared with just asking for verbal permission[117]. There are precedents for ethical approval being granted for proxy consent to be obtained[118], but a framework of good practice needs to be clearly defined at the outset[100]. Some have raised questions about the seeking of consent from relatives, particularly in end of life situations, and suggested that they may consent when the old person would not have done so[119]. Frailty and co-morbidity may reduce an older person's ability to complete a study's

usual full protocol if too burdensome[115], and increase the likelihood of confounding or incomplete data[120]. Mortality is high in very old age: deaths before and after interview play a major part in low study recruitment and subsequent attrition[108;113]. Decisions are then required on how to handle analysis if items are missing or responses appear inaccurate[121;122]. There is no gold standard against which to assess the accuracy of information since other data sources, such as GP case notes, are known to under-record many common health problems reported by older people themselves[123]. The use of proxy informants, not only for consent but also as sources of information, offers one approach to these problems but is not without difficulties[115]. Proxies tend to be more widely used the older the age of the participants[120], but it is worth noting that proxy informant themselves are often also old. Concordance between proxy- and self-report is variably reported from poor to remarkably good, with some systematic differences; the main factors associated with better accord being the frequency of contact and length of time the proxy has known the participant, rather than the degree of relationship[124-127].

The logistical difficulties involved in recruiting older people to research studies are rarely reported, but the few published examples of strategies adopted to meet these challenges are instructive, particularly those describing approaches to vulnerable groups such as palliative care patients[102], nursing and residential home residents[114;128], or people with mental health problems including depression and cognitive impairment[129].

Attitudes of older people to research participation

Despite the many difficulties discussed above, it is important also to 'accentuate the positive' in old age research. Even amongst the extremely old, many people are willing participants in research, sometimes at considerable expense of time and trouble to themselves. Motivation reported includes a wide range of reasons, including interest, hoping the study tests would serve as a check-up, enjoying the company, liking the researcher and altruistic "wanting to help other people", or in this very old age-range "feeling it's time to give something back"[130;131].

1.2.3 Researching falls: methodological issues

1.2.3.1 Classification and definition
Classification of falls
Definitions of falling
1.2.3.2 Measurement of falls by retrospective recall
1.2.3.3 Measurement of falls by prospective follow-up
1.2.3.4 Surveillance of documented falls and injuries
1.2.3.5 Falls data collection issues
1.2.3.6 Analysis of falls data

Besides the general aspects of research with older people, and especially very old people, discussed in the previous section, notoriously difficult issues of measurement and method beset research focussing on older people's falls. This section describes some of the crucial methodological issues in this field of research that need to be addressed in the translation of study objectives into study design, fieldwork and analysis.

1.2.3.1 Classification and definition

Classification of falls
Definitions of falling

A fundamental question in any research, different definitions of what constitutes a fall and various interpretations in clinical practice and study procedures all pose problems for falls measurement from both routine and research data.

Classification of falls

As mentioned briefly in section 1.2.2.1 *Routine data sources*, even monitoring the number of old people attending an Accident and Emergency department because they fell has been greatly complicated by the lack of any standard coding in the UK and internationally. Resultant injury is often the only information recorded but often the main problem, for coders and clinicians alike, is that the main reason for admission is not injury (which may be minimal or even none) but the older person's need for care because of their repeated falling. Classification options under ICD-10 (the International Classification of Diseases version 10) often used include R26.2 Difficulty in walking, R27 Ataxia, R42 Dizziness and giddiness, R55 Syncope and collapse and, all too often when none of these apply, R54 Senility. The process of agreeing on an appropriate replacement for these clearly inadequate options is now underway and the NHS

Information Authority has also been consulting on a new draft Dataset for Falls that may go some way towards addressing the crucial need for accurate data on falls presenting to medical attention. However, it will be some time before such agreed datasets are implemented and such data becomes available.

Definitions of falling

In 1987 the Kellogg International Working Group on the Prevention of Falls by the Elderly defined a fall as "unintentionally coming to the ground or some lower level other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or seizure" [132]. Since then this has become the most widespread definition used in falls research, the majority of investigators choosing to follow the view that collapsing due to syncope constitutes a very different problem to the classic perception of a fall. However, some researchers take a more inclusive approach[133] arguing that, as so many falls are unwitnessed, it is impractical to rule out loss of consciousness. Yet others have applied more stringent or specific criteria, preferring to measure, say, only documented falls, only falls that result in injury or only falls that present to medical attention. Caution is essential when attempting to compare data collected using definitions such as these that may appear broadly similar but clearly could vary widely depending on the circumstances in which they are applied. A new systematic review of fall measurement methods and definitions found that half the publications fitting their review criteria gave no details of how a fall was defined[134].

All findings from previous studies overviewed in the remaining sections of Chapter 1 must be considered in the context of how their measures of falling were obtained. The sub-sections below introduce the range of approaches taken in by other researchers.

1.2.3.2 Measurement of falls by retrospective recall

Pioneering early work on the descriptive epidemiology of falls was based on case series reports[135], interviewing subjects who had presented to hospital with falls or non-random community sampling[136]. Other retrospective approaches were used in large studies in the 1970s and 1980s. The Newcastle Study[137]applied case-control methods to a large scale community survey, and the cross-sectional survey that formed the starting point

for the Nottingham Longitudinal Study of Activity and Ageing reported falls data gathered from home interviews[3]. Asking people to recall their falls is obviously a less time-consuming and costly option than most other methods, so continues to be a popular survey approach[138]. It has been the chosen method when falls data are sought in the context of other on-going epidemiological research with large population cohorts. For instance, the Dubbo study of mortality and morbidity predictors in the elderly was expanded to include gathering fall and fracture data retrospectively[139]. However, the length of recall period used can have considerable effects on the data gathered[140].

1.2.3.3 Measurement of falls by prospective follow-up

Under-reporting of falls is a largely un-quantified problem with recall methods, so a prospective approach has become the method of choice in falls. When thoroughly planned and rigorously executed, a prospective cohort design can potentially provide a fuller picture than reliance on retrospective recall. However, the majority of currently published studies of this design report on just one or two years of follow-up. Only one study to date has continued long-term fall recording, using three-monthly falls diaries for up to seven year's follow-up of an original 1016 people in rural townships near Oulu, northern Finland[141]. Funding limitations explain the dearth of long-term studies using these high-cost methods. Fewer than half the studies in a recent systematic review of fall measurement methods used prospective data collection[134].

To follow-up falls prospectively a variety of methodologies have been tried, as can be seen from Table 1.2.3.3 These range from methods that ask study participants to regularly report back to the study centre – for instance by sending in report cards whenever they fall or by completing a weekly falls diary, fortnightly postcard, monthly calendar, or a regularly mailed questionnaire – to methods that are more labour-intensive for the research team, such as home visits or telephone follow-up, either whenever a fall is reported or at regular intervals regardless of fall reports.

The majority of these methods used in prospective studies still rely on participants' self-report. It is rare for community-based studies to include interviews with proxy

informants as part of their methodology[142-144], though in institutional settings the use of nursing records and reports from care staff are more the norm.

It is important to distinguish between studies that use prospective falls data collection methods as just discussed and longitudinal studies that are following their cohorts prospectively but only collect data on falls retrospectively through periodic surveys that ask about recalled falls. Section 1.2.2.3's overview of longitudinal cohorts in old age research mentions that only nine out of fifty-two longitudinal ageing studies, and just one of the "old old" ageing studies (Leiden 85-plus[93;94]), have published findings relating to falls. There was one study from the UK – the Nottingham Longitudinal Study of Activity and Ageing[3;145;146]; one from Japan – Tokyo Metropolitan Institute of Gerontology's Longitudinal Interdisciplinary Study on Ageing (TMIG – LISA)[147]; two from the Netherlands – LASA [148-152] and the Groningen Longitudinal Study of Ageing (GLAS)[153], plus five from the Americas - the Longitudinal Study of Aging (LSOA)[154;155], New Mexico Aging Process Study (NMAPS)[156], the Women's Health and Aging Study (WHAS)[157;158], the Health, Aging and Body Composition Study (Health ABC)[159] and a joint study combining the Hispanic populations in EPESE with SABE[160]. Of these, only one used prospective fall report methods (LASA asks participants to fill in fall calendars weekly and return them every 3 months), and one about remembered falls over a period less than a year (women in WHAS are re-interviewed 6-monthly). The remainder were either examining risk factors or reporting other outcomes, such as health care use, institutionalization or death, in relation to recalled falls measured at baseline, or asked for recall of falls in periodic interviews with intervals of at least a year but that could be up to four years apart, as in the Nottingham study.

Table 1.2.3.3 Falls measurement methodologies used in prospective studies of falls

Falls measurement methodologies	Studies that used the different methodologies
Postal follow-up	
Questionnaires mailed	- every month[161] - every 2 months[162] - every 3 months[163] - every 4 months[164] - every year[165;166]
Postcards	- weekly[167-170] - fortnightly[171] - every 2 months[156] - every 3 months or if fell[172] - every 4 months[173-176] - if fell[142]
Fall calendars	- monthly[177] - collected every 2 months but filled in weekly[178] - sent back every 3 months but filled in weekly[179]
Telephone follow-up	
Regular	- every 4 weeks / every month[142;143] - every 2 months[156;156;180;181] - every 3 months[167] - every 6 months[169;172;182]
As necessary	- if no postal return received[143;162;164;167;177;179] - if fall reported[162;164;170-172;177;179]
With proxy informant	- every 4 weeks / every month[142] [143;144]
Face-to-face interviews (home visits or clinic assessments)	- every 4 months[161] - every 6 months[157] - every year[94;147;156;183;184] - every 3 years[179] - baseline and study end[142;163;167;168;177] - if a fall reported[167;171]
Documented falls	- records kept by nursing / care home staff [161;172;185-194] - records kept by home care services[195] - hospital / GP notes to verify injury reports [142;172;177] - hospital in-patient records / incident forms[196-200] - routine data surveillance[201 202] [203;204]

1.2.3.4 Surveillance of documented falls and injuries

Some researchers have used injury surveillance systems already established in some areas, with Scandinavia notably offering the most comprehensive coverage. Others have compiled their own datasets from sources in which falls are routinely documented (such as primary care or A&E department notes) or record-keeping specifically set up for research purposes (such as log sheets devised for a residential care home study).

Searching for documented evidence of falls is extremely time-consuming and only a minority of studies have attempted to measure documented falls as well as reported falls. Apart from the obvious practical difficulties involved, this methodology also raises the problem of accounting for falls that are never documented. Only an estimated 24% of falls that occur at home ever present to medical attention[205], and it has been suggested that women were twice as likely to seek treatment as men[206]. When older people do report their falls there is often poor recording of this information, not only of the details concerning the fall but often even the fact that attendance was due to a fall is missing from the medical records, as shown in two recent UK studies in different settings. In the primary care setting, a study of osteoporosis data on GP information systems found that falls were far less likely to be recorded as contributory factors to fracture than the much rarer secondary causes of osteoporosis[207]. The same under-recording was found in an acute hospital setting: a survey of older people who attended Accident and Emergency with an injury found no mention of a fall in A&E records for 38% who reported falling as their reason for visiting the casualty department[208]. Despite legal obligations for employers and employees regarding reporting of accidents in the health service, the majority of which are falls, hospital incident forms are notoriously incomplete, perhaps not surprising given that up to 80% of in-patient accidents are not witnessed[209]. Even in nursing homes, where most falls do come to nursing attention, documentation of these falls is also known to be patchy[210;211]. Given these reports, the question of how representative documented falls are of falls in general needs to be carefully considered.

The longest overview of patterns of falls comes from a Finnish study which uses routine data sources for 25 years' retrospective trend analysis, focusing particularly on injurious falls – those most likely to be documented in the mortality data and in-patient recording

systems used[204;212;213]. Nevertheless there are difficulties in comparing studies across time, and especially in making international comparisons, not only because of changes in ICD coding, but also because of differences in the interpretation and application of coding and diagnostic criteria. Even major injuries resulting from falls, such as hip fractures, are not straightforward to monitor and experts recommend analysing both underlying and contributing causes of death since which label may be assigned, if any, varies from place to place[55]. Routine statistics from national sources are also limited in their ability to unpick important problems such as a small proportion of people accounting for a disproportionate percentage of, say, A&E attendances or treatment costs due to repeated falls and injuries[214].

1.2.3.5 Falls data collection issues

Recall bias is not entirely overcome by prospective designs. Study participants still need to be able and willing to remember to report falls occurring over defined periods, albeit usually much shorter intervals than is common in retrospective studies where surveys usually asked about falls "in the last year". However, shorter-term recall is not necessarily more reliable, as the classic "forgetting falls" study showed[167]. In this comparison of weekly postcard reports of falls with recall in 3 monthly telephone interviews, 1 in 3 people aged 60 and over did not remember a fall they had reported less than 3 months earlier, even falls that had resulted in serious injury that had been observed by the study nurse at a follow-up visit. The proportion forgetting falls that occurred 6 and 12 months before was surprisingly slightly less not more. A similar pattern was uncovered by the Oulu study of almost a thousand Finnish men and women aged over 70 where diary and telephone reports were also compared with medical notes. Only 43% of falls had been reported by the 3-monthly falls diaries, only 36% in 3-monthly phone interviews and a further 21% of all known falls were identified only by review of the medical notes[206]. Decreasing fall rates were obtained from Japanese men when prospective fall monitoring was carried out at increasing time intervals[215], illustrating again how follow-up interval affects results, just as recall period does in retrospective studies [140].

Reluctance to admit to falling, "not counting" falls that were "just an accident"[216] or "not worthy of being reported"[210], and memory all play a part in the under reporting of the extent of falling as a problem for older people. Each of these is often inter-related with other factors for which it is difficult for research methodologies to fully allow, such as embarrassment or shame, not wanting to be a burden, anxiety about loss of independence or transfer to institutional care[210;217]. Qualitative research methods may have a role in informing future studies that need to know how best to combine sensitivity to this multi-faceted problem with robust reporting methods that can provide reliable quantitative data on falls.

1.2.3.6 Analysis of falls data

The problems of definition and ascertainment outlined above contribute to the complexity of analysing data on falls. The resultant plethora of measures by which findings are reported and statistical methods used to obtain these can be confusing, as the summary in Box 1.2.3.6 illustrates. Comparison between studies are of course hampered by non-comparable measures and there is a risk that erroneous conclusions may be drawn from epidemiological and intervention studies when these methodological difficulties are not fully appreciated.

Over recent years systematic review and synthesis by collaborative research groups, with strong clinician involvement, have made an enormous contribution to falls research field by attempting to recommend minimum standards and core datasets that researchers could all report in order to reduce these inconsistencies in future. The Common Outcome Dataset for Fall Injury Prevention Trials developed by the Prevention of Falls Network Europe[218] has provided important reporting guidelines, many of which are as applicable to epidemiologists as to clinical trialists. Some of the methodological difficulties in falls research arise in the study of other recurrent, frequent health problems which pose specific challenges for analysts[219;220]. The many different analytical approaches to handling the particular problems of data on falls, such as the effects on measurement units on risk estimates[221], prompt regular debate in correspondence following fall publications but authoritative clarification was recently provided from New Zealand by one of the longest established falls research groups[222].

Falls data typically have widely dispersed non-normal distributions with frequent, recurrent events, a sizeable proportion of samples scoring zero and variable lengths of follow-up. Negative binomial regression, a form of Poisson regression that adjusts for over-dispersion, has been recommended as the best technique to handle such data and allow adjustment for the effects of multiple covariates that may also affect fall rates. Whether past falls should be included when attempting to control for other variables, or whether this amounts to over-adjustment that may mask the effects of other variables, is another statistical issue to be faced, but one on which there is no clear concensus[219].

Box 1.2.3.6 Variability of falls data

Outcome	Falls (various definitions) Documented falls Falls requiring medical attention Injurious falls Fall-related injuries or serious injuries
Recall / follow-up period	Varies enormously
Event rates	Incidence of falls Rate of falls/person-year or 100 p-yrs or 1000 p-yrs falls/patient-day or patient-year falls/1000 bed-days or bed-years Prevalence of falling Proportion of people who have fallen (retrospective) fall (prospective) Prevalence - recurrent falling Proportion of people who have fallen / who fall more than once in the last/next …months/years more than twice in the last/next…months/years Time to first fall
Estimates of risk or association	Relative risk of falls Odds ratios for falling Hazard ratios for time to first fall

All these issues of ascertainment, identification, verification and analysis of falls by older people have important implications for the interpretation on data from previous research and the current study.

1.2.4 The epidemiology of falls and their consequences in old age

1.2.4.1 Falls frequency estimates in different populations
- Community studies
- Falling in relation to age and sex
- Recurrent falling
- Falls in institutional care
- Falls in hospital

1.2.4.2 Injuries, long lies and deaths
- Fractures and other injuries
- Inability to get up after a fall
- Mortality

1.2.4.3 Psychological and social consequences
- Activity restriction and increased dependency
- Fear of falling

1.2.4.4 Implications for health and social care
- Health care
- Social care
- Costs

1.2.4.1 Falls frequency estimates in different populations

Community studies
Falling in relation to age and sex
Recurrent falling
Falls in institutional care
Falls in hospital

There has been an explosion of research interest in falls in the last couple of decades, with more focus in recent years on translating epidemiological findings into intervention strategies (see Appendices A and B and explanation of search strategy in the introduction to this section 1.2 *Background: related research to date*). However, although there is already a large body of descriptive epidemiological work on older people's falls, only a small fraction of the studies to date have concentrated on the older spectrum of the old age range and periods of observation have generally been limited. Tables 1.2.4.1-5 summarise the methodology used and measures of fall frequency reported by key cross-sectional, prospective and surveillance studies in community-dwelling and institutionalised samples and from population-based studies, presenting information on the study population's sample size, age range and gender; length of follow-up (if prospective) or period of recall (if retrospective); and falls measurement methods used.

Community studies

Generally speaking estimates from retrospective recall data (see Tables 1.2.4.1) tend to be slightly lower than from prospective studies (see Tables 1.2.4.2). The much quoted figure – that a third of old people fall each year – is a common finding in sample populations aged 65 or more, though estimates range from under 20% up to 44% in retrospective studies from different countries with differing age-ranges. Even amongst "healthy older people" 15% recalled falling in the past year[223].

In prospective studies of community-dwelling older people the range of reported prevalence of falling during a year's follow-up (29% to 52%) is a little higher than prevalence from a year's recall, but still with the most common estimates at around a third from studies of over-65-year-olds. Note that the higher rates in Table 1.2.4.1.2 are reported from studies that included older people particularly at risk of falling, for instance those who had fallen at least twice in the last year (57%[167-169]) or frail older people being discharged from hospital (50%[163]), from studies with follow-up for longer

than a year, and also interestingly from studies with volunteers[171;224;225]. Population-based studies (see Table 1.2.4.3), that include older people living in care homes as well as in the community, also report higher prevalence of falling. This includes the only longitudinal study of the oldest old that has reported fall rates – recalled falls in the year before interview of Leiden 85-plus Study participants gave a prevalence of falling as 49%, close to the 44% reported to have fallen in the following year[94].

Falling in relation to age and sex

Whilst the majority of studies report that falling is more common in older age groups, the common perception that women fall more than men is not so consistently supported by research findings to date. Tables 1.2.4.1 and 1.2.4.2 show falls frequencies separately for men and women if available from published data, and for the oldest age-band reported, as well as overall rates for each study. These illustrate the sometimes conflicting picture as regards the effects of gender on falls at different ages.

Studies with participants aged 75 or older[181;226], or reporting their highest age-band as "75-plus"[170] found 32% - 42% prevalence of falling in a year, within the range reported for over-65-year-olds. The range is similar in studies reporting annual prevalence at age "80-plus" (29% to 41%)[137;139;143;147] but a little raised in the "85-plus" age group (35% to 51%)[3;94;137;138]. One 'out-lying' result comes from a small volunteer study that reported annual fall prevalence as 58% based on only 12 individuals aged over 80 years[171;224].

Community studies in which women were found to fall more than men overall span two decades of research from the UK[3;137], north America[143;170] and Europe[227]. However, three of these studies found no significant gender differences in falling in older age-bands[3;137;143]. Others report no differences in men's and women's fall prevalence whether in young old age or in the oldest ages they recorded[142;147;205]. There is a growing body of evidence that being female does not increase overall falls risk[138;142;147;159;171;179;182;183;205;224;228]. Only one study reported that women fall significantly more than men in older age-bands, though they found no sex difference in younger age-groups[179].

One of the Japanese studies which reports far lower rates that most others interestingly found at baseline that recalled falling suggested the prevalence of men falling was almost half that of women[229], but in follow-up there was no gender difference[183]. Although it might be hypothesised that differences in methodology or sample populations may account for the variations between other studies, both retrospective and prospective studies have reported both gender or age effects and lack of effect from both.

The only study that reported rates for over-90-year-olds separately was one of Campbell and co-worker's early studies from New Zealand[142;205] that included only 17 (12 women and 5 men) aged 90 or more out of the total study sample of 761 people. Wide confidence intervals from such small sample sizes render the difference between women's and men's incidence rates at this age (199 vs 40/100p-years) non-significant. The authors report 121 falls per 100 person-years amongst people aged 80 or older, with no gender differences when the oldest three age-bands are combined. Small samples in the highest age-bands of many studies are likely to contribute to the great variation found in falls rates for both men and women.

Higher rates are generally reported for women in population-based studies monitoring falls injuries or admissions (see *Table 1.2.4.1.3*). A new study from Finland[230] reports a similar pattern but not, however, amongst the very oldest: men's injury rates were no less than women's over 90 years old. The gender difference in rates of presentation to medical care found in an earlier Finnish study is interesting[231], as the theory that men are especially likely to under-report falls has also been proposed[205].

Recurrent falling

Only a minority of studies provide details of fall frequency either as incidence rates or as prevalence of repeated falling. Reports of the proportion of community-dwelling older people who fall more than once in a year vary from 6% to 20%, the majority estimating that about a sixth are so affected. Rarely are rates of recurrent falling broken down by gender or age-band: 14% of octagenarians fell at least twice in a Canadian study with one year follow-up[143], and 29% of over-80-year-olds had two or more falls within a year in a prospective Japanese study[147]. Only two studies have reported annual

fall rates for the oldest age bands, the Dunedin[142;205] and Montreal[143] studies showing markedly different incidence (see Table 1.2.4.1.2).

Even fewer studies report how many people fall even more frequently. Eight per cent of Australian women aged at least 65-years-old in the Randwick Falls and Fractures Study recalled falling three or more times in the year before interview, and the same percentage fell this often in follow-up as well[232]. The proportion of older Japanese women in the Honolulu Osteoporosis Study who fell at least three times in a year was similar (5%)[164]. However, multiple falls are far more common in higher risk groups: a quarter of the over-70-year-olds in an Australian residential hostel[161] and one in five of study sample drawn from GP records of older men and women who had fallen in the previous year fell more than twice in the following year[167-169].

Table 1.2.4.1.1 Cross-sectional surveys of older people in the community – retrospective falls data

Author(s)	Study / Country	Population	Methods	Recall time	Prevalence ≥ 1 fall, ≥ 2 falls (if known)		
					Men ≥ 1 fall , ≥ 2 falls	Women ≥ 1 fall , ≥ 2 falls	All ≥ 1 fall , ≥ 2 falls
Blake et al[3]	Nottingham Longitudinal Study of Activity & Ageing baseline survey UK	n=1042 community-dwelling men and women aged ≥ 65	Interviewed by trained lay interviewer	Last year	24% ≥65 yrs 41% ≥85 yrs	42% ≥65 yrs 55% ≥85 yrs	35% ≥65 yrs 51% ≥85 yrs
Campbell et al[233]	Dunedin Study New Zealand	n=533 stratified population-based sample of men and women aged ≥ 65	Interviewed by research nurse	Last year	-	-	33%
Downton & Andrews[226]	Manchester UK	n=203 randomly selected men and women living in the community aged ≥ 75	Interviewed in own home	Last year	-	-	42% ≥75 yrs
Gabell et al[223]	Birmingham UK	n=healthy elderly men and women recruited through general practice aged ≥ 60	Interviewed in own home	Last year	-	-	15%
Gill et al[138]	Social, Environmental and Risk Context Information System Survey South Australia	n=2,619 (1,481 women +1,138 men) living in the community, random selection from phone directory aged ≥ 65	Telephone interview	Last year	27% ≥65 yrs -	32% ≥65 yrs -	30% ≥65 yrs 37% ≥85 yrs
Lord et al[232]	Randwick Falls &Fractures Study baseline survey Sydney Australia	n=704 community-dwelling women randomly selected from census aged ≥ 65	Interviewed by researcher	Last year	N/A	Women only	34% ≥1, 20% ≥2
Lord et al[139]	Dubbo Osteoporosis Study Sydney Australia	n=1762 (1060 women + 702 men) living in the community aged 60 – 100	Interviewed by nurse Postural stability tests	Last year	-	-	28% ≥1, 9% ≥2 ≥65 yrs 41% ≥80 yrs

Table 1.2.4.1.1 cont. Cross-sectional surveys of older people in the community – retrospective falls data

Author(s)	Study / Country	Population	Methods	Recall time	Prevalence ≥ 1 fall, ≥ 2 falls (if known)		
					Men ≥ 1 fall , ≥ 2 falls	Women ≥ 1 fall , ≥ 2 falls	All ≥ 1 fall , ≥ 2 falls
Niino et al[234]	National Inst. for Longevity Sciences Japan Longitudinal Study of Aging (NILS-LSA) baseline	n=1030 middle-aged and elderly men and women in NILS-LSA	Questionnaire about falls last year – frequency, circumstances and fear of falling	Last year	-	-	13% 40-59yrs 16.5% 60-79yrs
O'Neill et al[228;235]	part of EVOS - European Vertebral Osteoporosis Study Manchester, UK	n=1243 (726 women + 517 men) population-based sampling frame aged 50 - 79	Interviewed by trained lay interviewer	Last year	26%	26%	26% ≥1, 9% ≥2
Prudham & Grimley-Evans[137]	Newcastle Falls Study UK	n=2357 men and women living in a defined geographical area aged ≥ 65	Interviewed by health visitor	Last year	19% ≥65 yrs 33% 80-84y 41% ≥85 yrs	34% ≥65 yrs 44% 80-84y 32% ≥85 yrs	28% ≥1, 13% ≥2 ≥65 yrs 39% 80-84y 35% ≥85 yrs
Rekeneire et al[159]	Health ABC Study Pittsburgh and Memphis USA	n=3075 (1572 women + 1503 men) high functioning black and white community-dwelling elderly aged 70-79 years old	Baseline interview + physical tests for longitudinal study	Last year	18%	24%	21% ≥1, 6% ≥2
Reyes-Ortiz[160]	Survey on Health, Well-being and Aging in Latin America and the Caribbean (SABE) + Hispanic EPESE	n=9,765 in SABE n=1,483 in H-EPESE elderly men and women living in the community	Home interviews and assessments	Last year	-	-	22% to 34% across 8 sites
Sheldon[135]	Wolverhampton case series UK	n=202 men + women presenting 500 falls to hospital /GP aged >50	Interviewed by author in own home	N/A	Case series so no prevalence estimates	Case series so no prevalence estimates	Case series so no prevalence estimates

Table 1.2.4.1.1 cont. Cross-sectional surveys of older people in the community – retrospective falls data

Author(s)	**Study / Country**	**Population**	**Methods**	**Recall time**	**Prevalence ≥ 1 fall, ≥ 2 falls (if known)**		
					Men ≥ 1 fall , ≥ 2 falls	**Women** ≥ 1 fall , ≥ 2 falls	**All** ≥ 1 fall , ≥ 2 falls
Stalenhoef et al[227]	Maastricht, baseline survey for General Practice Study Netherlands	n=1660 men and women in postal survey of 4 GP lists' patients aged ≥ 70 (60% response rate)	Interviewed in own home, including functional and health assessment	Last year	31% ≥1, 12% ≥2	51% ≥1, 22% ≥2	44% ≥1, 19% ≥2
Yasamura et al[229]	Akita Prefecture Japan	n=807 men and women living in the community, random selection (baseline for follow-up study) aged 65-84	Medical assessment and interview	Last year	13%	22%	-

Table 1.2.4.1.2 Large cohort and small follow-up studies of older people in the community – prospective falls data

Author(s)	Study / Country	Population	Methods	Follow-up	Prevalence ≥ 1 fall, ≥ 2 falls if known			Incidence Falls/100 person-yrs		
					Men ≥ 1 , ≥ 2	Women ≥ 1 , ≥ 2	All ≥ 1 , ≥ 2	Men	Women	All
Berg et al[171;224]	Oxford OH USA	n=96 (58 women and 38 men) living in the community, volunteers from local adverts aged 60 - 88	Baseline visual + functional performance assessments Fortnightly report postcards Telephone follow-up after postcard report of fall	1 year	53% ≥60 yrs	52% ≥60 yrs	52% ≥60 yrs 58% ≥80 yrs	-	-	-
Campbell et al[142;205]	Dunedin Study New Zealand	n=761 (465 women + 296 men) from general practice population aged ≥ 70	Baseline assessment Report card sent in after fall Telephone follow-up every month by nurse Proxy informant interviews when needed	1 year	-	-	35%	70-74yrs: 47 75-79yrs: 60 80-84yrs: 99 85-89yrs125 ≥ 90yrs: 40	70-74yrs: 48 75-79yrs: 69 80-84yrs: 91 85-89yrs107 ≥ 90yrs: 199	70-74yrs: 47 75-79yrs: 65 80-84yrs: 94 85-89yrs112 ≥ 90yrs: 152
Cesari et al[195]	National Silver Network Home Care Project Italy	n=5,570 (3,280 women+2,290 men) community-dwelling elderly accepted for home care services mean age 77.2 years	Minimum Data Set HomeCare instrument administered on acceptance for home care Falls reported via homecare service	90 days	-	-	36%	-	-	-
Cummings[167] Nevitt[168] Northridge[169] et al	California & Columbia USA	n=325 (266 women + 59 men) able to walk, ≥ 1 fall in last year aged 60 - 93	Baseline interview incl. clinical assessment, neuro-muscular performance and visual function tests Weekly report postcards Phone interview every 3 months by nurse	1 year	-	-	57%	-	-	-
Davis et al[164]	Honolulu Osteoporosis Study Hawaii, USA	n=705 Japanese women mean age 74 +/-5	Baseline balance, strength, gait, ADL assessments Postal questionnaire every 4 months	33 months	N/A	Women only	30%	-	-	-
Donald & Bulpitt[184]	Gloucestershire Longitudinl Study of Disability UK	n=1815 men and women having 75+ health checks aged ≥ 75	Annual interviews (75-+ health checks)	3 annual surveys	9% in past 3 months	14% in past 3 months	12% in past 3 months	-	-	-

Table 1.2.4.1.2 cont. Large cohort and small follow-up studies of older people in the community – prospective falls data

Author(s)	Study / Country	Population	Methods	Follow-up	Prevalence ≥ 1 fall, ≥ 2 falls if known			Incidence Falls/100 person-yrs		
					Men ≥ 1 , ≥ 2	Women ≥ 1 , ≥ 2	All ≥ 1 , ≥ 2	Men	Women	All
Hale et al[170]	North Carolina USA	n=120 men and women ambulatory geriatric outpatients from a family medical practice aged ≥ 65	Weekly report postcards Telephone follow-up	1 year	20%	40%	36% ≥65 yrs 36% ≥75 yrs	-	-	-
Leveille et al[157]	Women's Health and Aging Study USA	n=1002 (n=940 in at least 1 f/up) community-dwelling disabled women aged ≥ 65	Baseline functional assessments Follow-up interviews every 6 months	3 years -falls in past 6 months	N/A	Women only	39% Y1 36% Y2 39% Y3	-	-	-
Lord et al[162]	Randwick Falls and Fractures Study Sydney Australia	n=341 women already taking part in Randwick Study aged 65 – 99	Balance assessment Postal questionnaire every 2 months Telephone interview if questionnaire not returned	1 year	N/A	Women only	39%	-	-	-
Maki et al[225]	Toronto Canada	n=96 ambulatory and independent elderly volunteers (men and women) aged 62-96	Balance tests in study lab, baseline interview Falls f/up	1 year	-	-	61%	-	-	-
Nikolaus et al[163]	Ulm Germany	n=279 men + women frail elderly case series just discharged from hospital	Follow-up questionnaires every 3 months Home visit at end of study	1 year	-	-	50%	-	-	-
O'Loughlin et al[143;236]	Montreal Falls Study Canada	n=409 (257 women + 152 men) living in the community aged ≥ 65	Baseline interview at home Telephone interview every 4 weeks Proxy informant interviews when needed	48 weeks	22,12% ≥65 yrs 41,18% ≥80 yrs	34,11% ≥65 yrs 36,13% ≥80 yrs	29,12% ≥65 yrs 37,14% ≥80 yrs	42.8/100p-y aged ≥ 65 65.9/100p-y aged ≥ 80	53.6/100p-y aged ≥ 65 65.9/100p-y aged ≥ 80	49.7/100p-y aged ≥ 65 65.9/100p-y aged ≥ 80
Salva et al[237]	Mataro Study of Ageing, Spain	n=448 men+women living in the community, representative cohort aged ≥ 65	Baseline interview, physical and cognitive assessments Repeated after 1 year	1 year	25%	37%	-	30.9/100 p-y	56.5/100 p-y	-

Table 1.2.4.1.2 cont. Large cohort and small follow-up studies of older people in the community – prospective falls data

Author(s)	Study / Country	Population	Methods	Follow-up	Prevalence ≥ 1 fall, ≥ 2 falls if known			Incidence Falls/100 person-yrs		
					Men ≥ 1 , ≥ 2	Women ≥ 1 , ≥ 2	All ≥ 1 , ≥ 2	Men	Women	All
Speechley et al[181]	Yale Health and Aging Project follow-up (Newhaven EPESE cohort) USA	n=336 (185 women + 151 men) elderly housing project residents + sampled community-dwellers aged ≥ 75	Baseline interview incl. clinical, balance and home hazard assessment by nurse researcher at home Telephone f/up 2-monthly	1 year	-	-	32, 9%	-	-	-
Stalenhoef et al[182]	Maastricht General Practice Study Netherlands	n=311 men and women living in the community (sample stratified on age, sex & falls history from survey of primary care patients) aged ≥ 70	Baseline + Yr 3 assessment Telephone follow-up every 6 weeks	3 years	34%	33%	33%	-	-	-
Study of Osteoporotic Fractures [173-176;238]	Study of Osteoporotic Fractures USA	n=9,704 women at baseline n differs in different publications at subsequent follow-ups but all > 6,000 aged ≥ 65	Baseline+ 2-yrly assessment Post-cards mailed 4-mnthly to ask about falls and #s	Up to 8 yrs On-going	N/A	Women only	63%	-	-	-
Suzuki et al[147]	Tokyo Metropolitan Institute of Gerontology - Longitudinal Interdisciplinary Study onAgeing Tokyo/Honshu Japan	n=685 (407 women + 278 men) living in rural community aged ≥ 65	Baseline+ annual interviews including clinical, visual, balance, strength and gait assessments	5 years	≥2 falls 23% ≥65 yrs 42% ≥80 yrs	≥2 falls 21% ≥65 yrs 22% ≥80 yrs	≥2 falls 20% ≥65 yrs 29% ≥80 yrs	-	-	-
Tinetti et al[180]	Yale Health and Aging Project (Newhaven EPESE cohort) USA	n=1103 (794 women + 309 men) elderly housing project residents + sampled community-dwellers aged ≥ 72	Baseline interview incl. clinical, balance and home hazard assessment by nurse researcher at home Telephone f/up 2-monthly	1 year	30% excl. falls with no serious injury	30% excl. falls with no serious injury	34,17% ≥72 yrs 37% ≥80 yrs	-	-	-

Table 1.2.4.1.2 cont. Large cohort and small follow-up studies of older people in the community – prospective falls data

Author(s)	**Study / Country**	**Population**	**Methods**	**Follow -up**	**Prevalence ≥ 1 fall, ≥ 2 falls if known**			**Incidence Falls/100 person-yrs**		
					Men ≥ 1 , ≥ 2	**Women ≥ 1 , ≥ 2**	**All ≥ 1 , ≥ 2**	**Men**	**Women**	**All**
Tromp et al[149;151;179;239]	Longitudinal Aging Study Amsterdam (LASA) Netherlands	n=1469 men and women living in the community (n=1365 or 1285 in some analyses) aged ≥ 60	Baseline+ ~3-yrly interview, physical and cognitive assessment Fall calendars filled in wkly returned by post 3-monthly	1 year	30,12% ≥ 60yrs 32,13% ≥ 80yrs	33,17% ≥ 60yrs 41,24% ≥ 80yrs	32,15% ≥ 60yrs	-	-	-
Vellas et al[156]	Albuquerque Falls Study New Mexico USA	n=405 men and women already volunteers in New Mexico Aging Process Study aged > 60	Annual interview including physical exam Falls postcards + telephone interview every 2 months	2 years	-	-	61%	-	-	-
Yasamura et al[183]	Akita Prefecture Japan	n=658 men and women living in the community, random selection aged 65-84	Baseline medical assessmnt interview repeated at 1 yr	1 year	17%	16%	-	-	-	-

Table 1.2.4.1.3 Population-based studies (community and institutional settings) – prospective falls and/or falls injuries data

Author(s)	Country	Design	Population	Methods	Length of follow-up	Prevalence /Incidence
Cryer et al [203]	South-East England UK	Retrospective case finding	Residents of South Thames (East) Regional Health Authority	Monitoring routine data sources- hospital in-patient records, OPCS mortality	3 years deaths 3 years in-patient records	Admissions due to falls Men >0.21 per 100/year Women >0.42 per 100/year
DeVito et al[201] Sattin et al[202]	SAFE study Miami USA	Community-based surveillance system	Residents of Dade County, Florida – 1827 fall injury events identified by surveillance of men and women ≥ 65	Monitoring records from Emergency Room, fire service, in-patient records, medical examiner	2 years	Fall-induced injuries aged ≥ 85 Men 13.85 per 100/year Women 15.88 per 100/year
EPOS Study Group[165;166]	European Prospective Osteoporosis Study 30 centres in 18 countries	Prospective cohort	N=6,302 men and women from population registers aged 50 – 79 years mean 63.9 ± 8.0 years	Baseline interviews and assessments Annual postal questionnaire	3 years	Falls Full sample centre range: Men 1.7-75.1 per 100 p-years Women3-52.5 per 100 p-years 75-79 yr-olds all centres: Men 22.3 per 100 p-years Women 35.3 per 100 p-years
Kannus et al[204;212;213]	Finland, nationwide	Retrospective secular trend analysis	All patients ≥ 50 years admitted to hospitals for a first fall-induced injury	Finnish National Hospital Discharge Register and Finland Official Cause-of-Death Statistics	25 years	Fall-induced injuries 1995 ≥ 50 years Men 972 per 100,000 Women 1469 per 100,000
Luukinen, Koski et al[240] [172]	Oulu Study Finland	Prospective whole population cohort – linking report and surveillance systems	377 men and 602 women living in the community in 5 rural districts (n=979) [also 37 men and 106 women (n=143) living in care institutions] aged ≥ 70	Falls diaries sent in whenever fell or every 3 months Telephone follow-up when fall reported or 3 months Medical / nursing notes	7 years	-
[94]	Leiden 85-plus Study	Longitudinal cohort study of ageing	n=599 at baseline from population sample reaching 85th birthday; 1 year follow-up n=480 (322 women + 158 men)	Interviews at baseline and 1 year Interviews at 1 year with - relative if cognitively impaired - GP / nursing home doctor re falls	1 year	Prevalence of falling ≥ 1 in - past yr 49% - f/up yr 44%

Falls in institutional care

The proportion of the older population living in long-term care institutions rises steeply with increasing age. Studies from a variety of developed countries – north America, Europe and Israel – over the last couple of decades have estimated national rates ranging from between a fifth and a half of people aged 85 or more, rising amongst over-90-year-olds to 41% in the Netherlands and 76% in France[241]. Although in the UK use of long-term care is declining, with the 2001 census reporting 23% of women and only 12% of men aged 85 or more living in communal institutions[45], this still represents a sizeable minority of the extremely old.

The incidence of falls in residential care facilities is up to three times as high as amongst older people living in the community[172;242]. Reports of prevalence of falling over a year ranges from between a half to two-thirds of residents in prospective studies (see Table 1.2.4.1.4), and even higher figures have been reported, for example 75% of the control arm of one intervention study[243]and falls incidence rates over 4/person/year amongst controls in another randomised trial[244]. Repeated falling is also more common: studies set in institutional care give a range from 9% to 41% for the prevalence of falling more than once a year. Rarely do studies in these settings report age- or sex-specific rates. However, even within this already high-risk population, there are sub-groups of long-term-care residents who may be identified as at even higher risk of falls or fall injuries (see discussion of population-specific risk factors in section 1.2.5.1).

Falls themselves increase the risk of moving into long-term care[177], as do key mental and physical factors associated with falls. Cognitive impairment is one of the most common reasons for initial nursing home admission[245] and measures of mobility limitation, especially lower limb function, have also been shown to predict nursing home admission[246]. The process of moving to a new care home itself can lead to a doubling of fall rates[247].

Fracture risk is also highest in elderly care home residents[248;249]. A recent study in Newcastle found that risk factors for fracture were extremely common in all the residential and nursing homes surveyed, but even higher amongst residents of specialist homes for elderly people with dementia[249].

Table 1.2.4.1.4 Follow-up studies of older people in communal settings – prospective falls data

Author(s)	Study / Country	Population	Methods	Follow-up	Prevalence			Incidence
					≥ 1 falls	≥ 2 falls	≥ 3 falls	Falls/100 person-yrs
Long-term care institutions (residential and nursing homes)								
Ashley..Gryfe et al[185;187]	UK	Active ambulatory institutionalised population Aged over 65		5 years	45%	-	-	66.8/100 person-years
Bueno Cavalinas et al[190]	Spain	n=190 elderly men and women who were able to walk unassisted aged ≥ 75	Baseline functional and cognitive assessment, morbidity,medication Falls recorded by care home staff	1 year	58%	-	-	75/100 person-years
Clark et al[161]	Sydney Australia	n=81 (70 women and 11 men) elderly hostel residents aged 70 - 97	Baseline clinical assessment Monthly questionnaires Four monthly visits Falls record kept by nursing staff	1 year	55%	40%	24%	-
Haga et al[186]	Tokyo Metropolitan Home for the Elderly Japan	n=1406 residents of a single home aged ≥ 65	Falls recorded by care home staff	1 year	-	14.5%	-	-
Jantti et al[188]	Tampere Finland	n=796 permanent residents of Koukkuniemi nursing home aged 61-97 years		6 months	26%	9%	-	94.7/100 person-years
Kallin et al[193]	Umeå Sweden	n=83 (58 women + 25 men) residents of a single residential care home	Baseline functional assessment and data collection from records Care home staff and study nurse completed fall reports	1 year	63%	41%	-	229/100 person-years
Kron...Becker et al[191;192]	Ulm Germany	n=472 long-term-care residents aged 60-104, mean 84±7	Baseline fall risk assessment using Resident Assessment Instrument Minimum Data Set Staff completed fall calendars	1 year	65%	-	30%	255.8/100 resident-yrs
Lipsitz et al[250]	International Cross-Cultural Study of Falls in Care Japan and USA	n=76 American + n=89 Japanese nursing home residents	Uniform data collection both sites from homes by project staff	6 months	USA 49% Japan 13%	-	-	-
Morse[189]	UK	Residents of 56 UK nursing homes 1,862 mean occupancy		1 year				144.5/100 resident-yrs

Table 1.2.4.1.4 cont. Follow-up studies of older people in communal settings – prospective falls data

Author(s)	Study / Country	Population	Methods	Follow-up	Prevalence			Incidence
					≥ 1 falls	≥ 2 falls	≥ 3 falls	Falls/100 person-yrs
Supported housing projects for the elderly								
Graafmans et al[178]	Amsterdam Netherlands	n=354 residents of homes/apartments for the elderly aged ≥ 70	Baseline assessment Weekly fall calendar collected every 2 months by nurse visiting	28 weeks	36%	16%	-	-
Huang et al[251]	Taipei Fall Risk Project Taiwan	N=103 men and women living in sheltered housing projects aged ≥ 65	Interview with research nurse and functional performance testing	1 year	50%	-	-	-

Falls in hospital

Falls by hospital in-patients are also attracting the attention of clinicians, researchers and policy-makers because of their serious consequences. Older people who fall while in hospital are likely to remain in hospital longer[198;199;252;253], with impaired rehabilitation, and are more likely to be discharged into long-term care[253]. The majority of such falls are un-witnessed, most often from bed or near the bedside[196;199;254]. Hospital falls are usually within the first few days of admission[196;197;200;254], most of the patients who fall more than two weeks into their stay fall repeatedly and more than half of all in-patient falls are recurrent incidents[196;254]. Studies that have examined injuries arising from in-patient falls have highlighted the increased mortality and costs[255]: in-hospital hip fractures had an even poorer outcome than hip-fractures overall[256]. One study focussed on the oldest old in hospital (88 non-bed-fast patients aged 80-99) and reported far higher rates of resultant injury than other studies: 17% fell during their stay of whom 40% suffered injury when they fell[257].

Quantifying falls in hospital from research to date is complicated by the non-comparable patient groups studied in different settings and the wide variation in measurement endpoints used, for example the number of falls/1000 bed days, relative risk of falling, proportions of patients who fall, time to first fall from admission and fall-induced injuries (see *Table 1.2.4.1.5*).

Although few risk assessment tools have been rigorously validated[258], studies of in-patients have identified confusion, agitation, impaired orientation, gait instability, falls history and sedative use as risk factors for falling during a hospital admission[196;259-262]. Prevention studies are difficult[221;254;263] but have highlighted areas for intervention[253], generally multi-factorial[264-267], including environmental modifications such as reducing the use of bed-rails (shown to have little effect on falls but marked effects on injuries[268]) and changing floor surface materials[269].

Table 1.2.4.1.5 Studies of falls amongst hospital in-patients

Author/ Authors	Study / Country	Population	Methods	Fall rates
Bates et al[252]	Boston, MA USA	All patients admitted during an observation period of 51 months to a district general hospital	Retrospective case:control study of patient fall injuries included calculation of fall rates over-all	6.6/1,000 admissions
Hanger et al[268]	Christchurch New Zealand	All patients admitted over 1 year to an elderly rehab unit pre- & post-introduction of new policy and education programme to reduce use of bed-rails (n=1968)	Study incident report forms	Pre-policy: 37/100 admissions 165/10,000 bed-days Post-policy: 44/100 admissions 192/10,000 bed-days
Oliver et al[196]	STRATIFY validation study London/Kent UK	Local validation phase 2: n=217 patients on 4 elderly wards Remote validation phase 3: n=331 patients on 6 elderly wards	Local validation phase 2: 395 weekly risk assessments Remote validation phase 3: 446 weekly risk assessments	18% (both phases) fell during wk after risk assessment
Salgado et al[257]	Sydney Australia	n=88 non-bed-fast patients admitted consecutively to an acute geriatric medical unit aged 80-99	Clinical assessment <3 days of admission Prospective falls monitoring until discharge	17% fell at least once while in hospital 6.8% fall injuries
Speciale et al[198]	Cremona Italy	N=649 (493 women + 156 men) consecutive admissions (4 months) to elderly rehabilitation unit mean age 78	Clinical, functional, balance and cognitive assessments, including retrospective function 1m before Data collection from hosptl notes,accident report forms	7% fell at least once while in hospital
Vassallo et al[197]	Nottingham UK	n=1025 (655 women + 370 men) consecutive admissions (17 mnths) for rehabilitation to geriatric hosp. mean age 81.7± 7.4	Admissn clinical assessment Data collection from hosptl notes,accident report forms	20% fell at least once while in hospital
von Renteln-Kruse et al[199;200]	Hamburg Germany	n=5946 consecutive admissions (over 3 years) to a geriatric unit	Data collection from hospital notes and accident report forms	17% fell at least once while in hospital

1.2.4.2 Injuries, long lies and deaths

Fractures and other injuries
Inability to get up after a fall
Mortality

Fractures and other injuries

Between 40% and 60% of falls lead to injury, with an estimated 30-55% resulting in minor injuries, 5-11% in major injuries excluding fractures and a further 5-13% in fractures[180;205;233;237;270-274]. Measuring injurious falls as a proportion of falls overall, up to 30% of falls lead to major injury[275]. The majority of falls that lead to injury occur doing everyday activities[276], and there is reportedly no variation in injury severity that relates to the type of activity at the time of the fall[185;230]. The vulnerability of older people to fall risks is compounded by their usually slower pace of recovery from any injury incurred.

The risk of injury rises with age[187;202;277]: the proportion of fallers needing treatment has been estimated as ten times higher for people aged over 90 years compared with people in their 60s[278], and the average age of those who sustain an injury falling is higher than those who fall without hurting themselves[171]. Injuries appear to affect proportionately more women who fall than men who fall[187;202;273], but only in under-90-year-olds[230]. Both these trends are in part explained by the contribution of osteoporosis to fracture incidence, with women's lifetime risk of sustaining a hip, wrist or vertebral fracture after the age of 50 (1 in 3) far out-stripping men's risk at the same age (1 in 12)[279;280]. Fragility fractures increase with advancing age and incidence rates are continuing to rise nationally beyond the 310,000 fractures per annum calculated in 2002[281]. By far the most common are the estimated 120,000 vertebral fractures, many of which arise atraumatically without any fall but which are often overlooked after a fall[282]. Forearm fractures are outnumbered by femoral fractures (estimated 50,000 per annum and 60,000 p.a. respectively[282]), the latter often arising from falls amongst older old people with slower reactions who are less able to break their fall on an outreached arm[283]. However, despite the important role of skeletal fragility in fracture risk, there is growing recognition of the contribution to fracture risk made by falling[165;166;284-287] and increasingly recurrent falling[288].

Hip fractures, which carry perhaps the most serious morbidity and mortality risks of all fractures, arise in about 1% of falls amongst over-65-year-olds[180;271;283], this percentage rising amongst the frailer and older: it has been reported that nearly half of falls in care homes for the elderly result in a hip fracture[289]. Although the reported proportions of falls which result in fracture is low, falls are the cause of 90% to 95% of hip fractures[290] and the absolute numbers of elderly people affected are considerable[291]. Thus the demands that fractures, especially hip fractures, place on health and social care systems are high[132]. The incidence of hip fractures rises steeply in older old age, rates doubling for every five years older from age 65 on[292], so can be expected to rise as the population ages. However, hip fracture incidence is rising even more steeply than would be anticipated from age-specific incidence rates[212;293-295]. As male life-expectancy increases so do rates of hip fracture for men, while male deaths as a result of fall-related injuries are rising even faster than population predictions[213].

Inability to get up after a fall

Being unable to get up from the floor after falling is rightly a major concern to many old people as, apart from fall-induced injury, it is one of the most serious consequences. The resultant length of time on the floor carries serious physical risks – hypothermia, dehydration, pressure-related injury, infection including brochopneumonia – besides the psychological impact from such a frightening experience. It has been suggested that many older people are too frail and unfit to get themselves up regardless of possible injury or shock after a fall[296], and assessments in laboratory, clinic, ward and sheltered housing settings have reported between 20% and 25% of older people cannot manage a floor rise test without help[297-299]. Being unable to get up even in such controlled assessments is predictive of serious fall-related injury, doubling the odds compared with other older women who have fallen recently, almost quadrupling the odds compared with others who fall again[299]. In observational community studies up to 37% of falls resulted in time on the floor because of difficulty rising, but up to 47% of those who fell are unable to rise without help on at least one occasion[168;300;301]. Data from clinical audit identified that 40% of calls on the London Ambulance for older people who had fallen were for assistance to get up and did not lead to admission or A&E attendance[302]. Nonetheless being unable to get off the floor is associated with higher rates of functional decline, hospitalisation, institutionalisation and death[301]. A primary care survey of over-65-year-olds with a recent fall found that half of those who had lain on

the floor more than an hour died within six months of a fall, compared with 25% mortality at one year for the fallers who had got themselves up, the latter rate already five times that of age- and sex-matched controls who had not fallen[300].

Mortality

Falls are the leading cause of injury mortality amongst people over 75 years[303]. Older people (65 years and over) account for 68% of deaths due to falls from stairs or steps, 85% of deaths resulting from slipping, tripping or stumbling, and 96% of deaths after unspecified falls or fractures, the falls coding categories most common amongst older people[304]. People aged 80 years or more accounted for over 60% of deaths resulting from falls, with the oldest age-band in the data sources (85 years plus) making up more than half the 'unspecified falls' mortality [304]. Although injury rates are higher for women who fall than men, older men are more likely to die following a fall injury than women[202].

Morbidity and mortality rates are high for older people who sustain fall-related fractures, especially hip fractures. In-hospital mortality has been recorded as 5% (older people aged 65 or more)[292] and up to 10% in a study of hip fracture patients aged 90 years or more[305]. One in five people, or even up to one in four, die within three months after a hip fracture[305;306]. Six month and one year mortality rates of between 16% and 54% have been reported in different populations[307], with higher rates in the oldest old from the few studies that followed up over-90-year-olds after hip fracture (46% to 70%)[307;308] and the highest rates of all found in cognitively impaired nonagenarians (80% to 85%)[307;308].

1.2.4.3 Psychological and social consequences

Fear of falling
Activity restriction and increased dependency

The consequences of falling for an individual go far beyond any immediate injury. Indeed, although the majority of falls do not result in serious injury, most falls by older people do have considerable repercussions and the health, social and psychological effects are often long-lasting.

Fear of falling

Many people who have had a fall become anxious about falling again, their fears particularly heightened in the period immediately afterwards[309;310]. Worry about the possibility of falling ranks higher than any other worries reported by older people, such as the fear of crime[311]. Such concerns are not confined only to those who have fallen[310]: there are 'fearful non-fallers' and conversely 'fearless fallers'[309;312;313]. Being afraid of falling is more common amongst people who report unsteadiness or balance problems but is not always related to poor levels of physical functioning[312;314]. Fear of falling has been reported to affect between a third and more than half of older people who have fallen[156;309;314-317], measured by various methods – a single question or scales assessing perceived confidence or self-efficacy in a range of daily activities[312;318-322]. However, recent research has attempted to focus on what are the most feared consequences of falling[317;323], revealing insights into older people's worries about both the immediate effects, such as pain or embarrassment, and the longer-term ramifications – loss of independence and identity.

Activity restriction and increased dependency

A fall may trigger a series of developing consequences: even if there are no immediate physical ill-effects, the psychological and social impact can be devastating, with loss of confidence and new or renewed anxiety prompting the curtailment of usual activites. Estimates vary as to how many older people say they avoid certain activities as a result of falling – from 10% amongst community-dwelling women aged 55 – 74 years[324] up to 50% reported in a sample fo transitionally frail men and women with a mean age of 81 years[316]. Restricting activity can then in itself hasten a spiral of decline – muscle weakening through disuse, resultant poorer balance, increased need for support with daily living tasks that the individual had previously managed independently, a diminished quality of life with perhaps more social isolation, loneliness and depression[156;273;314;315;317;325-332]. All these consequences can in themselves increase the likelihood of falling, thus fear of falling can be both an outcome and a predictor of falls[333]. Falls and fear of falling also share many risk factors in common including some, such as gait speed[313], that have been found to show stronger associations with fear of falling than with actually falling. The causative links between fear of falling and other factors may also be multi-directional: it can result from and lead to worse balance, disability in activities of daily living, poorer physical function, reduced quality of life,

admissions as fractures as well as falls. Thus a fall and resultant fearful activity avoidance may speed up decline into frailty and dependence[332;333].

1.2.4.4 Implications for health and social care

Primary care: falls needing medical attention
Secondary care: hospital admissions
Social care: care homes and home care
Costs

Primary care: falls needing medical attention

From a total population surveillance study, in one year 3.8% of over-65-year-olds were reported to seek medical attention because of a fall[271]. The proportion of falls reported to lead to injuries severe enough to warrant medical attention varies widely from between 14% and 43%[171;187;226;227;237;277;334] in different populations, some studies including only primary care consultations in these figures. Two-thirds of injuries reported in a postal survey of primary care patients aged at least 70-years-old were treated by their GPs[227].

The health effects of any fall may last some time, almost a third of older people with only a "minor" fall injury reported they had pain lasting at leasst two days, and a fifth still in pain four or more days later[171]. Even higher proportions affected much longer after the event are reported from older people whose fall needed treatment in Accident and Emergency: 43% were still in pain or having to restrict their usual activities 2 months later, and 41% of this group still had problems after a further 5 months[335].

Secondary care: hospital admissions

42% of falls that came to medical attention in an American injury surveillance area needed hospital admission[202]. Over half of all hospital admissions due to falls are people aged at least 65 years, but their cumulative days' stay in hospital amount to 87% of all hospital bed-days for unintentional injury admissions[304]. Rates of fall-related admissions are more than six times as high in the over-85 age group than amongst 65-69-year-olds[336;337]. Length of stay in elderly rehabilitation is reported to average five days longer for patients whose reason for admission was a fall[198]. Hip fractures account for more than 20% of orthopaedic bed occupancy nationally[282] and more than one in ten older people admitted with a hip fracture are still in hospital 90 days later[306].

Having been in hospital increases an older person's risk of health complications, subsequent disability and re-admission[338-340], but it has been shown that these risks are highest if a fall was the reason for admission[339].

Social care: care homes and home care

Many falls, especially devastating fractures, are a turning point from which the acute onset of disability leads to chronic dependence. It has been reported from the US that approximately half the old people admitted to hospital because of a fall injury who were living at home before then are discharged to long term care when they leave hospital[202]. Conversely, for 40% of admissions to care institutions, fall-related accidents are a factor leading to the move[132]. Longitudinal studies have reported between 3-fold and 10-fold increases in the risk for care home admissions associated with falling or repeated falling, with or without injury[155;177;184].

The need for increased care is particularly severe after a hip fracture. In the UK, more than a fifth of hip fracture admissions are discharged to nursing homes, although half of these people were living in their own homes before the fracture[306]. A further sixth only manage to return home with increased support[306]. A year after a hip fracture the proportions of people who still cannot walk, who find at least one basic ADL difficult or who are unable to manage instrumental ADLs are reported to be 40%, 60% and 80% respectively, and more than a quarter of people with these new disabilities will have moved into a nursing home for the first time[341]. Approximately half can no longer live independently[342], and adverse consequences are even more likely in advanced old age. Four times as many nonagenarians are housebound after a hip fracture as before and fewer than a third regain the independence they had before, with only 12% able to return to their pre-fracture place of residence[305]. This loss of independence has enormous implications for informal supportive care from family, friends or neighbours and for the formal home care and long-term residential care systems.

Costs

Several research groups have attempted to put a figure on the economic costs associated with falls by older people and other related expenditure. In one year (1999) in the UK, in which the health service saw almost 650,000 accident and emergency department

attendances and over 200,000 in-patient admissions by people aged 60 years or more who had fallen, the costs were estimated at £981 million in a ratio of 6:4 to health and social services. Falls by people aged 75 or over accounted for two-thirds of this[343]. Others have put the health and social care costs of fractures at £1.8 billion a year[344], using a broader age range – men and women over 50 – or for comparison calculated the costs of osteoporosis treatment to prevent fractures: £1.7 million five years ago[279]. The latest estimate for the average hospital costs alone of treating one hip fracture is £12,000[345], but three years ago it was estimated that costs for the first year after hip fracture, including long-term care costs, was already more than 2.5 times this figure[346].

A finding of particular relevance to falls research, given that recurrent falling is so common, comes from a Swedish study that tracked injuries for 12 years in a random sample of adults aged 20-89 years, revealing that the (mainly older) people who suffered three injuries or more over this period made up almost of fifth of the total injuries but took up over three fifths of hospital bed days and medical costs[214].

Estimates of the financial costs of falls and subsequent injuries have not put a price on the additional emotional, social and financial costs to individuals, carers, family and other agencies.

1.2.5 Risk factors for falls and their consequences in old age

1.2.5.1 Risk profiles: different populations, outcomes and fall history
- Different approaches
- Different populations may have different risk factors
- Different outcomes: recurrent falling and "one-off" falls
- Previous falls

1.2.5.2 Muscle weakness, balance, mobility and functional limitation
- Declining function
- Muscle weakness, balance, function and physical activity in relation to falls and injuries
- Physical activity interventions for falls prevention

1.2.5.3 Cognitive impairment

1.2.5.4 Sensory impairment
- Visual impairment
- Hearing impairment
- Other sensory impairments

1.2.5.5 Health-related risk factors
- Multiple co-morbidity
- Self-rated health
- Arthritis
- Incontinence / other bladder problems
- Depression
- Stroke
- Parkinson's disease

1.2.5.6 Medication risk factors

1.2.5.7 Environmental risk factors
- Home hazards
- Circumstances of falls

1.2.5.8 Other risk factors
- Nutrition
- Alcohol and smoking
- Feet

1.2.5.9 Evidence to date for different risk factors

1.2.5.1 Risk profiles: different populations, outcomes and fall history

Different approaches
Different populations may have different risk factors
Different outcomes: recurrent falling and "one-off" falls
Previous falls

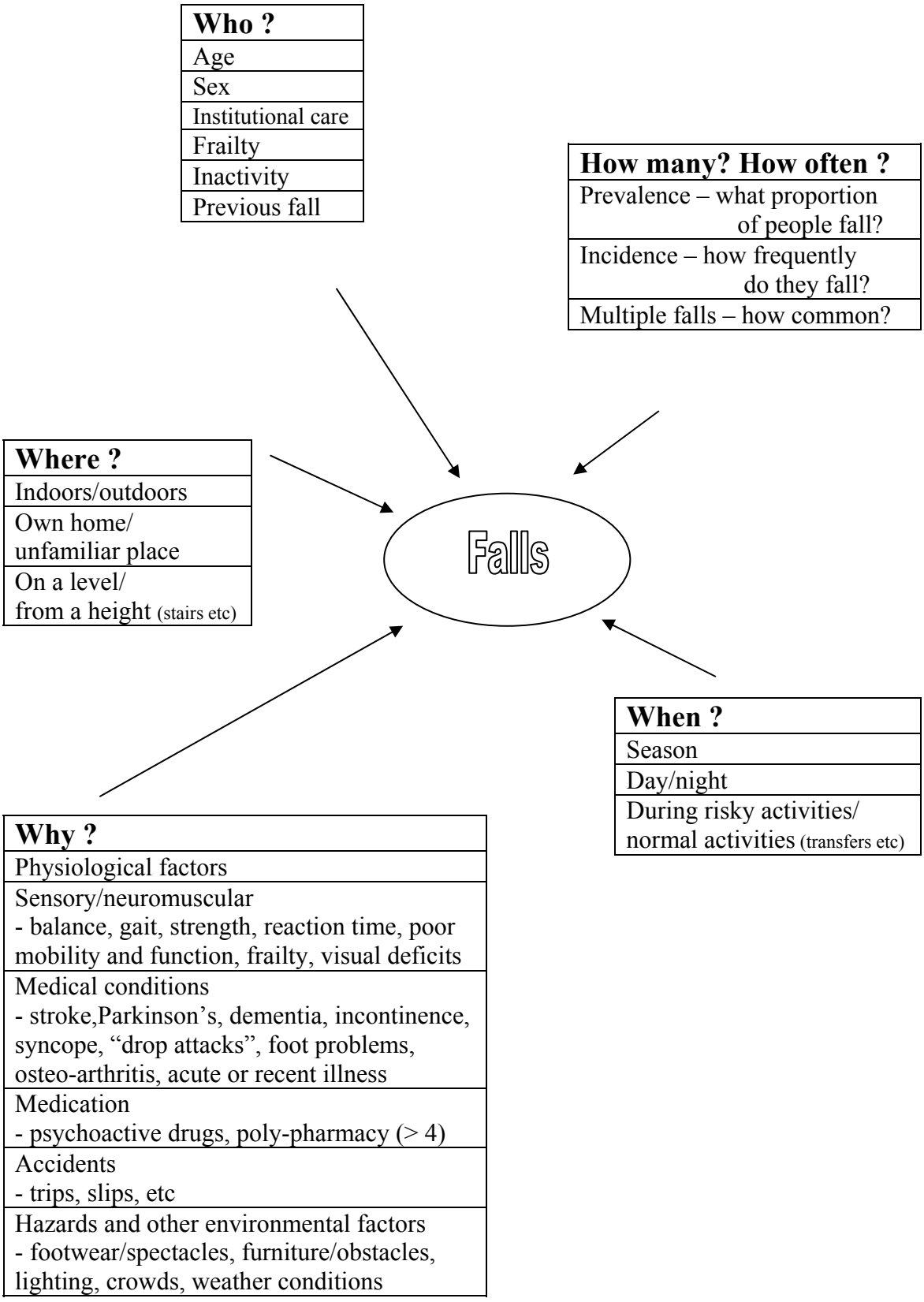
Different approaches

The scope of enquiries to identify the causes and results of falls has been extraordinarily broad: one review now a decade old totalled over 400 potential risk factors that had been identified[347], and the exponential increase in falls studies published since the early 1990s has added a wealth of research investigating these. The associations to be found between possible pre-disposing factors and falls, between falls or different types of fall and outcomes such and injury, hospitalisation, institutionalisation or death, and between suspected risk exposures and the consequences of falls have all been the subject of extensive enquiry. Figure 1.2.5 illustrates diagrammatically areas that have been studied for their possible associations with falling and the sections that follow provide a summary of this background of existing research, rather than a comprehensive review.

Circumstances surrounding falls have been examined from many angles and the part played by each factor variously estimated. The key finding from Sheldon's now classic description of the circumstances of a series of 500 falls[135] - that nearly half of all falls were due to external accidental causes, but that these accidental falls affected four-fifths of those who fell – is still a useful starting point from which to approach this complexity. A more recent review of 3684 falls evaluated in 12 studies estimated that accidental or environmental causes most likely accounted for about a third of falls[348]. To what extent a fall is "just an accident", the degree to which a risk factor may be modified and the effect that increasing old age may have on these unknowns are all still unclear.

It has been traditional since then to divide falls risk factors into intrinsic and extrinsic factors, with intrinsic factors said to become increasingly important with advancing age[349]. However, Lord et al[216] have argued recently that this over-simplification should be replaced by an ecological approach that takes account of the interaction between an individual and their environment. Thus, for example in Figure 1.2.5, the box showing possible reasons why people fall can be thought of as a spectrum of factors none of which may be an identifiable single cause of a fall. Instead there is likely to be an

Figure 1.2.5 Factors associated with older people's falls



inter-play of contributory factors from the physiological to the environmental extremes – a slip on the ice + poor reaction time + gait abnormality, say, or urinary urgency + a long-acting benzodiazepine + forgetting glasses + stairs. Skelton and Todd[350] take a similar view in their emphasis on the potential for dynamic interplay of risk factors that they categorise into three groups: intrinsic factors, extrinsic factors and exposure to risk.

Different populations may have different risk factors

Given the wide variety of methods employed in falls research to date, some conflicting results have been reported, but there is broad agreement on key areas. Having fallen before has been identified repeatedly as a risk factor for falling again[147;164;168;170;224]. The combination of more than one risk factor has been shown to increase risk, with the proportion of those at risk who fall rising from 8% of over 75 year olds with no known risk factor to 32% of those with two risk factors and 78% of those with four or more risk factors[180]. Frailty, increasing age and living in a care institution have also emerged as associated with falls in many studies. The less straightforward role of gender is outlined in section 1.2.4.1's summary of old age fall epidemiology; results give a complex picture that generally shows less difference between the sexes in older age-groups. These key factors exemplify the need to bear in mind the relative importance of different risk factors for different sub-groups. One study that developed falls risk profiles from elements of the "75-plus check-ups" identified a different cluster of predictive factors for the over-85s[184]. Too general an assessment of risk levels in a non-homogeneous category "older people" is likely to prove inadequate.

For instance, studies have pin-pointed the role of factors specific to institutional care settings, such as the use of restraints[191;192] or the need for assistance to dress or transfer[191], and have also confirmed the part played by factors equally applicable to those living in the community - cognitive impairment[188], age[187;194], incontinence[191;192], depressive symptoms[191;351], medication[190;351], visual impairment[188;192], slow gait speed[190], use of walking aids[188;194] and a history of falling[190;191]. As in research with community-dwelling older people, recurrent fall risk factors have also been shown to differ slightly from risk factors for single falls.

Different outcome measures: recurrent falling and "one-off" falls

It has been suggested by a number of previous researchers that the characteristics of people who fall repeatedly are different from those who report "just a one-off" fall. In one of the earlier key studies from New Zealand, Campbell and co-workers classified the older people who fell into those with "occasional" and "pattern" falls[233]. In another of the pioneering investigations of risk factors for falls occurring without syncope amongst community-dwelling over-65-year-olds, Nevitt and colleagues concluded that 'risk factors for having a single fall were few and weak, but recurrent falls were more predictable'[168]. Diverse studies have presented their findings in terms of which factors identify this higher risk group, for instance two large Australian cohorts, the Randwick Falls and Fractures Study[162] and the Dubbo Osteoporosis Study[139], the Dutch Longitudinal Aging Study Amsterdam[179;239], large Finnish population studies[240] and Mary Tinetti's seminal study of falls risk increasing with the number of co-morbidities[352], to name just a few of the better-known examples.

Certainly there are stronger associations between many risk factors and measures of recurrent falls than are often found with single falls, though some have reported risk estimates associated with potential predictive factors that are intermediate between those for non-fallers and those for people who fell at least twice during the period of recall or follow-up[139]. It has been suggested that "once only fallers" have more in common with "non-fallers" than "twice or more fallers"[337]. Others have identified sets of factors that predict repeated falls that are different from the factors associated with single falls[178;191]. However, not all studies confirm this supposition. An examination of single and recurrent fallers failed to find differences between them in either the circumstances or consequences of their falls[224], and it has been reported that in some groups non-recurrent falls may produce more major injuries and recurrent falls more minor injuries[337;353].

Previous falls

Having fallen before has been identified repeatedly as a risk factor for falling again both in the major community-based studies[147;164;168;170;180;182;224;354] and in institutional settings[258;259;355].

With a view to the targeting of resources at those most a risk, it has been proposed that falls prevention interventions concentrate on older people who have fallen at least once before or on those regarded as recurrent fallers. Different measures of fall history and definitions of repeated falling abound, most commonly "more than one fall in the past year" but there is considerable variation ranging from, for example "more than one fall in the past three months"[184], "two or more falls in six months"[356;357], "three or more falls in the past year"[168;191] to "two or more falls during five years' follow-up". These measurement differences that have been used to construct risk profiles, and evidence that the consequences of non-recurrent falls can be just as or even more serious than repeated falls[224;353], have implications for policy-makers' and practitioners' decisions on how research findings may be translated into risk assessment procedures and preventive strategies.

1.2.5.2 Muscle weakness, balance, mobility and functional limitation

Declining function
Muscle weakness, balance, function and physical activity in relation to falls and injuries
Physical activity interventions for falls prevention

Declining function

The link between falling and physical function is extensively reported and not a surprising finding, but the relationship is not as simple as might at first be thought. Muscle strength, balance, limited mobility and functional decline are all inter-related components of the complexities involved in maintaining postural stability that also all relate to the risk of falling.

With increasing age there is a progressive loss of muscle mass – sarcopenia, and therefore also of muscle strength and power, and all of these tend to be lower in women than men at all ages[358-361]. Muscle function plays an important role, along with an array of contributory factors including coordination, proprioception, sensory perception and cognition, in maintaining balance and determining walking speed, endurance and other aspects of mobility[362]. These factors also tend to worsen with age, with postural sway increasing[272;363] and central and peripheral nervous system changes leading to slower reaction times[364;365]. Levels of physical activity drop amongst older people[296;366-368], partly as a result of the increasing energy demands made by normal activities when muscle and other functional capabilities are declining, but this very decrease in activity also hastens the loss of function[369].

Declining muscle function – power as well as strength – is associated with numerous aspects of physical functioning[370;371] including walking speed[372;373], walking distance[374], needing a walking aid[375] and being able to stand up from a chair[376]. It has therefore been described as one of the steps on the pathway to disability[377], along with decreasing physical activity; it has been argued that it is even more vital for people with impaired mobility that they maintain physical activity[378;807], loss of which is itself a risk factor for decline[379;380], while keeping active is linked with quality of life, self-efficacy and well-being[381-383] and even preserved muscle function[806;926]. In the industrialised world fitness levels in all age groups are a growing cause for concern; amongst the elderly, a UK national survey found that one in three people aged over 70 never climb stairs and four-fifths of women aged 70-75 could not comfortably walk a quarter of a mile on their

own[384]. However, muscle strength, balance, fitness and sarcopenia are all factors that can be modified, declining with disuse, improving with increased physical activity at all ages including in old age[385-388] and even in extreme old age[389;390].

Muscle weakness, balance, function and physical activity in relation to falls and injuries
Informative reviews[296;365;368;391;392] have summarised the evidence for the association with falling of muscle weakness, balance and physical activity but, given the inter-play of these factors, the individual contribution of each can be hard to separate from the others[296]. Each plays a part in declining function and increasing disability in activities of daily living, but ADL impairment per se has been identified as increasing the risk of falling[232;393-395]. Likewise, poor balance, is often described as a risk factor for falls in terms of activities that also involve elements of neuromuscular function such as gait, sway, turning, reaching or rising from a chair[365]: a later section of this chapter (section 1.2.6 *Assessment of functional ability and prediction of falls risk*) provides an overview of measurement methods used and how they relate to falling.

A meta-analysis of the effects of muscle weakness in prospective cohort studies concluded that the odds of falling or repeated falling were increased almost 2-fold or 3-fold respectively[392]. The effects appear to be most marked amongst the most frail: nursing home residents who fell were found to have quadriceps strength lower by 40% than their non-falling co-residents, 70% lower than community-dwelling older people without falls[396]. Most of the evidence on muscle function in relation to falls is for the effects of generalised lower extremity weakness[142;164;169;239;250;301;397], but some studies have pinpointed a role for ankle dorsiflexors and plantarflexors[369;396;398] as well as the larger muscles, and a few have found associations with upper limb strength[142;164;239;301]. It has also been argued that muscle power may be more predictive of function and falling than strength[399-402], and loss of muscle power is more rapid in old age than loss of isometric muscle strength –3.5% versus 1.5% a year[359;403].

Physical activity measurement is beset with difficulties[404;405] and methodological differences may explain some of the variety in findings. A sedentary lifestyle and inactivity are linked to increased risk of falls and fractures, the link with fracture being both through the effects of physical activity on fall predictive physiological factors and through the effects on bone. There is an extensive literature from osteoporosis

epidemiology demonstrating the effects of physical activity and exercise on the skeleton[406-410], fracture risk[411-416] and their inter-relation with physical function[144;417]. Observational studies have examined different perspectives on activity or inactivity exposures: vigorous[418] or aerobic[419;420] exercise, occupational[421;422] and recreational[423] activity, past and recent levels of activity[424-427], walking[428;429], [430;431], and even temporary periods of immobility[144] such as hospitalisation can all affect bone strength and the osteoporotic fracture risk profile. Levels of hip fracture risk reduction of between 20% and 40% have been reported from observational studies[368]. However, the relationship between physical activity and fracture is more complex amongst the oldest and frailest: a case-control study of hip fracture patients in New Zealand found that increasing number of hours per week spent in physical activity protects against hip fracture in community-dwelling older people even in their 80s, but found no evidence to support this link amongst frail, far less active older people in institutions[432].

Besides physical activity in total[433], various types of physical activity have also been reported to relate to falls in different ways. For example, walking is commonly singled out as a protective factor[433]. Amongst elderly Dutch women referred to a geriatric outpatients, housework was the principal component of a physical activity scale found to predict falls[434], and in American men aged 65 or older household activity was the only form of activity that significantly predicted falls[435]. The Montreal falls study[143;236] gave the intriguing finding that frequent physical activity doubled the odds associated with falling but reportedly taking part in a diverse variety of physical activities halved the odds. The authors suggest these are not necessarily conflicting findings but could be an illustration of how, on the one hand, physical activity has beneficial effects on, say, balance while, on the other hand, potentially increasing exposure to falls risk. Since people who are less mobile have fewer opportunities to fall, some studies have attempted to allow for this by adjusting risk estimates for time spent being physically active[369;413;432;436]. Striking gradients in have been reported: in a study of home-dwelling 70 – 90-year-old women who had recently fallen fall rates ranged from 2.5 falls/1000 hours activity amongst the most active (>4 hours/week), through 7.5 falls/1000 hours activity in the intermediate group (2-4 hours/week) to 12 falls/1000 hours activity for the most inactive (<2 hours/week)[369].

In a recent review of the evidence on physical activity, falls and fractures among older adults, Gregg et al[368] concluded that the equivocal results from some observational studies of the associations between physical activity and the risk of falling might suggest a U-shaped or J-shaped curve[178;180;273]. The Canadian cohort results could fit this interpretation that both the most active and most inactive are at increased risk of falls[143]. Data from the Study of Osteoporotic Fractures support this hypothesis: proportions with recurrent falls were largest for the women at both extremes of energy expenditure per week – 12% in both the lowest and highest quintiles – but the relative risks of hip fracture nonetheless increased with decreasing physical activity[413].

When activity is severely limited the patterns of association are different again and the least mobile of all have been shown to have reduced risk: a community study of older men found that those who could neither sit nor stand had the lowest fall rates and those with poor to fair mobility had higher fall rates than an intermediate group with fair to good mobility[437]. Similar non-linear relationships have been reported from studies in institutional settings as well: in such populations with a lower range of mobility, falls incidence is reported lowest amongst the least active[432;438], especially those who could not walk[439] or who were unable to stand up without help[440] and highest amongst those who could stand but were unable to walk unaided[440] or who were limited but not the most limited in a range of functional indicators[191]. Others reported that, although fall risk might be less in the most vigorous, risk of serious injury should a fall occur was increased amongst the most highly functioning community-dwelling older people[181]; likewise in care settings injurious falls rates were higher amongst residents who could stand unaided[440] and who needed less help with daily activities[438].

Physical activity interventions for falls prevention

In the two decades since it was reported that exercise could delay decline below critical functional thresholds by ten or twenty years[441], numerous studies have tested different interventions, recent reviews have attempted to synthesise the evidence[442-446] and the successful approaches are now included in the latest guidelines on fall prevention (see Appendices A and B).

1.2.5.3 Cognitive impairment

The prevalence of dementia increases rapidly with age, approximately doubling in each 5-year age-band over 65. UK rates have been reported as rising from 1.5% of 65-69 year olds to 2.6%, 6.3%, 13% and 25.3% in age-bands 70-74, 75-79, 80-84 and ≥85 years respectively[447], and extrapolation would give even higher rates in the tenth decade. The latest international estimates put the prevalence across western Europe for ≥85-year-olds at the same level (24.8%) and forecast rates will double every twenty years[448].

Dementia and lesser degrees of cognitive impairment are strongly associated with increased risk of falling in many studies[178;180;273;449;450], though one review reported this link was only confirmed in half the studies included[348]. Incidence rates of over 4 falls/year[451;452] and prevalence of between 40% and 60% of the demented falling each year have been reported[180;451;453], two to three times higher than amongst cognitively intact older people[180;453]. In a large Swedish study 9% of over 2000 patients in geriatric care settings had fallen in the week before assessment[454]. Even relatively moderate degrees of cognitive impairment (MMSE <24[178] or <26[180;273]) have been shown to add to falls risk.

Amongst cognitively impaired older people there are additional factors that may further increase risk. Particularly high risks for falling have been linked specifically to deficits in immediate memory[148], being mobile enough to get up from a chair and needing help to walk[454]. Frail older people in the community whose cognitive impairment led them to wander are at increased risk[195]. In a nursing home for dementia sufferers men were found to have double the falls risk of women[451]; the same study suggested that falls risk decreases amongst the most severely demented and physically disabled[451].

Whilst only a minority of falls result in serious injury and a small fraction of falls result in fractures, there is evidence that fracture[393;455] and other injury rates are also higher amongst the demented, even in advanced old age[456]. Nine percent of community-dwelling elderly people in Japan with no dementia sustained injuries from falls during one year's follow-up compared with 41% of those with dementia[457]. Amongst fallers in an institutional setting dementia increased the odds of injury 7.5-fold[355]. A Mayo Clinic study found Alzheimer's disease patients, in comparison with age- and sex-matched

controls, had more than a 2-fold excess of fractures during the year of diagnosis and continuing even higher rates of hip fracture[458], whilst others have found a quarter of patients with dementia fractured when they fell, triple the age-adjusted fracture incidence[273;459;460]. The consequences of injuries sustained falling can also be more severe for the cognitively impaired: different studies have reported mortality after hip fracture as 70% at one year[461] and even 71% after only six months[462] – two to three times as high as in cognitively normal patients – and the odds of moving into care after a fall injury are five times as high[453]. Other work has found nursing home residents with dementia were no more likely to injure themselves falling than those without, but their injurious fall rate was significantly higher because of the marked difference in fall rates [452].

1.2.5.4 Sensory impairment

Visual impairment
Hearing impairment
Other sensory impairments

Visual impairment

The risks of falling posed by poor eyesight have been widely reported[232;239;463] and extensively investigated. Visual impairment approximately doubles falls risk on average[463], though risks increase with worsening impairment[463]. Many researchers have attempted to specify precisely which type of visual impairment poses most risk. Vision measures – visual acuity[162;188;275;464-467], depth perception[467;468], visual field dependence[139;469] and contrast sensitivity[162;465-467] – and eye conditions – cataract[466;470;471] and glaucoma[466;470] – have all been identified in a large number of studies investigating visual risk factors for falling, sometimes with even more specific detail, for example in a report that poor near, but not far, visual acuity was associated with increased areas of sway[472].

Visual difficulties and their effect on falls risk are clearly affected by other factors, particularly environmental conditions such as poor lighting[469;473]. Conversely, poor eyesight can affect how an individual responds to challenging environmental conditions, such as uneven or compliant surfaces[468;474], awkward balance situations[475] or an obstacle causing a trip.

One study of nearly a thousand community-dwelling older people[476] found that the increased risk of balance problems associated with reported vision problems decreased with age from almost 3-fold risk in those aged 65-69 to none in the over-85-year-olds, perhaps a reflection of the rising influence of other difficulties with increasing old age. Several researchers, recognising the interplay of multiple complex factors, put visual impairment in 'short-lists' of key predictors that could potentially identify those at high risk for a number of serious problems of old age, including falls along with, for example, incontinence, depression and functional decline[477;478]. Visual problems featured in similar short-lists of risk factors for fall injuries even with women in their 50s and 60s[479].

Visual impairments have also been shown to be clearly associated with injuries resulting from falls[242;275], specifically fractures[480] including hip fractures[290;464;481-483].

Hearing impairment

By contrast with the links now well-established between visual impairments and falls, the evidence concerning hearing impairment is more sparse and less clear cut. Studies conducted in the 1980s reported impaired hearing increased the risk of self-reported balance problems[476] and was associated with increased sway area in biomechanical platform testing[472], but the latter finding was not significant when adjusted for age and visual impairment. A recent study of falls risk factors amongst 825 hospital in-patients in an elderly rehabilitation ward identified hearing defects among several factors associated with unsteady gait assessed with the 'get up and go' test[484]. Other studies have also included hearing loss along with various other factors in risk profiles for common problems of the elderly including falls, amongst older people living in the community[477], in sheltered housing[251]and in care institutions[485]. Hearing loss has also been reported to predict poorer recovery from a fall[335].

One small case-control study of Colles fractures has reported an association found between hearing loss and fracture, and went so far as to suggest osteoporosis as the common cause, skeletal changes in the auditory ossicles perhaps contributing to conductive hearing loss[486]. However, the largest study to date specifically examining hearing in relation to falls, rather than any surrogate endpoints such as balance

measures, analysed prospectively recorded data on falls and fractures from 6480 women aged 65 or older in the Study of Osteoporotic Fractures[176]. This found no differences in falls rates or incident fractures between women categorised as having normal hearing, mild or significant hearing loss, regardless of adjustment for age or other co-variates. Thus, despite the auditory system's connection with balance control, the effects of hearing loss on falls risk has not been confirmed.

Other sensory inputs

Besides eyesight and hearing, other sensory inputs and psychomotor factors also affect falls. Extensive research in Australia has led the field in exploring the role of proprioception[162;468;469;487;488], tactile sensitivity[139;489;490] and reaction time[162;487-490] in postural control and establishing their relationship to falls risk. One of the many studies from Stephen Lord's group specifically examined the effects of psychoactive medication on these physiological risk factors and their relation to falls in over 400 women aged 65-99 years, reporting that both tactile sensitivity and reaction time were reduced [489]. Meanwhile other in-depth laboratory studies and large-scale epidemiological cohorts[270] have also confirmed increased falls risks associated with ankle proprioception[491], reaction time[492] and other somatosensory cues for postural control particularly in combination with competing attentional demands[493].

1.2.5.5 Health-related risk factors

Multiple co-morbidity
Self-rated health
Arthritis
Incontinence and other bladder problems
Depression
Stroke
Parkinson's disease

Health and disability have a bearing on the risk of falls. General health – whether subjectively reported or assessed by objective measures – and various specific health conditions have all been examined in relation to falling. Disability is addressed in more detail in section 1.2.5.2's discussion of the inter-relation of falls with functional impairment, physical performance and activity**.** Here prior research into the links between falls and various health-related conditions is overviewed to provide

background on some of this thesis' subsequent analyses, although not all the conditions of interest could be examined in the present study's data.

Multiple co-morbidity

Seminal work begun two decades ago on identifying high risk groups amongst older people living in the community[352] proposed a hypothesis that falls risk was an accumulation of the risk effects of multiple specific disabilities. Tinetti and colleagues reported a risk index to predict the risk of falling that was based on the number of chronic disabilities affecting an individual. Taking a similar approach to this early US study, UK researchers recently used data on over 4,000 women in their 60s and 70s enrolled in the Women's Heart and Health Study to examine the effect of multiple co-morbidity on falling[494]. They reported that the association found between reported falling and the number of chronic diseases was modified to insignificance by adjustment for the number of drugs taken. However, they pin-pointed a number of disease areas that conferred an increased odds ratio for falling: circulatory disease, chronic obstructive pulmonary disease, depression, and arthritis. There is considerable over-lap between this and other earlier population-sample studies in the conditions identified as specifically increasing risk, for example key UK, New Zealand and US studies high-lighted the role of arthritis, Parkinson's disease, more physical symptoms and dependency, anxiety, depression and cognitive impairment[3;142;168;226]. Suffering from at least two co-morbid conditions has also been found to related to increased risk of serious injury on falling[273].

Self-rated health

Self-rated health is reportedly a powerful predictor of a vast range of health outcomes, but relatively few studies have examined this factor in relation to falling. As falls data have been retrospectively collected in the majority of falls studies to date, clearly there is a need for caution interpreting any associations found with self-reported health. One of the earliest studies to examine this relationship – in two large Israeli samples totalling over 4,500 people aged over 65 years[495] – reported their findings in terms of falls having a negative effect on subjective health, though in the smaller sample this effect was modified by the presence of multiple chronic conditions. In a later smaller study of 283 over-60-year-olds, this time reporting falls at baseline and a year afterwards, the same research group identified poor self-rated health as one of a set of risk factors that

discriminated fallers from non-fallers[394;496]. More recently, a survey of 457 Polish over-75-year-olds found that falls in the previous year were more frequently reported by people who rated their health as poor[395]. By contrast, a cross-sectional survey of 431 community-dwelling Norwegians aged 67-97 that specifically examined the relationships between self-reported health and functioning and falling found no association between general health and reported falls[497].

Poor self-assessed general health has also been linked to fear of falling[311] and restricting activities because of a fear of falling[498]. A further interesting examination of attitudes towards falling amongst over 1,400 community-dwelling Americans aged 65 or older[499] found that people with poorer self-rated health were more likely to attribute their falls to their own limitations, whilst those who rated their health better were more likely to attribute falling to their surroundings.

Arthritis

Arthritis was identified as a risk factor for falls in some of the earliest falls research studies, using cohort and case-control methods with long-term care residents[351] and community populations of older people[3;142;168]. Similar findings have been reported since, in recent small-scale studies[251] and large international collaborations[160].

Small studies of diagnosed rheumatoid and osteo-arthritis patients have quantified impairments in balance, gait, proprioception and muscle strength that are predictive of falls[500-502]and reported reduced obstacle avoidance[503]. Musculo-skeletal pain in general has been highlighted as a key factor increasing falls risk, and effective analgesia or surgical joint replacement have been reported to reduce falls[157;503] or improve balance[502].

The relationship with fracture risk is not straightforward, given the different mechanisms driving skeletal changes in rheumatoid and osteoarthritis. Rhuematoid arthritis and its associated corticosteroid therapy induce osteoporotic changes[504;505 500]and increased rates of hip and vertebral fractures have been reported[504;506;507]. Osteo-arthritis, on the other hand, used to be thought to have an inverse relation with osteoporosis[508] but subsequent research suggests the conditions may share similar patterns of elevated bone resorption[509;510]. In the population based 1000 Women Study fracture rates have been reported to be higher in women with osteoarthritis of the hip,

lower with spine OA and to show no associations when only other joints were affected[511]. However, analysis of data from the even larger Study of Osteoporotic Fractures found no significant associations reduction in fractures despite significant increases in bone density associated with osteoarthritis[512]; the authors suggest that falls rates may explain this, although they found an increased risk of falls only in relation to 'self-reported physician diagnosed arthritis' and a conflicting decrease in falls amongst those with radiographic osteo-arthritis of the hip.

Incontinence and other bladder problems

Large population-based cohort studies with prospective falls follow-up of community-dwelling older people[159;160;174;229;239;240] have found urinary incontinence to be a key risk factor for falling and recurrent falling, and also for fractures[174;456;513]. The only such study large enough to investigate different types of incontinence separately[174] reported that amongst over 6,000 American elderly women urge incontinence was associated with increased odds ratios for falling and for non-vertebral fractures, but found no such associations with stress incontinence. A much smaller study of 118 elderly women attending a Japanese day care centre found that mixed incontinence was associated with increased falls risk, but was not powered for any effects of either stress or urge incontinence alone to show significant associations[514]. One study reported that the greater the number of episodes of nocturia the greater the risk of falls[515], but nocturia is not consistently reported to increase risk[183]. One case-control study examined the effects of another specific urological condition, over-active bladder, on falls and reported an association found with injurious falls[516]. Incontinence has also been identified as a fall risk factor for older people in institutions, both hospital[196;258;517;518] and long-term care[191], and to increase the risks associated with other conditions such as stroke[519;520]. It has been suggested[521] that the initially surprising finding that incontinence predicted lower fracture rates amongst nursing home residents[522], fits with a pattern of different risk factors applying to the least mobile compared with those who have limited mobility: in Australian nursing home and intermediate care settings incontinence almost doubled falls risk amongst residents with day-time or night-time incontinence who were able to stand unaided, but incontinence amongst those unable to stand without help showed no significant effect although falls rates tended to be reduced[440].

Depression

Depression was identified as a risk factor for falling in some of the earliest falls research[523;524], and has been repeatedly highlighted as a factor contributing to falls amongst older people both in institutional settings[191;351], and living in the community, whether independently[160;182;496;497] or requiring home care support[195]. It is reported to be associated with factors that themselves increase falls risk, such as functional decline and fear of falling[316;525]. It has also been found to play a part in increasing the risk of falling associated with other conditions such as stroke[526], Parkinson's disease[527] and symptoms of dizziness[525]. Falls and depression have also been linked by common risk factors for both[394], and the complexity of these inter-relationships suggest one-way causation cannot be ascribed in either direction. It has been suggested that the relationship between the two may be largely mediated by other variables, especially physical disability, medication use and recent previous falls, the latter showing a "dose response" effect of worse depression, and anxiety, scores found with greater fall frequency[524]. One of the Dutch longitudinal studies, that had depression and physical functioning scores pre-dating falls, postulated that following fall-related injuries depressive reactions did not set in until there appeared to be a stagnation in recovery of function [153].

The largest study to report an association between depression and falling – from follow-up of 7,414 women in the Study of Osteoporotic Fractures[173] – also found higher rates of incident non-vertebral and vertebral fractures amongst women whose Geriatric Depression Score results met diagnostic levels than were found in the non-depressed women. Subsequent investigation of another sizeable cohort study – 1,566 men and women aged 65 or older enrolled in the Cardiovascular Health Study – revealed a relationship between bone mineral density and depression[528]. There is no agreement on the explanatory mechanisms, but one hypothesis suggested[529] is that bone loss may be hastened by more sedentary behaviour of depressed individuals, a factor that might contribute to muscle weakness, reduced function and thus also falls.

Stroke

Only one study has reported falls rates associated with stroke in comparison with other older people – a case-control study that reported the relative risk of falls was increased more than two-fold amongst long-term stroke survivors versus controls[530]. Another

study also investigated stroke survivors living in the community, reporting that the usual risk factors were not useful fall predictors in this population[158]. Short-term falls risks are very high – a reported 73% fall within 6 months of discharge from hospital[531]. Most researchers in this field have studied case series of patients in stroke units to explore factors that might identify those at especially high falls risk[519;520;526;532], commonly reporting that the stroke patients' risk of falling was compounded by health-related factors predictive of falls in general, such as depression[526], cognitive decline[520] and incontinence[519;520].

Parkinson's disease

Besides the population cohorts from which Parkinson's disease was identified as a risk factor for falls[168] and hip fractures[290], many smaller case-control and case series studies have examined falling and fall-induced injuries amongst older people with Parkinson's disease[527;533-538]. These report very high prevalence of falling (all studies found almost 2/3 of PD patients reported at least one fall in the previous year), increased risk of fractures[538] and similar risk factors to those found amongst older people in general[534], especially previous falls[535].

1.2.5.6 Medication risk factors

Metabolic changes with age render older people especially sensitive to the effects of medications and thus vulnerable to potential side effects[539-541], and various physiological mechanisms have been proposed whereby different drugs may increase fall risk through their effects on the sensori-motor system, balance, dizziness, postural hypotension, reaction time or mental alertness[216;489;540;542;543]. Medication use, and particularly multiple medication use, is widespread amongst older people: 38% of over-75-year-olds in the UK take four or more prescribed drugs daily[109], and US data suggest half of over-65-year-olds are prescribed at least three medicines a day[544]. Countless studies have attempted to examine the risks for falling that different medication groups may entail, but this area of research is notoriously complex. Much of the epidemiological evidence derives from studies not primarily examining the effects of medication and even the studies for which this was a main objective have particular methodological issues to address. There are major issues of confounding by the

indication for prescription, by changes in prescriptions over the study time period, especially prescription changes after a fall, and many studies do not have the power to explore the relative effects of specific sub-classes of drugs within medication groups[216;545]. Research attention has largely focussed on the risks of polypharmacy and of particular 'culprit drug' groups.

The evidence that polypharmacy is associated with increased falling is generally stronger than that for particular medications. Multiple prescriptions of any combinations of drugs, usually counted as four or more, have been identified as increasing risk in many studies[142;232;355;489;539;544;546-548]. However, it has also been argued that poly-pharmacy is a surrogate measure of multiple pathology and may not be a risk factor in itself: in a large study of over 4,000 community-dwelling women in their 70s and 80s falling was associated with the number of chronic diseases but not with the number of drugs taken[494], but the reverse has been found in institutional care[351]. Multiple prescriptions also compound medication-related risks for poor health outcomes in general[549].

A range of medications have been scrutinised as possible 'culprits' for increasing falls risk, but psychoactive drug groups are those most commonly implicated. The increased risk of falling is generally reported to be between 2- to 3-fold[142;163;180;540;542;550-553] and hip fracture risk has also been found to double[554;555], but the associations are not consistent across all classes of psychotropics. Anti-psychotics are strongly implicated in falls amongst institution-dwelling older people[542;556], even when fully adjusted for confounding indications for use, but the evidence is less clear is community-dwelling samples[544]. Hypnotic and anxiolytic drugs, especially benzodiazepines, have also frequently been identified as increasing fall risk, but again there is conflicting evidence as to the relative importance of long- or short-acting preparations, dose, duration of use, and their effects in different populations[180;216;552;557;558]. Some findings support the suggestion that it is insomnia rather than the use of hypnotics that poses the greater risk[559], but a recent review concluded that the risks of hypnotic use in the elderly outweighed their slight beneficial effects on sleep[560]. The evidence for anti-depressant drug effects on falls risk and the relative importance of different classes – tricyclics and SSRIs – is also not conclusive, studies having reported findings both for[3;180;351;489;542;547;558;561] and against[137;544] such links. Other categories of medication

that have been examined in relation to falls include anti-inflammatories, analgesics, diuretics, anti-hypertensives and other cardiac drugs, again all with the potential for confounding effects including arthritis and other musculo-skeletal pain, urinary urgency and multiple co-morbidity. Generally associations with these drug groups are less established than with the psychoactive drugs, the most accepted being for digoxin and some other anti-arrythmics[353;562;563]. Many studies have had insufficient sample size to examine the range of drugs of interest, but comprehensive systematic reviews and meta-analyses attempting to overcome these difficulties have pooled data and concluded that only psychotropic drugs, and perhaps even less so anti-arrythmics, were significantly although weakly associated with falls[563;564].

1.2.5.7 Environmental risk factors

Home hazards
Circumstances of falls

Home hazards

The role played by environmental hazards, particularly in the home, is still a matter of debate. Observational studies provide little support for the common conception that falls often happen because of avoidable dangers posed by trailing wires or loose rugs. Two case control studies reported that the homes of controls who had no reported falls scored as badly on risk identification check-lists as the homes of older people who had recently fallen, fractured[565] or suffered a fall-related injury[566], and the contribution of environmental hazards in institutional settings is also not clear[276;438]. Several prospective studies all concluded that there was insufficient evidence, or none, to confirm that home hazards increase fall risk[169;180;205;567]. For example, Campbell et al pointed out that, in their study of 761 men and women aged over 70, hazard inspection during home assessments identified over a thousand loose rugs, only five of which caused a fall or falls, accounting for 9 of the 507 falls in total recorded in a year. On this basis they question the usefulness of interventions to reduce supposed risks in the home environment[205]. Reviews of such interventions have provided mildly discrepant findings, all couched in cautious terms: reviewing home visits to older people as a preventive strategy, only two out of six such studies aimed at reducing falls had any measurable effect[568]; a more recent review[569] suggested there was some evidence for environmental hazard reduction in the home as part of a multi-factorial approach and

confirmed conclusions from the latest Cochrane systematic review of falls prevention interventions[570] that assessing and modifying home hazards might be effective if targeted to people with a fall history and delivered by trained professionals

There is a suggestion that the additional risk of hazards around the home is only detectable amongst those with an otherwise lower risk profile, for example the more vigorous elderly compared with the frailer participants in a US study[567]. Recent findings from follow-up of the Leiden 85-plus study confirm this pattern: hazardous homes increased falls risk four-fold for those with no recent fall history but did not affect the already higher risk found amongst those with previous falls[94]. On the other hand, retrospective data showed fallers with cognitive impairment had significantly more hazards in their homes than non-fallers with cognitive impairment[565].

Circumstances of falls

Falls in the community most commonly occur in the daytime when people are most active, with typical estimates for night-time falls being only 20 – 26%[205;551]. In care homes, however, falls are reported to happen as frequently by night as by day[185]. Cold weather appears to be a more important factor for women[571], despite the fact that more outdoor falls have been reported amongst men, particularly those that occur whilst doing something relatively active[171;205]. The proportion of falls occurring indoors, and particularly in the usual place of residence, increases for both sexes with age[145]; indoor falls are tend to be associated with frailty while outdoor falls are more common in the 'healthy elderly'[145;223]. For all groups whether indoors or outside the majority of falls occur while walking on the level, with falls on the stairs accounting for only 6 or 7% of reported falls[164]. Not surprisingly, falls on stairs are more likely to be injurious, with over 10% of fall-related deaths arising from falls on stairs, usually descending,[572]. Falls while transferring, say from a chair to bed, account for a very small fraction of falls except in institutional settings[135], and fewer than 5% of falls take place during some form of potentially hazardous activity such as standing on a chair[573].

1.2.5.8 Other risk factors

Nutrition
Alcohol and smoking
Feet

Other factors have been less conclusively shown to be associated with falls in some studies, while other research has not found a relation.

Nutrition

Nutritional factors of particular relevance for fall and fracture risk are vitamin D status and calcium intake. Both are crucial for bone health and vitamin D also plays a role in muscle function and sensorimotor function. Supplementation has long been advocated for the housebound or institutionalised elderly[574;575] and found to reduce falls and fractures in some subsequent studies[576-585], although there is conflicting evidence from intervention studies on the fall or fracture preventative effects in older people who may not be deficient[582;586-588]. Observational studies of falls, function and fractures have shown links most clearly with serum vitamin D levels and in some reports with calcium intake[492;589-595]. Aneamia has recently been identified as a risk factor for recurrent falling[596]. Body mass index has been linked to injurious falls[273] although it is unclear whether this is more due to the association of low weight with fracture[597] or whether BMI is here a marker for frailty and the separately identified risk factor malnutrition[598].

Alcohol and smoking

Alcohol has rarely been shown to be associated with falling[142-143;599], though this may be confounded by reporting and measurement issues[600], and perhaps by the lower alcohol intake of the very frail[601]. Although there is evidence both for[597] and against[602] smoking at a risk for fractures, no studies have linked a link with falling.

Feet

Many aspects of the foot play a part in maintaining balance; recent research has highlighted the particular importance of ankle flexibility, plantar sensation and toe plantarflexor muscles as key predictors of functional ability as well as balance[603]. Inappropriate footwear is implicated[604-607] and problems with the feet, such as toe or nail deformities, ulcers or bunions, that make it painful to walk are also associated with falling[180;608].

1.2.5.9 Evidence to date for different risk factors

The overview of the wealth of evidence for a wide range of fall risk factors that this section overviews is summarised below in Table 1.2.5.9 This is adapted from tables in Lord, Sherrington and Menz's chapter on fall predictors[216], combined and re-ordered in line with themes in this section for ease of reference, and expanded to include factors beyond the scope of their review and more recent evidence[350;609-611].

Table 1.2.5.9 Risk factors for falling: summary of evidence to date

	Strong evidence	**Moderate evidence**	**Weak evidence**	**Little or no evidence**
Socio-demographic	Advanced age	Female gender Living alone	-	Alcohol intake
Previous falls	History of falling	Fear of falling	-	-
Weakness, mobility and limited function	ADL limitations Muscle weakness Impaired gait and mobility Impaired ability in standing up Impaired ability in transfering	Inactivity Impaired stability standing Impaired stability leaning/reaching Slow voluntary stepping	Inadequate responses to external perturbations	-
Cognitive and sensory impairments	Cognitive impairment Peripheral sensation poor Visual contrast sensititvity poor Reaction times slow	Visual acuity	Visual field dependence Hearing impairment	Vestibular function reduced
Health-related risk factors	Stroke Parkinson's Psychoactive or anti-arrhythmic medications Poly-pharmacy (>4 drugs)	Arthritis Incontinence Depression Acute illness Co-morbidity Self-rated health Nutrition status - low vitamin D, anaemia, low BMI	Dizziness Diabetes Foot problems Cardiovascular / circulatory dis. Antihypertensive medication	Orthostatic hypotension Vestibular disorders Non-steroidal antiinflammatory medications
Environmental risk factors	-	-	Poor footwear Inappropriate spectacles	Home hazards External hazards

Strong evidence - consistently found in good studies
Moderate evidence - usually but not always found
Weak evidence - occasionally by not usually found
Little or no evidence - not found in published studies despite research examining issue

1.2.6 Assessment of functional ability and prediction of falls risk

1.2.6.1 Reported and performance measures of functional ability
1.2.6.2 Falls and other outcomes associated with balance testing
Static balance
Dynamic balance
1.2.6.3 Falls and other outcomes associated with chair rising
Gait and gait speed
Tandem walk
1.2.6.4 Falls and other outcomes associated with gait
1.2.6.5 Falls and other outcomes associated with grip strength
1.2.6.6 Falls and other outcomes associated with combined tests
Tests of several domains
Dual task tests

1.2.6.1 Reported and performance measures of functional ability

It is important in clinical practice to be able to assess an older person's functional ability and to have an understanding of the possible implications of impaired function. Many areas of research also need to include such measurements, whether to characterise the population being studied or to quantify change, for instance in longitudinal cohorts or intervention samples – in epidemiological terms, to examine functional level as an exposure for another endpoint of interest, or as an outcome related to other exposures. An enormous array of methods have been employed to attempt these assessments, both methods that rely on accounts (self-reported or proxy-reported) of functional ability or disability, and methods that make direct observation of the patient or study participant performing a set of tasks designed to test their functional performance.

Each approach has advantages and disadvantages. Reported measures generally save time, at least save clinicians' or researchers' time – some such as detailed physical activity questionnaires, may be lengthy for an older person to complete – and often may be the only feasible method of assessment in a busy clinic environment or in a large-scale survey. However, subjective factors that may not be apparent or understood can influence reporting. Functional testing with a variety of physical performance measures allows objective assessment of skills, often with precisely quantified scales of competence, but requires the time of a trained observer, sometimes needs specialised equipment and inevitably involves the logistics of bringing observer and observed together – getting the older patient or participant up to a clinic or research centre, or

travelling to the older person's usual place of residence – so all performance measurement methods are more costly than measures of reported function.

Many approaches have been used with scales developed to suit specific circumstances. Reported measures usually focus on assessing functioning in activities of daily living, particularly mobility levels. Observed measures range from complex laboratory investigations, for instance with force-plates, gait sensors, dynamometry and sway detection systems, to sets of functional tests involving no more than a stop-watch or the space to walk a given distance, to very basic clinical observations such as asking an individual to stand up, walk across the room or turn around. The need for standardisation has long been recognised[612;613]: a number of researchers have reviewed different aspects of this complex field[391;392;405;614;615] (see Appendix B) and guidelines on assessment of older people now specify the "Get up and go" test as the expected minimum[616;617] (see Appendix A). Most of the commonly used functional tests - tandem stance (or sharpened Romberg) [618], one-leg stand[168;618], timed unsupported stand[619], reaching in one to four directions[363;620;621], step test[168;620], chair stand[168;362], walking speed[168;362], Performance Oriented Mobility Assessment (POMA or Tinetti Balance Scale)[622], Physical Performance Test[623], Elderly Mobility Scale[624], Berg Balance Scale (BBS) [625;626], Short Physical Performance Battery (SPPB)[246;362] and Timed Get-up-and-go test[627] - show, when documented, high reliability and acceptable concurrent validity[391;623;624;628;629]. It is beyond the scope of this review to examine the merits and problems of specific different measures that have been developed; this section is to highlight the findings to date regarding falls, the serious consequences of falls and other relevant outcomes that have been reported in relation to different types of functional measures. Table 1.2.6 provides a summary of what evidence there is to date relating falls and other outcomes to the functional performance tests selected for the current study; many measures have mainly been evaluated in relation to retrospective data but all those selected are supported by at least some evidence from prospective studies.

Table 1.2.6 Functional performance tests selected for the current study: relation to falls and other outcomes

	Falls	Recurrent falls	Injurious falls or fractures	Functional decline or disability	Hospital admission	Moving into care	Death
Combined test							
Short Physical Performance Battery (SPPB)	✓ 630	?	?	✓ 246;362;631	✓ 632	✓ 246;630	✓ 246 630
Component tests in SPPB used as separate tests							
Tandem stance	✓ 178	✓ 178	✓ 164;633 × 618	?	?	?	?
Chair stands	✓ 159;301;634	✓ 164;168	✓ 164;270;273;597	?	?	?	?
Gait speed	✓ 147;159;190;243;634 × 159;164;313	✓ 168;635 × 164	✓ 273;353;464 × 164	✓ 636-638	✓ 639	✓ 639	✓ 180;637;640
Dynamic balance							
Functional reach	✓ 164;641 × 251;620;634;635;642	✓ 182;641	✓ 164	✓ 630	?	✓ 630	✓ 630
180° turn	✓ 117;643	✓ 168	?	?	?	?	?
Muscle strength							
Hand grip	✓ 147;168;198 × 164;634	✓ 149;168;182 × 164	✓ 270 × ✓164	✓ 644-647	?	✓ 648	✓ 640;648;649

✓ Studies have reported evidence for an association between functional test and outcome
× Studies have found no evidence for an association between functional test and outcome
? No studies identified examining the association between functional test and outcome

1.2.6.2 Falls and other outcomes associated with balance testing

Static balance
Dynamic balance

A range of performance measures have been devised to assess aspects of maintaining postural stability that are generally described as static and dynamic balance. Standing balance tests include various stances (feet apart or together, in tandem or semi-tandem positions) on different surfaces (firm or compliant, usually measured on the floor and a foam layer) with or without footwear. Assessments may involve simple observation, stop-watch timing or equipment ranging from relatively low technology sway-meters to elaborate laboratory-based posturography systems. Some tests pose additional challenges, introducing sudden perturbation, turning or requiring the individual undergoing assessment to move their centre of gravity by reaching out. The predictive value of such tests has been extensively evaluated and many are strongly linked with falls, some more consistently so than others.

Static balance

So-called "static" balance is never entirely without the body's slight unconscious sway motion and interest in the relation between this postural sway and falling is not new[650;651]. However, there has recently been a huge body of research in this field[139;225;272;487;490;635;652] highlighting the increased sway both of people reported to have fallen and of those who subsequently fall, in institutionalised as well as community-dwelling older people. Timed balance in various stances has been better evaluated as a component of a number of combined assessments (see section 1.2.6.5) and there is conflicting evidence on using the tandem stance alone[164;618;633] to identify fall risk. The one-leg stand test generally, but not always[618;633], produces lower values amongst older people who have fallen recently and low scores also predict subsequent falls[391] using a variety of cut-points – less than two seconds[168] or not being able to hold the position at all[180] – and holding for less than five seconds predicted injurious falls[156]. However, it is of doubtful use with the frailest old people because of its "floor effect" and the high rate of not attempting the test reported for older people who have fallen before, use walking aids or who are cognitively impaired[642].

Dynamic balance

Fewer studies to date have used dynamic balance tests but there is consistent evidence for the assessments that involve turning from those which have. Poor performance in the 180° turn is associated with past falling[117;643] and needing to take five or more steps predicts future recurrent falls[168]. Turning is an important element of several composite assessments – 180° in both the "up-and-go" tests (timed or just observed), 360° in the Physical Performance Test and the Berg and Tinetti balance scales – but tends not to be reported separately. Analysis of the strategies used by older people turning have shown particular factors that may increase staggering or tripping during turning include very short step length, especially when turning in a non-preferred direction[653;654].

The functional reach test in effect assesses the limits of stability and was therefore designed originally with fall prediction in mind. Development studies in older American men produced the widely quoted findings that being able to reach forward less than 10 inches, without needing to take a step, doubled the risk of falling in the next six months, reaching less than 6 inches gave a 4-fold increased risk and not being able to reach at all predicted fall rates 8 times as high as those amongst men who could reach more than 10 inches[641]. Although there is some evidence supporting the test's predictive validity in women – a 30% risk reduction amongst Japanese women in Hawaii with a long functional reach (≥35cm) – other findings have been inconsistent with no associations found in a range of studies with equivalent or longer follow-up, including women only and mixed community-dwelling samples[620;635;642].

1.2.6.3 Falls and other outcomes associated with chair rising

Standing up from a chair tests dynamic balance too, but is also strongly linked to lower limb strength and power. Differing test protocols observe individuals' attempts to rise with or without using their arms to help, counting the number of successful chair rises within a set time limit (such as the 30 second test[655]) or timing how long it takes to stand up a specified number of times (often five, as in the SPPB, or sometimes three or even ten[656]). Time taken and whether or not someone can stand up from a chair at all have both been shown to relate strongly to past and subsequent falls[159;164;169;301;477], repeated falling[164;168] and injuries resulting from falls[164;270;273;597].

1.2.6.4 Falls and other outcomes associated with gait

Gait and gait speed
Tandem walk

Gait and gait speed

The more in-depth composite measures of balance – the Tinetti and Berg balance scales[622;625;626] – require a trained therapist to make detailed assessment of gait patterns. Laboratory techniques for complex gait analysis also confirm strong associations between falling and gait unsteadiness (stride variability, stride, swing or stance time[657]) or gait patterns (toe clearance, sole inclination and trunk sway[658]) but such methods are impractical in most clinical or research settings. More widely adopted, particularly in larger scale studies, is the measurement of walking speed, a key indicator of mobility. Normal gait speed declines with age: studies have found decreases of 7% - 20% for each decade after the age of 60[372;659;660], or 3.5% decline for each year older, reportedly even steeper declines in older old age[373]. Maximum walking speed and "comfortable", "preferred" or "usual" walking speed are both commonly used measures, and caution is needed in comparing findings from studies using different methodological approaches – various distances, number of timed walks, start point of timing and so forth. Reduced gait speed is widely reported to be a powerful predictor of many adverse outcomes, including injurious falls leading to both minor and major injuries[353], fractures[464], disability[636-639], hospitalisation[639], nursing home admission and mortality[180;637;640]. It has been suggested that it may be such a good predictor because disability in walking reflects not only a combination of strength and balance deficits, but also psychological factors such as fear of falling[369]. This complexity may help account for some of the discrepant findings on the association of gait speed with falls[313], for example in one study of elderly sheltered housing residents where walking speed related not to falls but to fear of falling[313]. Other inconsistent findings were the lack of association found between fall and gait speed measures for women in two large studies, the women only Honolulu Osteoporosis Study[164] and the Health-ABC study which found gait speed lower was only lower in men who fell[159].

Tandem walk

Besides timing walking speed, set walking patterns have also been used to test walking ability. Such tests include following a line, say a figure of eight or straight route,

walking backwards or walking heel to toe. This last, the tandem walk, has been shown to strongly predict falls with injury[168] including hip fractures[661].

1.2.6.5 Falls and other outcomes associated with grip strength

Although lower limb muscle strength is clearly important in the aetiology of falling (see section 1.2.5.2), hand grip has been widely used in many studies and in some has been considered a proxy indicator for overall muscle strength or as a marker of frailty[662]. Grip strength is higher in men and declines with age at a rate of 2 – 3% a year from the age of 65 onwards[663]. It is strongly related to loss of function[644] and both prevalent and incident disability[645-647] and predicts many outcomes that may follow frailty, including nursing home admission[648] and mortality[640;648;649]. Studies have shown it to be associated with fracture history and bone density[664-666]. In a study of predictors of recurrent falling amongst community-dwelling men and women who had already fallen twice, hand grip was one of the very few factors that predicted the risk of any subsequent fall – most factors related significantly only to recurrent falls[168]. However, there are also reports from large well-designed studies that hand grip strength bears no relation to falling; interestingly these are all from women only studies[164;634].

1.2.6.6 Falls and other outcomes associated with combined tests

Tests of several domains
Dual task tests

Tests of several domains

Composite assessment scales that involve elements of the different domains above have generally been evaluated in relation to the outcome risks that they were devised to identify. Thus there is good evidence for the fall predictive validity of the POMA / Tinetti[180;352;630;667] and Berg[625;668] balance scales and consistent reports of the physical function batteries SPPB and PPT predicting outcomes indicative of declining function: admissions to hospital[632;669] or care homes[246;670], disability[246;362;631;670;671] and mortality[246;670]. Recent work has shown that the POMA can also predict the loss of mobility leading to social consequences such as isolation or moving into care for older people the year after a hospital admission[630]; this same study provides the only

published findings to date on the fall predictive value of the SPPB lower extremity performance tests, reporting an association only in univariate analyses.

Dual task tests

There has been a growing interest over the last decade in the effects of performing more than one task – a mobility test and a cognitive exercise – at the same time. Dividing attention was noted to interfere with balance performance more for older people than younger[672], and attempting various cognitive tasks – numerical or verbal[673;674] – has been shown to result in changes in voluntary stepping and gait pattern or general reduction in motor performance[675-678]. The idea that someone "stops walking when talking" because the attentional demand of doing both simultaneously is too great prompted a short prospective study of sheltered housing residents in Sweden that revealed striking differences in falls rate predicted by this simple observation[679;680]. Findings have been replicated[681], associations found between dual-task tests and fall risk factors[682], but further research in this new field is needed and on-going[683].

1.2.7 Assessment of bone fragility and prediction of fracture risk

1.2.7.1 Quantitative ultrasound to assess skeletal fragility
1.2.7.2 Quantitative ultrasound can distinguish risk factors
Previous fractures
Physical activity
1.2.7.3 Quantitative ultrasound as a predictor of fracture risk

1.2.7.1 Quantitative ultrasound to assess skeletal fragility

There is increasing interest in quantitative ultrasonography (QUS) as a relatively new modality for assessing bone strength, but there is very little data on QUS measurements in the over 90-year-old age range[684]. Most manufacturers reference data do not range beyond 79 years old[685].

Compared to Dual Energy X-ray Absorptiometry (DEXA) - the current "gold standard" test for osteoporosis – QUS is cheaper, quicker, more portable and does not involve ionising radiation[686-689]. For these reasons it has been proposed as particularly appropriate for use with older populations such as the housebound and institutional care residents[690]. Moreover, it has been argued that with increasing age the advantages of DEXA over QUS diminish, as the difference between the relative risks of fracture predicted by each standard deviation of the two methods found in women under 80 years was not observed in women aged 80 or older[691]. As the technology becomes more widely available, its potential as a screening or pre-screening test has been suggested, to target fuller osteoporosis assessment to those at highest risk[692]. It is still contentious whether or not this approach increases sensitivity and specificity or is more cost effective than current reliance on clinical referral criteria[693-698]. Conflicting results have been reported, but virtually none provide information on the oldest old.

Quantitative ultrasound does not measure bone mineral content or density directly so it cannot be used to diagnose osteoporosis as currently defined. Its relation to DEXA remains controversial and correlations have been reported as low to moderate[697;699] or high[689], especially when comparing measurements at the same site[700;701]. It has been suggested that ultrasound parameters may measure qualities of bone other than just density that may be important factors in fracture risk[686;699]. Ultrasound velocity is related to the elasticity and density of bone, and ultrasound attenuation is related to the structure, as well as the density, of cancellous bone[687;688].

1.2.7.2 Quantitative ultrasound measures distinguish risk factors

Previous fractures
Physical activity

Previous fractures

Cross sectional and case:control studies of both community-dwelling and institutional samples of men and women have shown that ultrasound parameters can distinguish between people with and without vertebral, hip and other fractures[426;690;700;702-705].

Physical activity

In younger populations both ultrasound velocity and attenuation are associated with various measures of physical activity including marathon running[706], brisk walking[428;429], number of steps walked daily[430], stair climbing[409], recent[427], current[425;426]and outdoor[410] physical activity.

1.2.7.3 Quantitative ultrasound as a predictor of fracture risk

There is now also convincing evidence from prospective studies that low QUS parameters are independent risk factors for osteoporotic fractures. This was first demonstrated among residents of institutional settings in a UK study of over 1,400 women aged 70 or older that found a combination of a score for cognitive impairment (CAPE[707]) and broadband ultrasound attenuation (BUA) measured at the heel predicted hip fractures over ten years' follow-up[693]. Since then a growing number of observational cohort studies have also found BUA is predictive for fractures overall[708-713], for wrist[710] and hip fractures[708;709;711;714] especially for trochanteric fractures[708;715], and also for second hip fractures[696]. One UK study of women aged 70 and over recruited through general practice reported that BUA was not an independent predictor of hip fracture over five years' follow-up[698]. Apart from this report, the positive findings are from large prospective cohorts from around the world – Finnish post-menopausal women[712], American women aged over 65[708], French women aged 75 or more[714], English men and women aged 42-82[711] and 45-75[710], Japanese men and women over 60[713] and Dutch men and women aged 70 or more[709] – and show a remarkably

consistent effect: fracture risks approximately double for each standard deviation decrease in broadband ultrasound attenuation.

However, the numbers of extremely old people are very small even in these big studies and many of them included only community-dwelling older people so cannot adequately represent the population reaching advanced old age. What data there are so far on quantitative ultrasound measures in very old age comes from studies of the elderly in communal settings that include higher proportions of over-90-year-olds than community studies, but which are also unrepresentative. These have tended to be cross-sectional surveys[716;717] or smaller-scale treatment trials[718] and extended follow-up for fractures is rare[693].

Given the dearth of information on ultrasound measures in advanced old age, the latest CC75C survey provided an opportunity to gather these skeletal data alongside the collection of functional measures. In the current study's small sample it was anticipated that the number of fractures would be too low to consider fracture as an endpoint potentially predicted by ultrasound measures. Instead the aim was to examine the inter-relation of calcaneal ultrasound and functional performance, and to explore associations between these and other factors that previous researchers have linked to bone strength and fracture risk, including previous fractures and reported function, mobility and physical activity.

1.3 1.3 Study objectives

1.3.1 Research questions unanswered in the literature to date
1.3.2 Translating research questions into study objectives

1.3.1 Research questions unanswered in the literature to date

Almost two decades of extensive investigation in the rapidly expanding field of falls research have not yet provided answers to the many questions implied in Downton's early hypothesis that, whilst fall rates appear to increase with age, "falling in extreme old age may be lower because of selective survival of a very fit cohort"[217]. The over-all paucity of research concerning the oldest old means that many 'unknowns' remain. As the literature overview in the preceding section (Chapter 1.2) illustrated, there are still very few data on falls and their consequences in advanced old age, and there is likewise scarce evidence concerning risk factors for falls, fractures, other injuries or sequelae of falls amongst the very old. The functional mobility of men and women aged over 90 years has rarely been examined in detail and there is a dearth of normative data on skeletal measures in this age range.

In general intrinsic risk factors appear to become increasingly more important than extrinsic factors with advancing age, but the inter-relation of factors also grows in complexity. Strategies for prevention tried so far tend to focus on modifiable risk factors; however, to what extent a fall in extreme old age is "just an accident", the degree to which a risk factor may be modified and the effect that increasing old age may have on these unknowns are all still unclear. With ever-present constraints on resources for health and social care, pertinent unanswered questions remain – is it possible to identify high risk factors amongst the oldest old in order to target falls prevention initiatives most effectively? …if so, which screening tests are most predictive of falling? …or most predictive of falls leading to serious adverse consequences such as health service use, dependence on care or death? …or, alternatively, rather than involve resources in identifying high risk target groups, should all those aged over 90 years be treated as at high risk of falling?

1.3.2 Translating research questions into study objectives

The many questions that research has so far either not adequately addressed or been unable to answer (see sections 1.2 and 1.3.1) have helped to shape the current study's aims into specific objectives for investigation. Informed by the uncertainties in the research literature and current practice, key potential risk factors for falls and their consequences were highlighted as needing to be quantified in the oldest old and to be investigated in relation to falling. These descriptors include measures of function and skeletal fragility. Initial examination of the relevance of these factors to reported previous falling was planned to shed light on their relevance to this age group, to be followed by further examination of their value as predictors of subsequent falls and fall sequelae. A representative sample of men and women in advanced old age identified through the Cambridge City over-75s Cohort study provided the opportunity to pursue these objectives, as summarised in Box 1.3.2 below.

Box 1.3.2 Study objectives

1) To characterise a population-based sample of men and women aged over 90 years old in terms of their putative risk factors for falls and the consequences of falls, including objective measures of cognitive function, physical function and skeletal fragility

2) To measure falls and their consequences in this representative nonagenarian sample from both reported fall history and prospective fall incidence over 1 year

3) To examine which factors are associated with recalled falls in the cross-sectional data, and to test whether these are predictors of prospectively recorded falls

4) To examine which factors are associated with serious consequences of falls

5) To examine which factors are associated with skeletal fragility

CHAPTER 2

STUDY METHODOLOGY

2.1 The Cambridge City over-75s Cohort study methods to date

2.1.1 The CC75C study methodology
- 2.1.1.1 Study Design: from population survey to longitudinal cohort
- 2.1.1.2 Study population: baseline recruitment and attrition over time

2.1.2 Measures used to date
- 2.1.2.1 Data collected
- 2.1.2.2 Measures of falling in previous CC75C interviews

2.2 Protocol development for the current study

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- 2.2.1.1 Additional physical activity question – stair climbing
- 2.2.1.2 Previous falls
- 2.2.1.3 Fear of falling
- 2.2.1.4 Previous fractures and risk factors for fracture

2.2.2 Introduction of physical measures
- 2.2.2.1 Physical function performance measures
- 2.2.2.2 Quantitative heel ultrasound scans

2.2.3 Prospective falls data collection for one year follow-up
- 2.2.3.1 Calendars
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2.3 From protocol to practice

2.3.1 Pilot study
- 2.3.1.1 Aims of the pilot study
- 2.3.1.2 Methods of the pilot study
- 2.3.1.3 Outcomes of the pilot study

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- 2.3.2.1 Ethical issues
- 2.3.2.2 Liaison and logistics

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- 2.4.3.3 Alternative data from proxy informants
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- 2.4.2.1 Data descriptive of the sample
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2.4.3 Analysis of association: potential risk factors and outcomes of interest
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2.1 The Cambridge City over-75s Cohort study methods to date

2.1.1 The CC75C study methodology
2.1.2 Measures used to date

2.1.1 The CC75C study methodology

2.1.1.1 Study Design:
from population-based survey to longitudinal cohort
2.1.1.2 Study population:
baseline recruitment and attrition over time

2.1.1.1 Study Design: from population-based survey to longitudinal cohort

The study that forms the basis of this thesis was developed within the framework of an existing population-based longitudinal study of ageing, the Cambridge City over-75s Cohort (CC75C) Study. This began in 1985 with a cross-sectional survey screening for the prevalence of cognitive impairment in the elderly, the Hughes Hall Project[719]. An incidence survey more than two years later (the Cambridge Project for Later Life: CPLL[720-722]) started the process of longitudinal follow-up that continued through three more rounds of interviews at approximately three to four yearly intervals (the Cognitive Function, Activities of Daily Living and Service Use Studies: CAS1[723], CAS2 and CAS3). Together these studies have become a prospective cohort study and are known collectively as the CC75C Study.

The current study thus forms the sixth main survey in this longitudinal study and the flowchart in Figure 2.1 summarises the main stages in the CC75C study to date. For simplicity this omits the various branch studies of sub-groups of the sample population selected for more in-depth screening after a number of these full-sample interview waves.

2.1.1.2 Study population: baseline recruitment and attrition over time

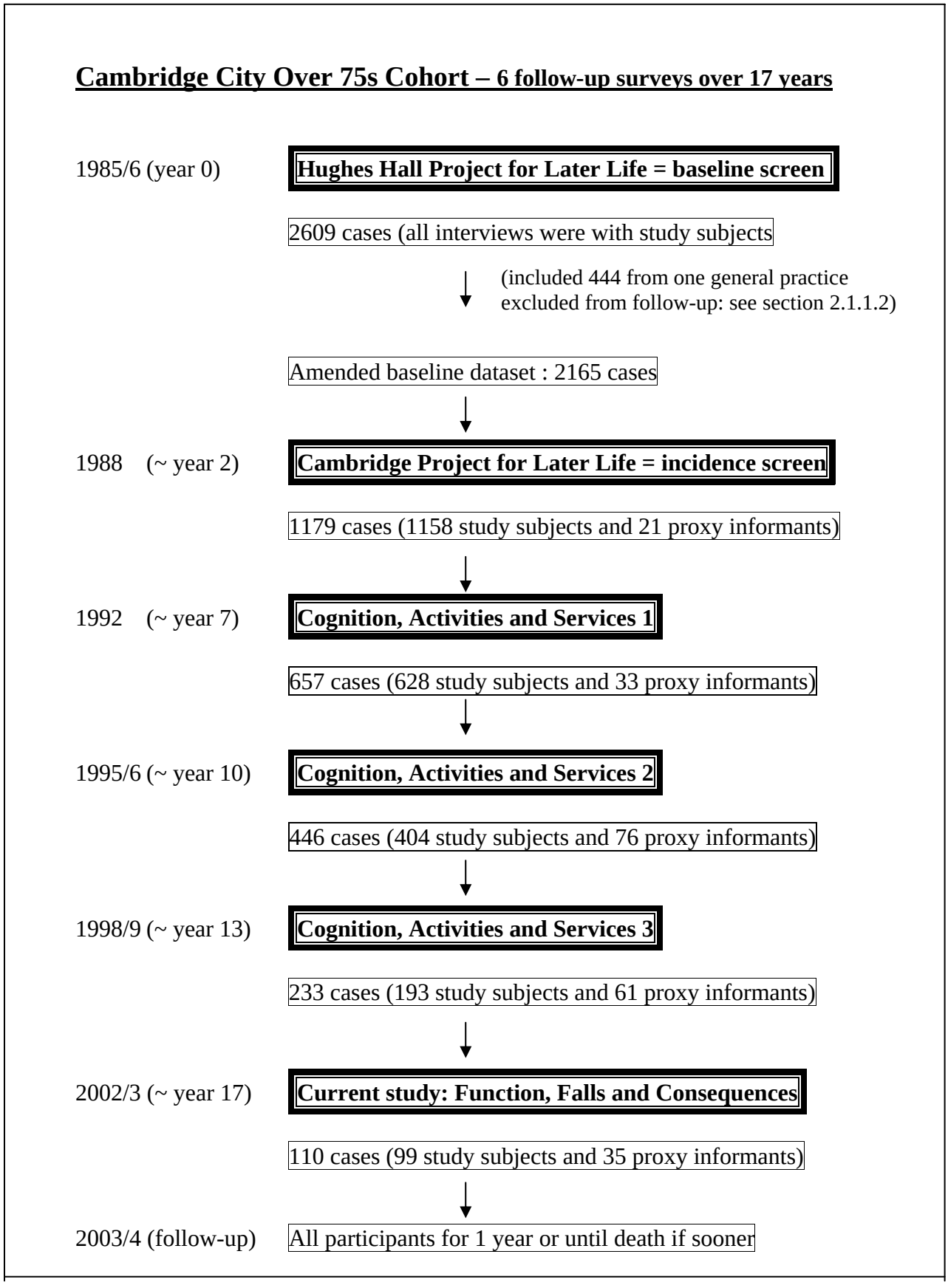
Study participants were initially recruited from 7 general practices in the city of Cambridge, UK, with the approval of Cambridge Local Research Ethics Committee. All those aged 75 and over from 6 practice lists, and one in three of those aged 75 and

over from the seventh practice, were invited to join the study. One surgery followed a different recruiting protocol that resulted in a lower response rate (80%) than amongst the others, so this group were dropped from the main CC75C cohort follow-up to avoid the complexities of selection bias. Of the eligible patients from the remaining 6 practices, consent to take part was given by 95% of those approached, or their relatives, equivalent to 40% of the city's population aged 75 and over. The study population was therefore highly representative of the sampling frame as a whole – the "old old" age group in Cambridge.

2609 men and women were interviewed in their normal place of residence by trained lay interviewers using a structured questionnaire between 1985 and 1987. For the purposes of this study, data from only 2165 of these have been taken as the baseline dataset, excluding those identified from the surgery with the different recruitment protocol.

Attrition due to refusal, inability to locate and, primarily, mortality has been marked. After the baseline survey the protocol allowed for a relative or other proxy informant to be interviewed when information would otherwise have been lost from the study, but these were only a small minority. By the latest follow-up only 110 of the original 2165 took part (see Figure 2.1).

Figure 2.1 Outline of the CC75C Study – main interview waves



2.1.2 Measures used to date

2.1.2.1 Data collected
2.1.2.2 Measures of falling in previous CC75C interviews

2.1.2.1 Data collected

Changes in emphasis of data collection over time
Introduction of questions to gather data on falls
Demographic descriptors
Residential status
Cognitive function
Depression
Self-reported health
Self-reported health conditions
Perceived instability
Activities of daily living
Social, physical and other activities

Changes in emphasis of data collection over time

Although dementia and cognitive decline were the primary focus of the CC75C study, from the outset data were collected on a range of other domains: basic demographic details, residence status, family and other social contacts, activities of daily living, mood, self-rated health and reported physical health problems. The questionnaires have been adapted over time, keeping the baseline interview questions more or less unchanged with additional questions inserted, or additional response options added to existing questions.

In the last three (Cognition, Activity and Services) interviews before the current study more detailed questions were added on the use of health services and receipt of care. New topics included physical activity and, in just the last two interviews, self-reported falls (see the following sub-section Chapter 2.1.2.1).

The present study makes use of data on a range of covariates that are examined in relation to the new data collected on function, falls and fall sequelae in the follow-up study. Measurement of each of these is described below (see also Appendix C *Cambridge Project for Later Life (CC75C) interview schedule*).

Demographic descriptors

Age was calculated from confirmed dates of birth. Educational level was a binary score based on school leaving age – either up to 14 years old, or 15 years and older. The number of years in school and, if applicable, in further education were also recorded. Social class was based on the Office of National Statistics /Office of Population, Censuses and Survey's Standard Occupational Classification into social class based on occupation using six classes: professional; managerial and technical; skilled non-manual; skilled manual; partly skilled and unskilled occupations[724]. For men and single women this was based on their last reported occupation; the study followed the census practice of taking the husband's last occupation as the indicator of a married woman's social class. These six classes were further categorised into two groups: manual and non-manual.

Residential status

Data were collected throughout on whether study participants lived alone or, if not, with whom they lived and whether they lived with anyone physically or mentally frail. The type of accommodation occupied was coded as one of six options that could be summarised as three categories, after clarification from the respondent if necessary: living at home (in a house or flat), living in sheltered accommodation and living in institutional care (long-stay hospital/council or private residential home, nursing home). For analyses these were further dichotomised as either living at home or living in any supported living setting (sheltered/care home).

Physical and mental health

A number of approaches to measuring different aspects of health were used in the interview, including both self-report questions and standardised objective assessments. The interview schedule has always addressed the mental health factors cognition and depression. Physical health measures included a simple hearing and reading vision test, and several batteries of questions asking respondents how they rated their health overall, how different conditions affected them day-to-day, and which of a list of diagnoses they had ever had.

Cognitive function

At baseline the Mini Mental State Examination (MMSE)[725] was used to screen for cognitive impairment; later the screen was expanded to include the CAMCOG[726] assessment of all participants if possible, which includes the MMSE. In some of the earlier sub-sample studies, the Cambridge Examination of Dementia in the Elderly (CAMDEX)[727] was also used. At baseline both options in the parallel versions of the MMSE were used – serial 7s subtracted from 100 and spelling w-o-r-l-d backwards – and the better response was taken to calculate the summary score in a range from 0 to 30. Later waves used the serial 7s option only.

The MMSE uses a battery of 21 questions that generally take 10 to 15 minutes to administer, originally developed in 1975 by Folstein and co-workers[725]. Its use is now widespread both in clinical practice and in epidemiological studies. Its validity, reliability and interpretation have been extensively researched in different populations and settings. Although found to give highly variable positive predictive values, ranging from 31 to100%, to be less sensitive at its lower limits, and to have recognised ceiling effects, it has been shown to have a high test-retest reproducibility, with reliability coefficients between 0.80 and 0.95, to correlate well (0.70 to 0.90) with other cognitive screening tests[728] and to have high correlation with instrumental activities of daily living[729].

Depression

The Depressive Symptom Scale section of the CAMDEX[727;730] comprises 10 questions (scored 0-11) that are included in the current CC75C schedule's section on "Mood and recent events" (see Appendix C questions 48-49, 53-60, 64-65) along with additional anxiety questions.

Self-reported health

The baseline question "How would you rate your health at present?" was re-phrased at the second interview to ask both "… compared to others of same age?" and "… now compared to two years ago?" Answers could range from very good to very poor on a five point Likert scale. Related new questions were also introduced at this stage about having more or less energy, again compared with others and with self two years earlier, and about any difficulties sleeping.

Reported diagnoses and physical symptoms

The study design at baseline did not allow for collection of health status data from medical records, so the study has had to rely on interviewees' replies to the question "Have you had or has a doctor ever told you …" for broad diagnostic categorical data (see Appendix C question 67). Physical symptom data were collected from self-reports in nine areas of potential difficulty, allowing for "other conditions" to be specified, with a tenth "trouble with nerves" added in 1992/3 (see Appendix C question 68). The latest survey repeated the wording used in the CC75C schedule since the Year 6 interview "I would like to ask you about some specific conditions which may have affected your day-to-day routine in the last month…." followed by a list of conditions. Of particular relevance to the current study of falls are the items asking about "Poor vision", "Arthritis/rheumatism", "Marked weakness in leg/arm", being "Unsteady on your feet" and having a "Tendency to fall". Interviewer instructions required ascertaining whether the symptoms prevented the respondent from carrying out day-to-day activities, so that responses could be coded as either "No", "Yes, disabling" or "Yes, present but not disabling".

Hearing and eyesight

The interview included two brief assessments that provide objective data on hearing and visual disability in addition to the reported measures from these items in the list of conditions described above. For the Whisper Test participants were asked to repeat exactly what they hear when the interview, positioned a metre away but out of their line of vision, says slowly two sets of three letters and numbers (3 A F, 1 F 3) starting at a whisper, then at normal speech volume and, if still not repeated accurately, then shouted. Inability to hear and repeat both sets accurately when spoken at normal volume was classified as hearing impairment. Visual impairment was classed as the

inability to read print with 3mm capital letters, from the brief eyesight assessment in which participants were asked to read aloud a couple of lines from a test sheet of various extracts in different print sizes. The defining cut-points follow those used in other epidemiological research with older old people[88].

Activities of daily living

Level of functioning was assessed in 12 activities of daily living (ADLs) in the baseline interview: use of the telephone, shopping, preparing meals, housework, laundry, walking, use of walking aids, bathing, grooming, dressing, using the toilet and taking medications. Four further questions were added in the second and subsequent interview rounds about managing finances, transport, wheelchair use and ability to feed oneself[731]. Responses were graded 0 if fully independent and 1 to 2, 3, 4 or 5 indicating a range of limitation in function depending on the question of interest. For this thesis, the questions on walking, use of walking aids, use of wheelchair and transport were selected as of particular interest.

Social, physical and other activities

From the first interview the questionnaire included an item asking about attendance at any groups in the last month - over 60s club, other social club, church group or any other group – or whether the study participant had taken part in any voluntary work in the last month. Regular, occasional or no church attendance was also recorded. At the second interview attending church was included with attending the other options above, but the question wording changed to ask about the last week, rather than month, with an additional question asking about any other regular events that took place less than weekly. There was another new question from this round onwards: "In general, do you get out and about as much as you would like to?" which interviewers did not put to the housebound. All the above were coded as a dichotomous Yes/No response.

The last three interviews expanded this section to ask those for whom the question was not deemed inappropriate whether they managed to do any physical activity or exercise. Interviewers specifically asked about five activities – keep fit, walking, gardening, DIY and cycling – with another option to specify any other type of physical activity. Again the answers could only be Yes or No, with no attempt to measure the frequency,

duration or intensity of any of these options, nor was there any time frame on this question.

At the same time nine questions were added about other sorts of activities – visits to places of interest, amateur music/drama, going to pubs/restaurants, classes/lectures (these four were omitted if housebound) knitting/sewing, hobbies/crafts/collecting, card/board games etc, reading and any other activities (everyone was asked these five) – done in the last fortnight. An extra item asked "Have you taken any kind of educational or training course in recent years?", and all were coded 1/0 forYes/No.

2.1.2.2 Measures of falling in previous CC75C interviews

Questions on falls already in interview schedule
Limitations

Questions on falls already in the interview schedule

Whilst developing the protocol to meet current study's special focus on falls, it was important to bear in mind the longitudinal nature of the study and therefore to preserve the existing question wording.

All the previous interview schedules have touched on falls briefly in a section about physical health problems in general. The wording and emphasis changed slightly, from "What particular difficulties do you have?" in the first survey to "Have you recently had an illness or condition which prevented you carrying out your normal day-to-day routine?" in the Year 2 interview. Both of these led into a list of particular conditions including "unsteady on feet" and "falls". At Year 6 "falls" was changed to "tendency to fall" and this has been used since then.

Different response options used in some earlier waves of the study such as either the addition of a new time period ("in the last six months" was added at the second interview to baseline questions about whether any physical health problems had affected day-to-day routine "in the last month"), or the extra option of reporting whether a given health condition was disabling or not, rather than just whether it was present or not.

A separate new section of seven questions specifically about falling was added in Year 10 (1995/6) and repeated in Year 13 (1998/9), while the "tendency to fall" item remained on the list of possible disabling health conditions as well. These were intended to gather details on whether study participants

- had had a fall in the last 3 months,
- how many falls they had had,
- whether the fall was from standing height,
- whether the fall was from a greater height than standing,
- where it/they took place (indoors/outdoors),
- when it/they took place (at night/by day),
- and whether the cause could be ascribed to accident/black-out/dizziness/other reason.

Where more than one fall was reported, details were only entered for one fall.

Limitations

The investigation of falls was never a prime research objective earlier in the CC75C study, but data have been collected on falls along with other common problems of older people simply as part of the process of building a picture of the health and social well-being of the population. The question wording and time-frame of enquiry changed between some interviews and at no previous stage in the study was there any attempt to trace what proportion of the self-reported and proxy-reported falls were also documented elsewhere. The data did not include any information on whether the respondent presented to medical attention after the fall or whether any injury resulted.

Clearly therefore there are limitations to these previously collected falls data from the earlier CC75C surveys, but their analysis[732] has informed development of the present study as explained in the following section (see Chapter 2.2 *Development of methods for the current study*).

2.2 Protocol development for the current study

2.2.1 Expansion of the interview schedule
2.2.2 Introduction of physical measures
2.2.3 Prospective falls data collection for one year follow-up

An expanded protocol to address the research questions of the current study was developed around the core measures already in place from earlier surveys of the CC75 cohort. Developments were in three main areas:

- Addition of measures in the main interview to address falls, injuries and related risk factors
- Introduction of physical measures – functional testing and ultrasound scanning
- Collection of data on falls through prospective follow-up for a year

Up until the current study the main CC75C surveys had all been cross-sectional and none had included anthropometric measures.

2.2.1 Expansion of the interview schedule

2.2.1.1 Additional physical activity question – stair climbing
2.2.1.2 Previous falls
Measuring frequency
Circumstances
Consequences
2.2.1.3 Fear of falling
Falls efficacy or confidence
Worry about falling
2.2.1.4 Previous fractures and risk factors for fracture

The standard CC75C interview schedule was adapted to the focus of the current study with changes ranging from the addition of just a single question in one section (physical activity), through the expansion of existing sections (activities of daily living and falling), to the addition of a completely new section on fractures.

2.2.1.1 Additional physical activity question – stair climbing

In Year 10 of the CC75C study a new set of questions was added to the interview schedule as the study took on a focus on service use and activity levels. Along with questions about social contacts and other leisure pursuits questions were added to establish a broad picture of physical activity in older age. The questions were adapted from the Nottingham Ageing and Physical Activity Study[366] but simplified in the interests of shortening administration time of an already lengthy interview, so no precise measures of frequency or duration of different activities were gathered. This same set of questions was used again in this current study.

It was at this section in the interview that an additional measure was inserted in the latest interview. Given the findings from the EPIC-Norfolk study of the association between heel ultrasound measures of bone strength and frequency of reported stair climbing in a population of middle-aged and older men and women[409] it was decided to include the EPIC question as part of the physical activity questions:
"How many times do you climb up a flight of stairs (approximately 10 steps) each day?"
(see Appendix C interview schedule question 32g)

2.2.1.2 Previous falls

Measuring frequency
Circumstances
Consequences

The study's focus on falling demanded a fuller fall history to be taken at interview than the data recorded in recent CC75C interviews from three questions on fall frequency and circumstances. More detail was wanted on both these aspects and, for the first time, on the consequences of falls. Protocol development sought ways to extend data collection with additional validated tools without creating problems for longitudinal analysis incorporating earlier CC75C data.

Measuring frequency

It was important to keep the wording of existing CC75C interview questions on falls:

"Have you fallen in the last three months?"

"How many times have you fallen?"

However, other periods of recall had also been used earlier in CC75C – one month and six months. Six months is a not uncommon time frame reported in other previous studies[356;668;733] but most other authors have reported falls recalled over a year. The methods were adapted slightly in order to allow for comparison with other studies and with other periods of recall used earlier in CC75C, planned for subsequent longitudinal analyses.

Comparison of the existing CC75C wording with questions used in other studies showed it sufficiently close to be able to easily add in that used in the Study of Osteoporotic Fractures, EVOS / EPOS and many that followed them:

"Have you fallen in the last 12 months? If so, how many times?"

Respondents were also asked to say when any falls in the last year happened or when the last fall they could remember occurred, even if they could only date these approximately. This served both to clarify reported frequency and allowed subsequent coding into different time frames of recall for comparison with "last month" and "last 6 months" reports earlier in CC75C and other studies.

Circumstances

Previous CC75C interviews asked about the time, location and ascribed cause of the last recalled fall in terms of response options Day / Night, Indoors / Outdoors and Accident / Blackout / Dizziness / Other cause. Other researchers in previous studies have used varying degrees of complexity to describe these aspects, sometimes as detailed as noting exact the exact time or place, for instance, which room in the house[201;205;334;349;734] or the type of floor surface[232]. Causation is a complex issue and others have chosen instead to detail activity at the time of falling[205;232]. The methodology selected for the current study was to seek as full a description as possible in the respondent's own words and subsequently extract factors for analysis using categories found informative in the Dunedin and Randwick studies.

Consequences

Until the current study CC75C had no data collection on any consequences of falling. New items added to the fall history recorded any injuries under classes of injury type and site adapted from the work of Nevitt, Cummings, Hale, Lord and co-workers[170;232;270] in response to the Study of Osteoporotic Fractures question "In what

way did you hurt yourself?". Data entry classified up to three injuries per fall, although the verbatim description was also entered to preserve details of all injuries. These were subsequently categorised for analysis as major or minor injuries following the widely used definitions applied in the major Scandinavian falls injury surveillance studies[204;206;275]. This specifies fractures, joint dislocations, lacerations needing sutures or intracranial injuries as "major injuries", whilst "minor injuries" include lacerations without sutures, bruises, abrasions, sprains and other minor soft-tissue injuries causing a mark of violence on the body.

Other studies have attempted to assess the seriousness of fall injuries or other sequelae in terms of treatment required. For the current study established measures of whether or not medical attention was sought at all[205] and, if so, where[164] and who else was told were adapted to the UK setting (changing "Emergency room" to "Accident and Emergency" for example). No other studies were identified which recorded the use of personal alarm systems or other call bells, but the pilot study had identified this as an important factor. New questions were therefore added to ascertain whether the participant had access to any such call alarm systems, when asking about use of services, and a new item fitted in the fall history to determine whether any alarm was activated after a fall.

The crucial distinction between falls from which the faller can or cannot get up has been highlighted in earlier studies[297;301] and this factor was an important addition to the current study's protocol, including Tinetti's wording to ask about needing help to rise[301] and following Nevitt, Cummings and colleagues' wording and categorisation of time on the floor[168].

The protocol developed for recording falls history at interview – the questions and coding options used for time, location, ascribed cause, circumstances and consequences – was also followed in the prospective collection of falls data in the year after interview.

2.2.1.3 Fear of falling

Falls efficacy or confidence
Worry about falling

The importance of the psychological element to falling and the spiral of events that a fall can trigger had to be included in studying falls and their consequences in this sample of a potentially vulnerable population in extreme old age. As reviewed earlier, a variety of methods has been used to assess levels of concern about falling or loss of confidence resulting from falling[322]. The challenge in developing this part of the protocol was to allow measurement of these vital aspects without over-burdening the study respondents with additions to the already lengthy interview.

Falls efficacy or confidence

The well established Falls Efficacy Scale was originally developed by Mary Tinetti and colleagues with community-dwelling older Americans[318] and has been slightly adapted and validated in a UK setting[321]. This FES-UK is a 10-item scale that asks study participants to rate how confident they are in performing each of a list of daily activities. These were selected as being readily added into the activities of daily living section of the CC75C interview.

As first used in the UK this involved circling numbers from 1 to 10 to indicate the range from "extremely confident" to "no confidence at all". However, given anticipated problems with visual and cognitive impairment in the current study sample, it was decided to use a further modification that had been tested in Scandinavia[735] that further simplified the measurement to just three options, adding an intermediate category "fairly confident". The sum of scores (0, 1 or 2) from the ten questions were scaled to the usual FES 0-100 range and these continuous data were split into three groups for analysis, as closely to tertiles as the distribution would allow. These cut-points were lower than those used in an Australian study[315;736] following the same analytical approach because in the current study the distribution, although also skewed, was more widely spread.

Worry about falling

A second measure was also selected with the intention of including a simple measure that might be useable even with respondents unable to complete the full interview, and

to specifically assess fears rather than confidence. The single question "Are you worried about falling again?"[156] had been used as part of a WHO validated questionnaire[737] in the New Mexico Aging Process Study to identify the high incidence of fear of falling amongst older people who had experienced a fall. This wording was added into the CC75C interview immediately after taking the falls history.

2.2.1.4 Previous fractures and risk factors for fracture

Fracture history was never specifically recorded in earlier CC75C interviews. Although the current study did not intend to examine predictors of fractures as an outcome measure – an endpoint that would require a far larger study – descriptive findings on injuries resulting from falls are important. A simple measure of previous fractures was therefore needed, since fracture history is so strongly related to fracture risk. As skeletal fragility is one of the study measures, other factors relevant to bone strength were also seen as important.

Measurements of skeletal frailty in this current study followed the protocol from EPIC-Norfolk (part of the European Vertebral Osteoporosis Study), it was decided to also follow EVOS/EPOS in question wording and recording of fracture history. It was beyond the scope of the current research to attempt validation of reported past fractures from hospital or general practice records, although this was done for prospectively reported fractures during follow-up. However, the European Prospective Osteoporosis Study has examined the validity of fractures self-reported with their methodology against record-checking in a sub-sample[738].

Additional questions on fracture risk factors besides the EPOS wording followed the Study of Osteoporotic Fractures to ensure that all items from their Fracture Risk Index were measured[597]. It was not possible to establish whether fractures women reported were post-menopausal or not so the S.O.F. cut-point "fractures since age 50" was used for classification taking dates of fracture from the EVOS/EPOS questions. The EPOS validation study[738] found that 91% of their elderly subjects had reported their fracture dates correctly to within a month of the actual date in hospital records and that the accuracy of fracture site report was highest for hip and distal forearm fractures.

Confirmation of reported past fractures was sought from a proxy source if possible, as the Study of Osteoporotic Fractures found proxy informants' reports were more accurate than self-report. They found no evidence of under-reporting of fractures and false positive reports were lowest for fractures of the hip, wrist or upper arm[739]. Hip fractures were also amongst the most accurately recalled diagnoses in an American study of the validity of reported reasons for hospitalisation[740].

2.2.2 Introduction of physical measures

2.2.2.1 Physical function performance measures
2.2.2.2 Quantitative heel ultrasound scans

2.2.2.1 Physical function performance measures

Criteria for selecting functional performance tests
Summary of functional test protocol

Criteria for selecting functional performance tests

The selection of functional measures to include in the testing protocol needed to take account of a number of factors additional to the usual requirements that any study should expect of any test (see Box 2.2a). An optimum balance was needed between the range of data to be collected and the range of participants from whom data could be collected. As discussed above, there are a host of tests that have been shown to be related to falls risk but some of these would have been beyond the capabilities of the majority of this study's participants. The usefulness of data which only show floor or ceiling effects is limited and of course safety was a major consideration[99], especially as many assessments were likely to be conducted without anyone else present. These reasons ruled out a number of commonly used assessments, for example balance tests standing on one leg, or standing on a foam surface with eyes open and closed. Equipment needed to be minimal, so even the "low tech" methods of recording body sway were not considered because of the time implications and inevitable variability that would be introduced by attempting set up under widely differing conditions. It was important to aim for a protocol that could usually be completed in under half an hour as these measurements were to be taken during a visit that would generally also include a heel ultrasound scan.

Summary of functional test protocol

The full protocol and recording sheet used with the CC75C sample are shown in Appendix D *CC75C functional test protocol* and Appendix E *Simple Physical Performance Battery (SPPB) protocol* and summarized in Box 2.2b (each measure is described in detail in Chapter 5.2).

Box 2.2a Factors affecting selection of functional measures to include in test protocol

Particular factors in this study	Requirements for this study	Requirements for any study
Very elderly participants, often frail Various settings, often participants' home Often without anyone else present	Safety Ease of administration Length of time needed not long Over-all acceptability to participants Equipment needed not excessive Relevance in a very old population	Validity Reliability

Box 2.2b Summary of functional performance tests used in the CC75C study

Static balance tests	Timed unsupported 60 sec. stand	TUSS[619]
	Side-by-side 10 second stand	SPPB[246;628]
	Semi-tandem 10 second stand	SPPB[246;628]
	Tandem 10 second stand	SPPB[246;628]
Gait speed	8 foot (2.4m) timed walk	SPPB[246;628]
Dynamic balance tests	Single chair stand	SPPB[246;628] screening test
	5 repeated chair stands	SPPB[246;628]
	180 degree turn	Simpson et al[117;643]
	Functional reach	Duncan et al[363;641]
Muscle strength	Hand grip strength	Takei dynamometer

2.2.2.2 Quantitative heel ultrasound scans

A single portable heel sonometer (CUBA Clinical, McCue Ultrasonics, Winchester, UK) was used for all subjects, calibrated in situ before each different participant's scans against a standard manufacturer's phantom that was in use for cross-calibrating scanners in the UK arm of a pan-European study (EPIC-Norfolk). Ambient temperature was also recorded. All measurements were taken by a single operator (I was the project nurse for all interviews and measurement visits) following the EPIC protocol[711;741] described below.

The CUBA Clinical scanner is a dry system with gel-coupling and participants were asked to remove shoes and socks or stockings. Everyone was assessed for ankle oedema and graded as "marked", "slight" or "none"[742]. A few participants (6 women) were keen to "help research" and have the scans done but refused to remove tights under their trousers. As planned analyses had included exploring asymmetry in measurements within individuals, these participants were scanned despite this protocol breach provided they were not wearing thick support tights or compression socks. Subsequent analyses adjusted for this along with other potentially distorting factors such as room temperature and oedema. Occasionally it was not possible to scan both heels due very severe oedema, dressings over leg ulcers, an ankle in plaster or a previous fracture with metal fixings.

Two Broadband Ultrasound Attenuation (BUA) measurements within 3 dB/MHz were obtained for both heels of each participant and their mean taken as the separate left and right os calcis measures, as per protocol. Results reported here use the mean of the left and right heel measurements, unless only one heel was measured in which case that single mean is used.

Height was measured with a portable spirit-balance sonic device which allowed the use of walking aids to stand for height measurement, but height data are missing on those unable to stand. Weights are also missing for those unable to stand unsupported long enough to use standing scales, except in care homes with seated scales. (Advanced Weighing, Weighcare Sonometre, Newhaven, UK)

2.2.3 Prospective falls data collection for one year follow-up

2.2.3.1 Calendars
2.2.3.2 Telephone follow-up
2.2.3.3 Fall definition

The most comprehensive falls data collection methods reported in other studies to date (see Chapter 1.2.3 *Researching falls: methodological issues*) have used a combination of regular reports provided by study participants or informants, plus follow-up (usually by telephone) in the event of falls being reported or lapses in reporting. In the current study a similar combined approach was chosen as most suited to this very old age-group. It was recognised that this would be a time-consuming methodology not often possible in large population studies. In this respect the study's relatively small sample size would be advantageous and the opportunity to attempt intensive follow-up data collection in a little researched population was not to be missed.

2.2.3.1 Calendars

Willingness to help research by reporting falls has been noted in previous research, for instance Luukinen and co-researchers[353] found that only 3% refused to record falls in their study of all over-70-year-olds in five rural districts in Finland.

Previous studies have highlighted the discrepancies between recall of falls over relatively short and longer periods[167;206]. The possible disadvantage of over-burdening participants with too frequent form-filling was weighed against the advantage to be gained from shorter recall intervals and the ease of remembering a relatively frequent routine. This determined the choice of weekly[167;170] rather than more intermittent returns[156;171;177;275].

The form of report chosen was a calendar with week at a glance pages to tear-off and return in pre-paid envelopes supplied (see Appendix F *Fall calendar*). The calendar has cost advantages over regular questionnaire mailings and may also be regarded as more acceptable than very frequent postal questionnaires[217;743]. Other studies had reported the convenience of calendars over report cards LASA[239]. Compliance both with

weekly returns and the calendar format have been reported to be high[167] [177;206;239]including with proxy informants for cognitively impaired study participants[744].

Some previous studies have used a variety of categories to classify the circumstances of falls, as described in section 2.2.1.2 above. It was decided that the complexity this can lead to in the choice of boxes to tick could be a disincentive to completing any fall report. A simple report (fall or no fall) to provide basic information that could then be followed up has been found [239] to encourage adherence to the reporting regime.

Calendar layout for the current study therefore allowed for either minimal reporting – just a tick beside the day to indicate if a fall occurred – or providing more information under prompted headings (time, location, what were you doing at the time?). There was also space overleaf to describe how the fall happened. These written descriptions and the verbal accounts given in phone-calls or follow-up visits were later classified according to categories reported in previous fall studies and other features that emerged from the wealth of descriptive data.

2.2.3.2 Telephone follow-up

Even studies that primarily relied on participants returning written reports of whether or not they had fallen (fall diaries, postcards, calendars or questionnaires) reported also needing to telephone for information from erratic responders. Most previous studies[164;177;206;232] have built in telephone follow-up or personal visits after a fall was reported. This approach was chosen as appropriate for the current study, with the expectation that the need for phone follow-up might be higher than reported in studies of younger community dwelling old people. It was difficult to estimate in advance what proportion of follow-up would need to be by telephone. Previous studies generally have not specifically reported such details, for example Nevitt and Cummings refer just to 99% weekly follow-up by postcards or phonecalls with no breakdown of how many each[168].

Details taken after each reported fall during the year after interview followed the same format as that developed for the interview questions on recalled falls (see above section

2.2.1.2). In addition, the follow-up monitoring kept track of changes of place of residence – moving into respite or long-term care – and hospital admissions.

2.2.3.3 Fall definition

Participants and proxy informants were encouraged to report anything that could be construed as falling, even "nearly" falling, as a means to avoid the under-reporting of falls that a respondent might feel "didn't really count as a fall". This was deemed preferable to presenting respondents with the lengthy definition of a fall that has been commonly used in falls research since 1987 when the Kellogg International Working Group on the Prevention of Falls by the Elderly[132] defined a fall as "unintentionally coming to the ground or some lower level other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or seizure" (see section 1.2.3.1 *Problems of classification and definition* in Chapter 1). The current study followed this definition but the decision whether a fall "counted" or not was made by the researcher rather than the respondent. All reports received during follow-up were coded as either a "fall" or a "near fall", following the Kellogg definition, and at interview the falls history taking discounted any reports that did not meet the criteria.

2.3 From protocol to practice

2.3.1 Pilot study
2.3.2 Recruitment issues

2.3.1 Pilot study

2.3.1.1 Aims of the pilot study
2.3.1.2 Methods of the pilot study
2.3.1.3 Outcomes of the pilot study

A small pilot study was conducted between April and early June 2002 prior to starting the current study.

2.3.1.1 Aims of the pilot study

Although the CC75C study's methodology is well established, new developments in the protocol for the current study necessitated a pilot study. The aims of this pilot were:

- Systems set-up
- Feasibility testing
- Risk assessment
- Further training
- Refinement of protocol

Only by testing the protocol in practice could workable administrative and quality-control systems be devised. New measurements added to the standard CC75C interview schedule used previously validated tools (see section 2.1.2) but it was important to assess their feasibility in combination, the safety and acceptability of the new measures and their impact on interview timing. The pilot study also provided the opportunity for familiarisation with the schedule and formed part of the graduate research training programme. It was anticipated that the protocol might need refining after initial testing.

2.3.1.2 Methods for the pilot study

The pilot study was conducted with the help of a Health Centre in a village near Cambridge, deliberately chosen for its location outside the city to avoid the chance of accidentally including any of the study sample in the pilot study. The CC75C study was introduced to the practice partners with a proposal for collaboration and they agreed to contact a small sample of the 95 people aged over 90 years old registered with the practice. These patients selected from their lists were sent letters signed by their own GP telling them about the study and that the project nurse would call to explain more unless they preferred not. Random sampling within purposefully selected sub-groups was used to select 10 people that included:

- Men as well as women
- People living alone and with family member(s)
- People living in the community and
    - in at least one of the sheltered housing schemes in the area
    - in the one care home covered by the practice

      (dual registration as both residential and nursing home)

One element of the pilot study involved testing the feasibility of further measurements of muscle function and bone density in a sub-sample. All pilot study participants were invited to join this additional study and have these further investigations, which involved a taxi trip to Addenbrooke's Hospital in Cambridge but no overnight stay. The visit was to include lower and upper limb muscle strength tests (Cybex dynamometer) in the Human Performance Laboratory and DEXA scanning (Lunar bone densitometre) in the Addenbrooke's Wellcome Trust Clinical Research Facility.

2.3.1.3 Outcomes of the pilot study

Recruitment uptake and timing
Systems and protocol refinements resulting from the pilot

Recruitment uptake and timing

Two of the ten people who received letters from their GPs about the study contacted the health centre asking not to be approached. The practice provided nine names to be contacted, an oversight in communication that provided lessons in diplomacy. It was not possible to interview a further two whose children preferred them not to be troubled.

It was possible to complete interviews with the remaining six people (four women and two men), one of them only on second attempt to contact after her husband suggested waiting as she was unwell. As a result of the lessons learnt from this episode, recruitment in the main study survey was helped by returning at a later date if so asked, rather than assuming that "not now" meant refusal.

Five of the six volunteers interviewed had ultrasound heel scans, four had functional performance tests of strength and balance, and three made the additional accompanied trip to Addenbrooke's for bone density scanning and isokinetic muscle strength measurements. Interviewing and conducting measurements in the participants' own homes (i.e. excluding the hospital visits arranged for the following month) involved eleven visits spread over four weeks. The length of visits ranged from fifteen minute (for an initial call, explanation and arranging a return date) to over three hours (for a volunteer who suggested having the heel scan and performance testing in the same visit as the interview "to get it all over and done").

The pilot confirmed the need to offer two separate appointments for completion of interview, functional mobility measures and ultrasound scans. It established the feasibility of splitting the interview – already lengthy without the cognitive assessment – and conducting the CAMCOG along with the physical tests on a second visit. However, it also showed that for some people full assessment was possible all in one day – a finding that proved important when the main survey involved planning visits to study participants who had moved to other parts of the country. As anticipated, there was wide variability in the length of time needed for different people, so this had to be

reflected in subsequent timetabling of appointments and served to plan timescales for the main study fieldwork.

Systems and protocol refinements resulting from the pilot study

The order as well as the timing of assessments was tested. A routine was established such that, on the second visit, the delay of setting up the portable ultrasound scanner and running its start-up quality assurance checks, including the standardised phantom scan, provided a rest or comfort break for participants after the functional testing.

The acceptability, appropriateness and safety of the functional tests were assessed and their order was also refined. In the study age group there is inevitably a degree of risk in some of the functional performance assessments[99], as with any exercise testing. However, the Short Physical Performance Battery (SPPB) has been shown to be very safe in extensive trials among elderly disabled populations and this protocol was strictly followed[628]. These well established field tests of balance, lower limb muscle strength and mobility were carried out by a registered nurse with further qualification in exercise training for older and disabled people. Additional functional tests in the protocol are also widely used in clinical practice as well as research, but a particular concern in the pilot was to assess whether this protocol was achievable in the home setting where there would often be no-one else present besides the participant and the project nurse.

Safety concerns confirmed the need to include the Timed Unsupported Stand (TUSS – standing balance with feet apart for up to a minute) as a screening measure before starting the more challenging static balance tests from the Short Physical Performance Battery (SPPB). The seated functional reach test was dropped from the protocol. This had been considered as an option for participants unable to manage the functional reach test standing unsupported. However, the participants with physical or cognitive impairments that precluded the standing test found the seated test problematical too, due to either difficulties following instructions or restricted upper limb movement.

The pilot study also trialed the acceptability and safety of bringing very elderly people in to hospital for the day to have isokinetic muscle measurements and bone densitometry performed. The volunteers in the pilot study underwent a medical examination beforehand following the American College of Sports Medicine's guidelines on exercise testing, and all participants were also be seen by the doctor again after completing the

isokinetic dynamometry. The radiation exposures involved in DEXA densitometry are so low as to be classed in the "trivial" risk category. All three volunteers reported that they had "enjoyed the day out" and found the research tests interesting and "not too tiring". However, the logistics involved in co-ordinating accompanied visits to two departments for the minority who consented to this extra visit led to a decision to defer this part of the intended data collection for another separate study.

Finally, the pilot was also necessary to test the systems devised for falls data collection. The format used in the pilot study for the fall and fracture history sections of the interview that had followed the earlier interview schedule formats proved unwieldy and was simplified into a convenient layout (see Appendix C question 186a-b). Pilot study responses to the falls questions clarified the need to take details of the last recalled fall and the last fall with injury.

Falls histories taken during the pilot study identified a new factor not previously recorded – the potential role of personal call alarms in summoning help after a fall and the effect that the availability of these systems could have on the outcome of falls. This prompted the addition of a question on call alarm access to the section of the interview on service use and a further item in the falls history on whether they were used after a fall.

Acceptance of the fall calendars was low: despite the pilot study volunteers being asked if they would be prepared to complete these for a shorter period than in the main study only two people agreed, only one of whom completed them for three months requested. This clarified the need for alternative methods of falls data collection and prompted the development of follow-up tracking systems, phone-call logs and fall report data sheets.

The pilot proved an invaluable exercise without which a number of unresolved issues might have resulted in reduced recruitment, lower quality or inconsistent data collection.

2.3.2 Recruitment issues

2.3.2.1 Ethical issues
2.3.2.2 Liaison and logistics
Tracing and contacting GPs
Contacting study participants
Information and consent
Liaison with care homes and other agencies

The term "recruitment", with its connotations of identifying suitable subjects for clinical trials, may seem incongruous in context of a longitudinal study for which the cohort's baseline sample was already recruited many years before. The term is used here in relation to the current study to denote the process of tracing and contacting cohort participants still alive, and offering them the option to join in a further survey continuing the research project in which they had previously participated. Some of the usual recruitment concerns, such as inclusion and exclusion criteria, are irrelevant since the aim was to enrol in the current study any participant in any previous interview round of the Cambridge City Over 75s Cohort study.

This section describes the two main areas – the ethical and practical issues – that had to be addressed in this process.

2.3.2.1 Ethical issues

The age of the study population raised particular issues with potential ethical implications (see Chapter 1 section 1.2.8 for an overview of these issues). It was anticipated that many would be frail, some not well and a considerable number cognitively impaired to varying degrees. Section 2.2 discussed the need to ensure that interviews and assessments were not over-burdensome, and it was likewise important that an invitation to take part in further research should not in any way be an imposition on the older person or others involved.

The study followed a protocol approved by Cambridge Local Research Ethics Committee (LREC number 01/330) with safeguards to protect the potentially vulnerable study populations that were additional to the already stringent procedures used in earlier CC75C surveys. Despite the consent to take part in longitudinal research already

granted by all study respondents, the ethics committee required that this time GPs' permission be sought before contacting any participants directly.
Great care was paid to the question of obtaining fully informed consent in such an elderly group, particularly when there was any degree of cognitive impairment, and section 2.3.2.2 below explains the procedures used.

Whilst in no way wishing to over-ride the wishes of study participants, the study was concerned not to under-represent the frailest and most cognitively impaired of the cohort. Every effort was therefore made to seek the consent of a relative or other closely involved carer when the older person was not able to give informed consent himself or herself. Proxy consent was sought for two alternatives. This was either just to interview the proxy informant about their relative, thereby filling in gaps to ensure vital information was not missing. Alternatively permission might also be granted to conduct a limited interview with the older person, at least attempting the cognitive assessment, sometimes including also other subjective questions that could not be asked of a proxy or even more of the interview if possible.

2.3.2.2 Liaison and logistics

Tracing and contacting GPs
Contacting study participants
Information and consent
Liaison with care homes and other agencies

Tracing and contacting GPs

Participating practices were contacted to double-check whether each participant was still alive and registered with that surgery, and to check whether the GP recommended contacting a carer first due to any recent changes (see Appendix G *Other study documentation*). Data protection legislation prevents direct tracing of individuals so local primary care services were asked for information on where a participant was currently registered if they were said to have left their last known practice. Primary care service organisations in other regions were also contacted as necessary and through them new GPs identified to contact in turn.

Contacting study participants

Survivors were invited to continue in this follow-up study initially by letter with an information sheet (see Appendix G *Other study documentation*), with the option to request not to be contacted by the research nurse. Respecting these requests, all other previous participants (or a carer if the GP so recommended) were then telephoned to arrange a time to visit and explain more about this phase of the study. Participants were encouraged to have a friend, relative or carer with them if they would like to for this visit.

Information and consent

At this initial visit the study information sheet was explained, questions answered and every attempt was made to ensure the participant and any friend, relative or carer present fully understood what the study involved. It was stressed that participation was entirely voluntary and that the study team greatly appreciated the valuable contribution they had already made to research before participants were asked whether they wished to give their consent (in writing if possible – see Appendix F *Other study documentation*) to take part in the current study. Only then would the study interview begin or a time would be arranged to return if more convenient.

To ensure maximum participation in the study overall, consent was obtained to take part in as much or as little of the study as the older person chose, and it was repeatedly stressed that s/he could change their mind later. The additional measurements of balance, muscle strength and bone were offered as "optional extras" that would be measured on a subsequent visit if the participant were agreeable. The reasons for the one-year follow-up to collect falls data prospectively were repeated at the end of the main interview and the fall calendar explained, but this also was offered with the alternative of telephone contact if completing a weekly calendar seemed to onerous.

Liaison with care homes and other agencies

Care homes and wardens of sheltered accommodation were contacted if a participant was resident in any such supported setting. They were sent information in advance of the initial visit and, when so advised by the GP, their assistance in arranging an interview was sought. It was not always clear in advance of visiting whether a participant was living with relatives but, if this was known, they were also contacted

beforehand. It was anticipated, and indeed proved to be the case, that much of the study's success would rest on liaison to build and maintain the goodwill of all these and other agencies – for example district nursing teams, call alarm mobile wardens, practice managers and receptionists as well as the GPs, care home staff and relatives already mentioned.

2.4 Methods for the current study: Data handling and analytical approach

2.4.1 Data handling
- 2.4.1.1 Data entry and cleaning
- 2.4.1.2 Missing data
- 2.4.1.3 Alternative data from proxy informants
- 2.4.1.4 Datasets
- 2.4.1.5 Re-coding into derived variables
- 2.4.1.6 Presentation of results

2.4.2 Descriptive data analysis
- 2.4.2.1 Data descriptive of the sample
- 2.4.2.2 Data describing performance in functional mobility tests
- 2.4.2.3 Data describing falls
- 2.4.2.4 Data describing the consequences of falls
- 2.4.2.5 Data from quantitative ultrasound scans

2.4.3 Analysis of association: potential risk factors and outcomes of interest
- 2.4.3.1 Proportions of people who fell or fell repeatedly
- 2.4.3.2 Count data: numbers of falls
- 2.4.3.3 Serious consequences of falling
- 2.4.3.4 Adjusting for confounders
- 2.4.3.5 Fracture risk factors in relation to ultrasound measures

2.4.1 Data handling

2.4.1.1 Data entry and cleaning
2.4.1.2 Missing data
2.4.1.3 Alternative data from proxy informants
2.4.1.4 Datasets
2.4.1.5 Re-coding into derived variables
2.4.1.6 Presentation of results

2.4.1.1 Data entry and cleaning

The main CC75C interview schedules were checked for completeness and consistency of coding before being entered by a commercial data-entry firm whose operating procedures included double-data entry. Data from the detailed falls history, falls follow-up, medication and the functional test results were entered in-house by the researcher. The portion of the falls history taken at interview that overlapped with the standard questionnaire (i.e. questions about recent falling already in the CC75C interview before the current study was developed) was cross-checked with the commercially entered data. One tenth of the data entered in-house was double-entered as a further check for accuracy in addition to the cross-checking of falls data on the full sample. Quantitative ultrasound measures were downloaded from the scanner software.

Each variable was checked for missing values and programmed checks were used for consistency between variables and for outlying values beyond the range of coding options. Misunderstanding by one of the commercial data-entry operators of the conventions used to code missing data necessitated thorough checks on all missing codes (see below) and of numerical responses that took values potentially miscoded as missing data. Although a laborious set-back, this process ensured that the data underwent even more extensive manual checking, with validation against the original sources, than might otherwise have arisen.

2.4.1.2 Missing data

Where data are missing CC75C has followed a convention since its outset of distinguishing between different reasons this arises. Different codes are used for:

- questions not asked (7, 77 or 777)
- questions asked to which no answer was obtained (8, 88 or 888)
- questions not applicable (9, 99 or 999)

A question "not asked" could be simply an omission by the interviewer or used after an interview is abandoned for all remaining items. Coding 8/88/888 does not distinguish between a refusal to answer a question, a "Don't know" or lack of response for any other reason. Only a few CC75C questions can be rated "not applicable" (e.g. "Are you able to use the telephone?" is not applicable if someone does not have a telephone), and this code may also indicate some physical obstacle to answering a question, such as blindness preventing the visual recognition section of the cognitive assessment.

2.4.1.3 Alternative data from proxy informants

The use of proxy informant interviews is one approach to minimising the problem of missing data. Paired but separate interviews with a closely involved relative or other carer in addition to study participants were conducted whenever possible for individuals who could not complete the interview or who provided inadequate or inconsistent responses. In some cases the proxy interview served only to check details on a limited number of questions, for example medication or the time of the last hospital admission. Thus it was not always the case that the proxy interview provided information that the respondent could not. To avoid losing data dummy variables were set up to identify which set of interview responses provided fullest data on each set of questions. There were still some questions for which data were missing on a few respondents and tables always show the denominator where this missing data exists. Missing data are inevitable for those questions seeking a subjective answer, such as self-rated health or feeling lonely, since these could not be asked when the only interviewee was a proxy informant.

2.4.1.4 Datasets

Two datasets were developed from the raw data.

Data were merged from initially separate files (interview data, functional test results, ultrasound scanning parameters and follow-up reports) to create the main dataset with all these measures. Paired participant and proxy informant interviews were included as separate cases within the one dataset, with identifier variables to select different combinations of n=110 cases from the total n=134 depending on the analyses run.

A second dataset contained data on each report received during prospective follow-up. Cases in this data file were falls rather than individuals. Some people in the study did not feature in this dataset at all if they reported no falls, whilst others had multiple entries.

2.4.1.5 Re-coding into derived variables

Derived variables created in the main dataset included dichotomising questions with several response options and summarising a number of items. For example, dichotomising was appropriate if the distribution of responses showed very few in some groups of a categorical variable where several could be classed together, e.g. “climbing stairs at least once a day” rather than more detailed breakdown of number of flights climbed daily. Summary items included scores taking the sum of a group of variables, for instance the “total number of limited activities of daily living”, or new variables to identify those meeting a criteria derived from several variables, such as “limited in at least 2 basic activities of daily living”.

MMSE scores, using the serial 7s option, needed categorisation for analysis. Whilst in some earlier CC75C analyses[745] these scores were divided into four grades (1 to 4 representing scores 0-17, 18-21, 22-28 and 29-30) as was accepted practice then[746], more recent work[747] in this field has established slightly different cut-points (1 to 4 representing scores 0-17, 18-23, 24-28 and 29-30). Continuous MMSE data from the

current survey were examined taking both sets of cut-points for comparison and the latter, now more widely accepted, taken as the basis for three categories (cognition severely impaired/moderately impaired/intact) in analyses using cognitive function as a covariate with other outcomes of interest.

The falls data were further coded after data entry to provide summary descriptive data on fall circumstances, making use also of verbatim reports transcribed on the fall log sheets or details participants added to their fall calendars.

New variables were added to the main dataset that were derived from the falls dataset so as to link individuals to their reported falls data, for example “any injury sustained from a fall during follow-up”.

2.4.1.6 Presentation of results

Findings are presented to maximise information conveyed while minimising confusion. Figures are intended as an aid to ready understanding of the wealth of data. Tables provide details not readily displayed visually. For example, a graph of differences in incidence rates may be accompanied by a table of relative risks and their confidence intervals, both presenting analyses of the same risk factor. All risk estimates presented have been rounded to one decimal point, with the exception of confidence intervals close to 1. For these two decimal points are shown to clarify which side of 1 the confidence interval boundary lies.

2.4.2 Descriptive data analysis

2.4.2.1 Data descriptive of the sample
2.4.2.2 Data describing performance in functional mobility tests
2.4.2.3 Data describing falls
2.4.2.4 Data describing the consequences of falls
2.4.2.5 Data from quantitative ultrasound scans

2.4.2.1 Data descriptive of the sample

Categorical data are tabulated to show both frequencies and proportions in different groups. Where bi-variate relations are explored in cross-tabulations, for example when comparisons are drawn between the sexes or between participants in the current survey and the baseline sample, Pearson chi squared testing is used, with Fisher's Exact test where applicable for low cell counts. The score test for trend is used for comparisons across groups in ordered categorical variables, for instance maximum walking distance.

Summary statistics for continuous data include the median and inter-quartile range to add information on non-normally distributed variables that mean and range would not adequately convey.

2.4.2.2 Data describing performance in functional mobility tests

The majority of these measures were initially recorded during the tests as continuous data, for instance the number of seconds a balance stance was held or the number of steps taken. Subsequent categorisation was determined a priori whenever possible, either using established scoring of the SPPB tests (see Chapter 5.2.2 *Measures of observed mobility*) or taking cut-points identified as markers of falls risk in previous research studies, for instance a given number of steps or gait speed. Otherwise continuous measures were dichotomised at the mean. Comparisons between men and women use non-parametric Mann-Whitney rank sum tests for continuous variables that were not normally distributed and again Pearson chi squared testing, with Fisher's Exact test where applicable, to compare proportions in the performance categories as described above.

2.4.2.3 Data describing falls

Consensus guidelines on reporting of falls studies[218] have recently clarified a minimum dataset of outcomes that are expected to ensure valid comparison across different studies. Whilst intended as guidance for fall prevention intervention studies, these recommended measures are helpful principles for epidemiological research as well.

The key distinctions to be born in mind are between measuring falls and measuring how many people fall. All the falls data in this study are presented both in terms of incidence (number of falls/person-year) and prevalence (of being a "faller" or a "recurrent faller").

Another measure often used to assess the effect of a preventive initiative is the time lapsed between intervention and the first fall thereafter of each study participant. The current study was purely observational so this outcome is less relevant than it would be to an intervention trial. The mean time from interview to each individual's first fall is therefore used only to describe the patterns of falling. Given the small sample, for a number of variables the log rank testing of the validity of using Cox regression analysis was not clear. Hazard Ratios are therefore presented only for a few key descriptive characteristics as indications of their effect of on the length of time to first fall but are not taken as a main measure of falls risk.

2.4.2.4 Data describing the consequences of falls

The serious consequences that could arise from falling are described both in terms of the frequencies and proportions of study participants who suffered these ill-effects, and the proportions of falls that led to these sequelae. Any report of a serious consequence of even just one fall was classed as affecting that individual, for instance being unable to get up from the floor on one occasion despite being able to on another. Although time data were recorded where relevant (such as dates of transfer to residential care) the patterns of these data are complex (for instance repeated hospital re-admissions) so they have been simplified, for example to "total length of stay in hospital" and "moved into care home".

2.4.2.5 Data from quantitative ultrasound scans

Analyses used the mean Broadband Ultrasound Attenuation values for each individual of the means of two measurements for each heel (taking BUA measurements obtained with <3dB/MHz of each other as per protocol). BUA data was used for analysis rather than velocity of sound (VOS), the other ultrasound parameter recorded with the CUBA-Clinical system, because more studies have used BUA than VOS to report fracture risks associated with ultrasound measurements (see section 1.2.7 *Assessment of bone fragility and prediction of fracture risk*). The mean and median values for BUA in the current study sample were almost the same so, in analyses using BUA as a binary variable, data were dichotomised as "above average" or "below average". World Health Organisation (WHO) cut-points for osteoporosis and osteopenia identified so few in the 'normal range' that the data could not be split using T-scores, which were in any case defined in terms of DEXA-scan rather than ultrasound scan T-scores. Summary statistics for this continuous measure are also presented.

2.4.3 Analysis of association: potential risk factors and outcomes of interest

2.4.3.1 Proportions of people who fell or fell repeatedly
2.4.3.2 Count data: numbers of falls
2.4.3.3 Serious consequences of falling
2.4.3.4 Adjusting for confounders
2.4.3.5 Fracture risk factors in relation to ultrasound measures

Data were collected on a wide range of factors and, as with many such comprehensive cohort studies, it is important to be aware of the risk of erroneous interpretation due to multiple hypothesis testing. The plan of analysis therefore specified a priori which analyses needed to be done selecting for examination only factors that the literature review identified as previously linked with falls risk or that had to be considered as potential sources of bias or confounding. The associations between these factors and measures of falling recorded in the current study were examined using bi-variate cross-tabulations and regression analyses. The same approaches were used both for the cross-sectional data gathered on recalled falls and for the prospective falls data.

2.4.3.1 Proportions of people who fell or fell repeatedly

As suggested from the literature review (see Chapter 1.2.2), in which many earlier studies found stronger associations and different factors associated with repeated falling than with reports of single falls[139;162;168],[178 179;191;239;240;352], two sets of logistic regressions were performed. These took as outcome measures for the (a) retrospective and (b) prospective data respectively:

- reporting any fall (a) in the past year / (b) during the follow-up year
- reporting more than one fall (a) in the past year / (b) during the follow-up year.

2.4.3.2 Count data: numbers of falls

To take account of the data collected on fall frequency, the retrospective and prospective analyses respectively took the measures:

- the number of falls reported (a) in the past year / (b) during the follow-up year

as the outcome for negative binomial regression analyses. This method is a form of Poisson regression that adjusts for over-dispersion (greater variance than expected in a Poisson model). Standard Poisson techniques assume a distribution with the variance approximately equal to the mean, so are not appropriate for typical data on reported falls with high zero counts, strong positive skew, wide ranges and large variances. Taking instead a negative binomial model – a form of the Poisson distribution in which the distribution's parameter is itself considered a random variable – allows the variation in this parameter to account for any variance in the data that is higher than the mean. This has been recommended as the correct approach in analysis of results from falls intervention trials[218;222] and the justification for its use is equally applicable to epidemiological data.

2.4.3.3 Serious consequences of falling

Variables examined were either binary, coding whether given "yes"/ "no" outcomes of any fall arose (for instance a long lie or injury), or categorical, coding to what extent a follow-up outcome resulted from falling (a hospital stay or move into care). The categorical variables were dichotomised to identify those whose admission was at least in part due to a fall in order to use logistic regression to calculate odds ratios for the serious consequences of falls described associated with risk factors identified in the falls analyses.

2.4.3.4 Adjusting for confounders

Univariate analyses were used to identify potential confounders to be entered as adjusting covariates in subsequent multiple variable regression modelling. The relative risk of falls during follow-up was used as the key measure with which to model the effects of adjustment for confounding, as this measure reflects data collected on fall frequency rather than simply fall status (non-faller, faller or repeat faller). Odds ratios are often used in cohort studies as alternative risk estimates, but this approximation for relative risk is more applicable to relatively rare outcomes[748], another argument for

taking the relative risk of falls as the chosen measure to adjust. Again analyses used negative binomial regression, with backwards stepwise multi-variable techniques to refine the model as described below.

Variables found to be significantly predictive of falls were grouped in sets of related factors to identify which were most predictive when adjusted for the others in the same set, in order to avoid using multiple highly correlated factors. Likelihood ratio testing assessed the relative contribution of each variable within each set. A variable was discarded if this test showed the significance of its inclusion in the model at $p>0.1$ since, with the relatively small sample size, using $p>0.05$ as the cut point was too stringent. The strongest predictors from each set were selected for a "shortlist" to form a model used to test the potentially confounding effects of covariates on risk estimates for every factor already analysed individually. Following the method advised by Cumming et al[219], the sample was also stratified by recalled history of falling in the past year and the same adjustment model applied to avoid the potential for over-adjusted risk estimates had this factor been included.

2.4.3.5 Fracture risk factors in relation to ultrasound measures

Linear regression was used to examine the relation between previously identified risk factors for fracture and broadband ultrasound attenuation (BUA), a quantitative ultrasound parameter that has been shown to predict fracture risk. Correlations were first examined between BUA and other continuous measures that can affect skeletal fragility – weight, height, body mass index and age. Multi-variable modelling with linear regression tested the effects of age, sex, anthropometry and variables related to ultrasound quality assurance[742;749-753] on the full sample scanned and (without sex) on separate gender groups, checking colinearity and plots of residuals for each model's goodness of fit. Quantitative ultrasound data from men in their nineties are even scarcer than from women this age so it was important not to disregard the male data as too small a sample to analyse. It was thus established that data from all participants scanned could be analysed together, using the model developed to adjust for the effects of confounding covariates including sex.

CHAPTER 3

PARTICIPATION AND ATTRITION: STILL A REPRESENTATIVE SAMPLE?

3.1 Introduction

3.2 Participation and attrition
- 3.2.1 Tracing and contacting study participants
- 3.2.2 Drop-out and return in a longitudinal study
- 3.2.3 Minimizing missing data, maximising participation
- 3.2.4 Attitudes to participating in the study

3.3 Is a survivor sample still a representative sample?

3.4 Comparison with over-90-year-olds in the baseline sample
- 3.4.1 Age and sex
- 3.4.2 Other socio-demographic factors
- 3.4.3 Cognitive function

3.5 Discussion and summary

3.1 Introduction

The preceding chapter's section 2.3.2 on study recruitment includes discussion of the ethical issues raised by tracing the surviving CC75C study participants and inviting them to take part in the current study, and describes in some detail the methods used to address these. This chapter therefore departs from the format of all the subsequent chapters that present results after methods and moves straight into presenting data concerning this recruitment process in section 3.2 below. This chapter also assesses the impact of attrition and follow-up recruitment on whether the remaining participants are still representative of the population they are taken to represent. Section 3.4 compares some basic characteristics of participants in this latest survey with people of the same age range in the baseline sample, before Chapter 4's more detailed description of the study sample population. The chapter ends with discussion of the implications of these comparisons for interpretation of the study findings

3.2 Participation and attrition

3.2.1 Tracing and contacting study participants
3.2.2 Drop-out and return in a longitudinal study
3.2.3 Minimizing missing data, maximising participation
3.2.4 Attitudes to participating in the study

3.2.1 Tracing and contacting study participants

Respondents were traced and contacted in two main phases, initially following-up just the people with whom contact had been made in the last previous interviews conducted in 1998/99. Tracing was slow as there had been many changes of residence and resultant moves away from the last registered GP: 55% (93/168) of the people whom this wave of recruitment set out to contact had moved and /or changed GP surgery since last interview.

The process revealed that many more than expected had died since this last survey, and the additional time that it took to trace the survivors contributed to an even higher rate of deaths before interview. Concern that the sample size would be smaller than had

been estimated when the validity of planned analyses was examined a priori prompted a second recruitment phase.

In this second phase, participants were identified with whom contact had been lost earlier in the longitudinal follow-up but who appeared from study records to be still alive. Further liaison with GP surgeries, primary care registry services and the Office of National Statistics was needed to check status and the same tracing and contacting procedures then followed for this second recruitment wave.

The two phases overlapped, tracing the second batch starting before all interviewing of the first had finished, as illustrated in Figure 3.2.1.

3.2.2 Drop-out and return in a longitudinal study

Figure 3.2.2 give details (shown separately for these two recruitment phases) of attrition in this wave of the study – deaths before interview, refusals, illness and other reasons for loss to follow-up such as refusal, illness and remaining untraced. Initial concern that the second phase of tracing and contacting might be identifying a somewhat different group from the first phase proved unfounded – comparison of demographic, cognitive and disability descriptors revealed no major differences. The two groups have therefore been treated as one in all analyses, a decision further justified by the fact that these 22 people not interviewed since baseline were not the only ones to have skipped subsequent surveys.

In fact, many of those recruited through the main phase tracing more recent contacts had not been consistent participants in all the main CC75C interview waves. Twenty-eight of them had missed being interviewed in person for at least one previous survey since baseline (14 last time, 6 the survey before that, and another two each had not been interviewed since the next two preceding interview waves). Only two of them had had a proxy interview instead when not seen in person. In all 50 of the 110 people who took part in the current study had failed to participate in at least one previous "full-sample" survey of this longitudinal study. Nonetheless, 44 of these 50 who had missed at least one survey agreed to be interviewed in person, and for 30 of them these were participant

interviews only. One of these 50 had a joint interview with a relative present, and for a further 13 of them paired interviews were conducted with both participant and a proxy informant. Interviews with only a proxy informant were obtained for just 6 of this sub-set who might have been expected to be less willing to be seen.

The differences in death rates between the two waves of contacting (26% and 3%) reflect the much shorter time between identifying and interviewing the smaller group of respondents traced from the baseline sample. The higher refusal rates in this second group may reflect the longer time since previous interview, whatever their reasons for not taking part in the study since baseline. No interview (neither study participant nor proxy informant) could be obtained for only 9% of those approached in the first wave, or 12% of those who had not died before interview, but in the second wave these figures were 28% of those approached, or 29% of survivors. This slightly lowered the overall rate of participation to 84% of survivors (see again Figure 3.2.2), still a remarkably high level of uptake from which it might be reasonable to infer the sample is still representative of the survivor population. The subsequent sections of this chapter examines this assumption in more detail.

Figure 3.2.1 Fieldwork timescale

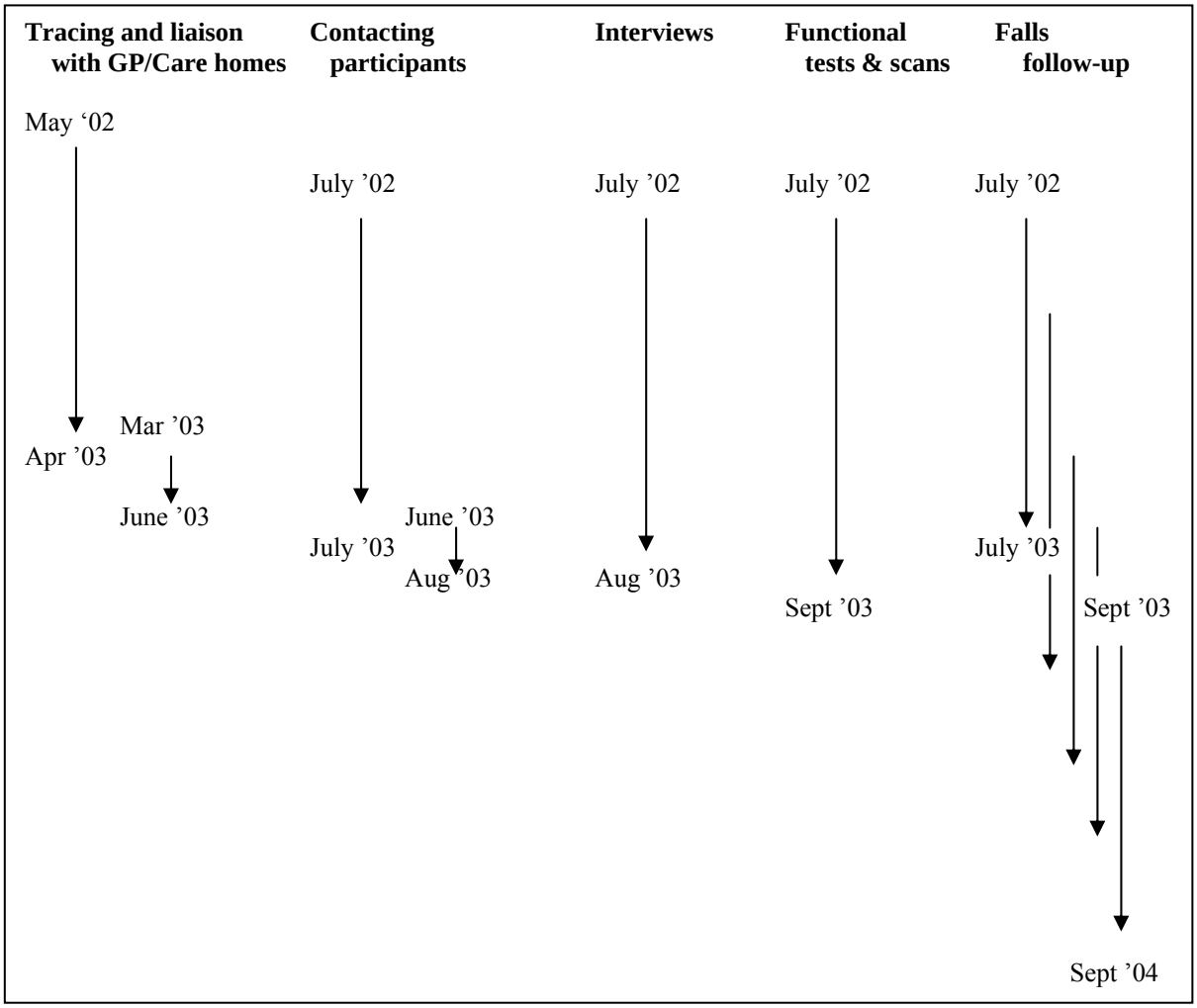
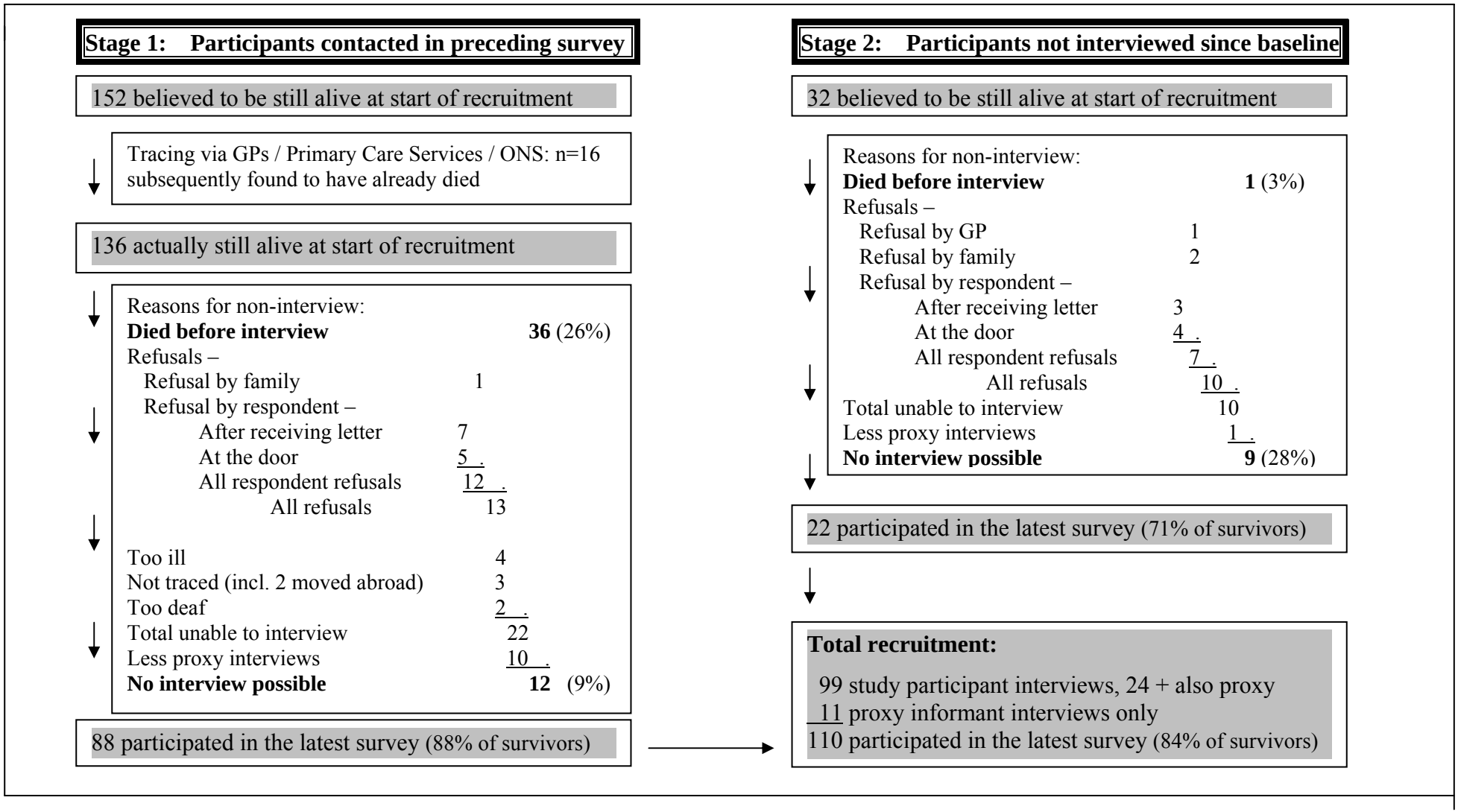


Figure 3.2.2 Recruitment and attrition in the latest CC75C survey and follow-up study



3.2.3 Minimizing missing data, maximising participation

The high response rate may in part be due to the time-consuming methods adopted to address the particular circumstances of such an old age study population. The timescale for this fieldwork shown in Figures 3.2.1 included the administrative and liaison work involved in tracing and the "doorstep" phase of approaching, obtaining consent, conducting interviews and measurements, and then the year's prospective follow-up stage. Table 3.2.3.1 details the wide variation in the number of approaches needed to fix up interviews ranging from none if a participant was willing to be interviewed at the first contact to numerous attempts to call round when no-one was in, phone-calls liaising with wardens, relatives and so on. The majority of participants required two visits, or sometimes more, to complete interviews and additional assessments. Most preferred that the cognitive assessment section at the end of the already long interview be postponed to a second visit, and just four people later refused this on my return.

Flexibility in allowing the interview schedule to be interrupted and completed on another occasion ensured higher levels of completeness than would otherwise have been possible. 79% of the 99 interviews with study participants themselves and 87% of the 35 proxy informant interviews were complete. Failure to complete a respondent interview was almost always due to cognitive impairment, and the four incomplete proxy interviews were with proxies who were only asked to fill in information that the study participant could not provide. The dual approach when necessary ensured that data were only truly missing for a minimal proportion of variables and from only a very small number of people in each of these (see Table 3.2.3.2). The exceptions were the subjective questions that could not be asked of a proxy informant instead.

All participants who were interviewed in person were asked whether they "would be happy for the project nurse to come back another day to take some measurements of your muscle strength, how your balance is and how you walk". The written consent form allowed for separate agreement to have functional performance measurements and/or a heel ultrasound scan – see Chapters 5 and 10). Consent to these additional arms of the study was also high. Diagrams in Figures 3.2.3.3 and 3.2.3.4 show the numbers participating in the different types of interview and additional assessments**.**

Table 3.2.3.1 Number of attempts to contact and visits needed

	Mean (SD)	Median	IQR	Range
Approaches before or between interviews	2.6 (3.1)	1	1 – 3	0 – 18
Visits for interview and/or measurements	2.0 (0.8)	2	1 – 2	1 – 5
Total number of approaches and contacts	4.6 (3.2)	3	3 – 6	2 – 20

Table 3.2.3.2 Extent of missing data

Objective questions - either proxy or respondent interview [n=110]	Subjective questions / assessments - participant interview only [n=99]
86% of variables: full data for all n=110 participants	<1% of variables: full data for all n=99 participants
6% of variables: missing data for 1-5% of participants	51% of variables: missing data for 1-5% of participants
1% of variables: missing data for 6-10% of participants	30% of variables: missing data for 6-10% of participants
7% of variables: missing data for ≥ 10% of participants	18% of variables: missing data for ≥10% of participants

"Not applicable" codes have not been included
"Don't know" codes are treated as valid responses to the subjective questions

Figure 3.2.3.3 Interviews with study participants and proxy informants

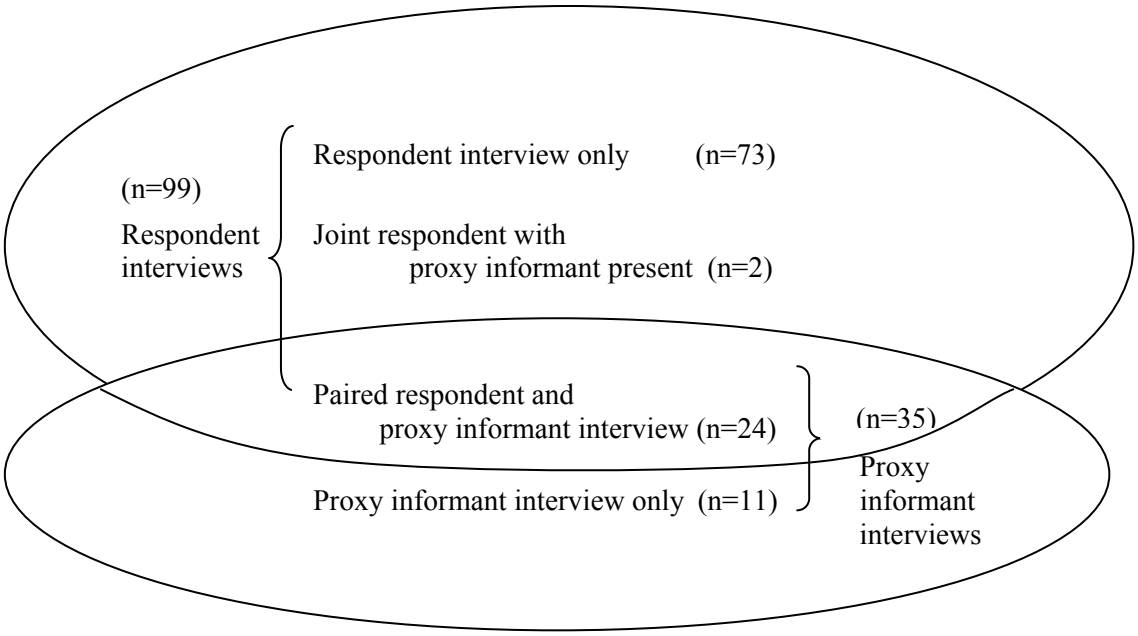
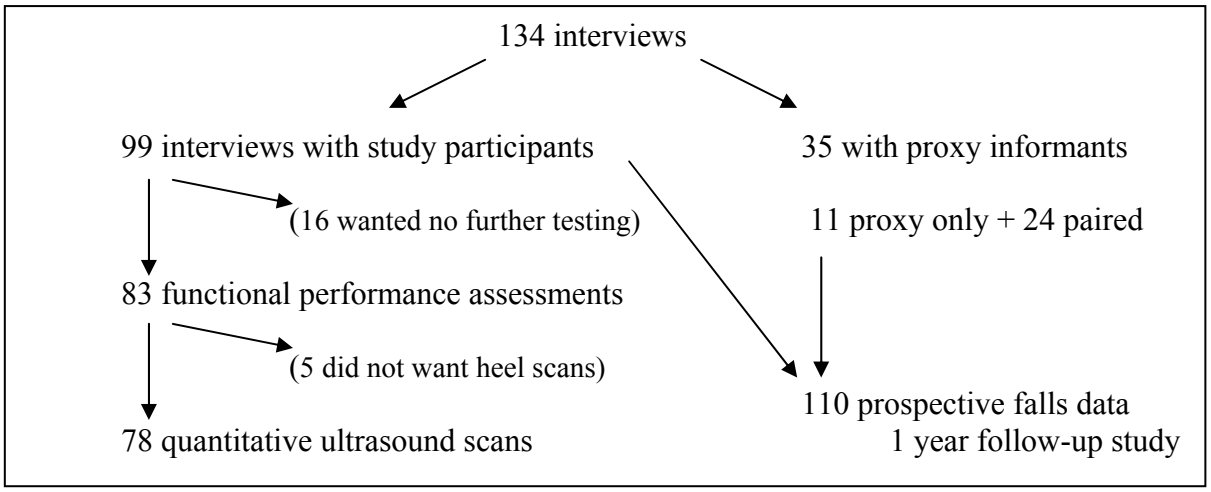


Figure 3.2.3.4 Interviews and additional measurements



3.2.4 Attitudes to participating in the study

The interview schedule ended with a question designed to get feedback from study participants: "How do you feel about answering all these questions?" Responses, recorded verbatim and categorised as shown in Table 3.2.4, reveal a high level of both altruism and enjoyment.

Overall there was great willingness to help research, in the hope that this would help others, both on the part of the older people themselves and of their relatives and carers. "I know it's too late to make any difference to me now but I'm happy to answer anything if you think it might help someone in the future" and "I never do anything useful these days so it's good to be asked to help" were typical. My thanks at the end of each visit were usually met with thanks in return, often expressed in terms of gratitude that "researchers care about old people". Some people clearly did find the interview tiring but this was often phrased in terms such as "It was rather long but all very interesting…" It was anticipated that the cognitive assessment might be most problematic and indeed some participants frankly commented that they "did not like all those memory questions" but others singled these out for positive comments such as "It makes a nice change to have a bit of a challenge". Some of the more isolated older people particularly welcomed the chance to take part because of they were pleased to have any visitor calling: "Oh, I don't mind answering questions…I don't usually have anyone to talk to…Do come again" and the project nurse was always made welcome.

Table 3.2.4 Older people's views on participating in the study

Categorisation of comments	**n**	**(%)**	**of n=99 participants**
Somewhat concerned	3	3	
Unconcerned	24	24	
Enjoyed it	33	33	
Don't know	2	2	
Other comments	24	24	
Not asked	13	13	

3.3 Is a survivor sample still a representative sample?

Serious attrition can threaten the validity of results in any cohort study, and longitudinal studies of older people are particularly affected[113]. The common reasons for older people to drop out from research studies include death, illness, moving away, and refusal (by participants or their carers). A recent systematic review[754] of attrition in longitudinal population-based ageing studies identified consistent patterns of drop-out between interview waves. Many studies do not distinguish refusal from other reasons for loss to follow-up, but causes of attrition have been found to be associated with age[754], educational level[131], cognitive impairment[754-756] and poor general health status[113;754;757]. All these sources of attrition are non-random and may compromise the generalisabilility of any findings.

Differences between participants, non-participants and dropouts in clinical trials involving older people have been described[107;758], and the consequences of attrition for population-based observational studies are now also attracting interest[759-761]. Previous research has largely been concerned with non-response at recruitment, rather than subsequent drop-outs, and with specific areas such as cognition.

An earlier analysis[732] of how the individuals participating in the last previous interview wave at Year 13 – the cohort survivors – compared with their age-peers at baseline found that in many respects cohort survivors do not differ from the baseline population of the same age. A few differences were found in functional level, but the principal significant differences were in self-rated health and the level of participation in social activities. Both of these are factors that might be expected to encourage commitment to taking part in a long-term study, and similar findings of better self-rated health amongst survivors have also been reported from Denmark[92].

3.4 Comparison with over-90-year-olds in the baseline sample

3.4.1 Age and sex
3.4.2 Other socio-demographic factors
3.4.3 Cognitive function

When the CC75C study originally began in 1985 the extremely high recruitment rate (95% of all over-75-year-olds from general practice age-sex registers) ensured the baseline survey covered a highly representative population-based sample of older people in Cambridge. To assess to what extent the current sample of nonagenarian survivors may differ from the cohort's original sample their demographic characteristics are compared in the following section with those who were of the same age in the baseline population when the study began.

3.4.1 Age and sex

Over-90-year-olds make up only a small fraction of the older population: Figure 3.4.1.1 shows the age distribution of the full CC75C population-based sample of over-75-year-olds originally interviewed between 1985 and 1987. Selecting all those above the same minimum age (91.6 years) at baseline identified a group of almost identical age range and age distribution (n=62, 51 women and 11 men), as Figure 3.4.1.2 illustrates. There were no differences in the gender proportions.

3.4.2 Other socio-demographic factors

Table 3.4.2.1 compares the participants in the latest CC75C survey – over-90-year-olds in the current study – with those in the baseline sample of the same age in terms of other socio-demographic factors. These details are also shown separately for the men and women aged over 90 at baseline in Table 3.4.2.2, giving comparable data to that shown in the following chapter's Table 4.3.1.1 for the current survey of the cohort survivors.

There was a slight decrease in the proportion of older people whose home is their house, flat or a granny flat in the recent sample compared with those the same age at baseline (56% vs. 69%). However, the proportion living in sheltered accommodation doubled (from 6% to 17%) and, if sheltered housing is classified along with living in separate

households as community-dwelling, then living in the community is as common in the latest survey as at baseline (74% vs. 76%). No differences were found in the proportion living in institutional care: 26% in Year 17 vs. 23% in the baseline age-matched group.

Comparison of the survivor sample and the age-matched baseline group shows a minimally higher proportion of the more recent sample widowed (86% vs. 80%) but overall higher proportions of both men and women living alone in the community in the current survey (69% vs. 53%).

Non-manual social class was slightly more prevalent amongst cohort survivors taking part in the current survey (48%) than amongst their age peers in the baseline sample (42%) and there were no differences in school leaving age. There were missing baseline data for both these variables.

3.4.3 Cognitive function

Compared with the latest survey sample, rates of cognitive impairment are even higher in the sub-group from the same age range in the baseline sample as Figure 3.4.3.1 illustrates. Overall rates of cognitive impairment using baseline MMSE scores are 58% (32% severe + 26% moderate) or 81% (32% severe + 48% moderate) depending on whether the narrower or broader band of intermediate MMSE scores is used to define the moderately impaired group (18-21 or 18-23). The differences in the prevalence of any degree of cognitive impairment between those aged over 90 in the baseline sample and in the latest survey at Year 17 are not significant ($p = 0.8$) when moderate cognitive impairment is defined with the narrower cut-points (MMSE 18-21). These differences are greater but still non-significant ($p=0.08$) with a more broadly defined moderate group (MMSE 18-23). As Table 3.4.3.2 details, there is no evidence of a change in the distribution of cognitive impairment amongst the sexes between baseline and the latest survey.

Figure 3.4.1.1 Age distribution of the CC75C full baseline sample

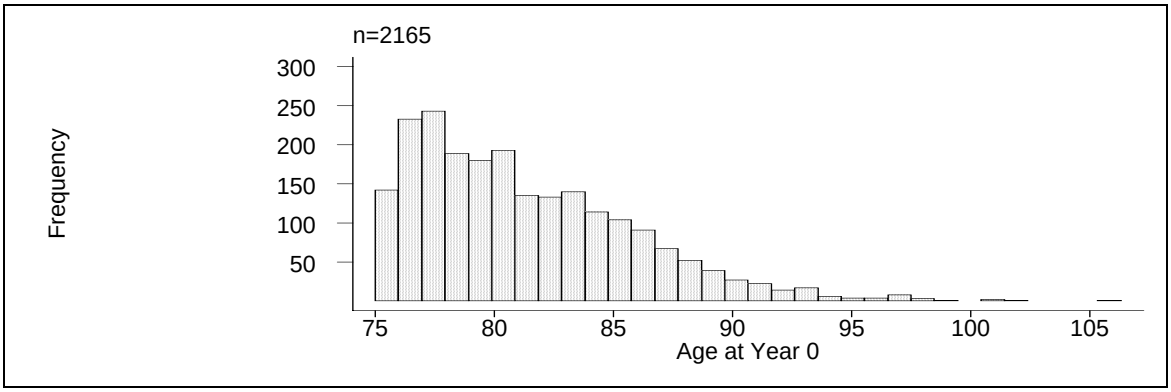
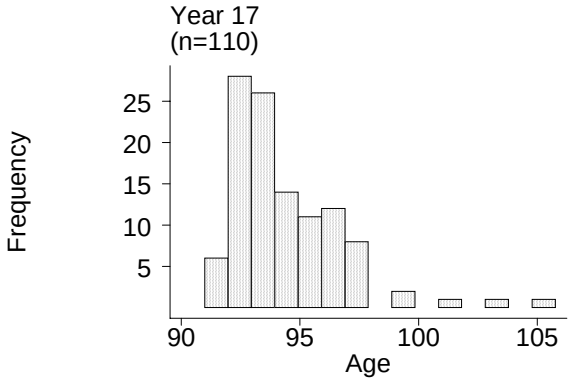
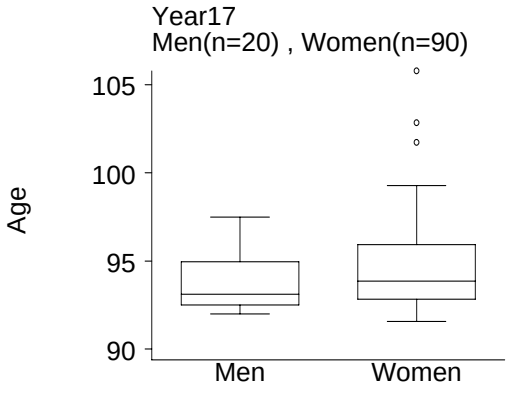


Figure 3.4.1.2 Age distribution of participants in the current survey compared with baseline sample of the same age

Year 17 survivor sample [n=110]	All [n=110]	Men [n=20]	Women [n=90]
Age - mean (SD)	94.4 (2.4)	93.8 (1.7)	94.6 (2.5)
- median	93.8	93.1	93.9
- inter-quartile range	92.7 - 95.8	92.5 - 95.0	92.8 - 95.9
- range	91.6 - 105.8	92.0 - 97.5	91.6 - 105.8





Year 0 baseline sample same age-range as survivors [n=62]	All [n=62]	Men [n=11]	Women [n=51]
Age - mean (SD)	94.7 (2.9)	94.8 (2.7)	94.7 (3.0)
- median	93.6	93.9	93.6
- inter-quartile range	92.7 - 96.6	92.7 - 97.3	92.6 - 96.6
- range	91.6 - 106.3	91.9 - 100.5	91.6 - 106.3

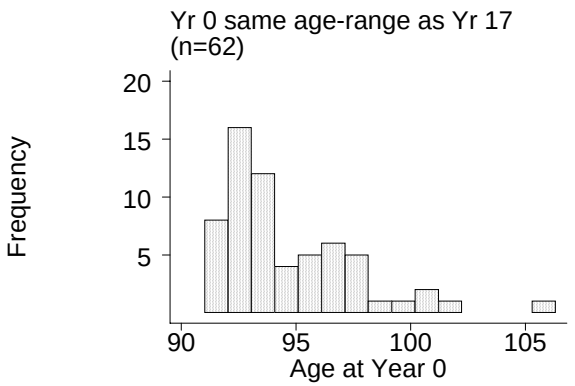


Table 3.4.2.1 Other socio-demographic characteristics of participants in the current survey compared with baseline sample of the same age

	Year 17 current survivor sample [n=110]		Year 0 baseline sample same age [n=62]	
	n	(%)	n	(%)
Gender				
- women	90	(82)	51	(82)
- men	20	(18)	11	(18)
Place of residence				
Living in the community				
- house/flat/granny flat	62	(56)	43	(69)
Supported living				
- sheltered accommodation	19	(17)	4	(6)
Living in institutional care				
- residential home	20	(18)	13	(21)
- nursing home	6	(6)	0	(0)
- hospital	3	(3)	2	(3)
- all institutional care	29	(26)	15	(24)
Living alone *	43/62	(69)	23/43	(53)
Marital status				
- married	7	(6)	6	(10)
- widowed	94	(86)	47	(76)
- single	9	(8)	9	(14)
Social class †				
- manual	55	(52)	33/57	(58)
- non-manual	51	(48)	24/57	(42)
Age left school †				
- aged 14 or less	67	(61)	36/60	(60)
- aged 15 or more	43	(39)	24/60	(40)

* Denominators shown for living alone are numbers living in the community:
Year 0: n = 43, excluding 17 women and 2 men living in sheltered housing or institutional care
Year 17: n = 48, excluding 43 women and 2 men in sheltered housing or institutional care
† Denominators for social class and age left school reflect missing baseline data (only obtained Year 0)

Table 3.4.2.2 Other socio-demographic characteristics: Year 0 baseline sample of same age-range as surviving participants in Year 17 - by gender

	Men [n=11] n (%)	Women [n=51] n (%)	All [n=62] n (%)
Place of residence			
Living in the community			
- house/flat/granny flat	9 (82)	34 (67)	43 (69)
Supported living			
- sheltered accommodation	0 (0)	4 (8)	4 (6)
Living in institutional care			
- residential home	2 (18)	11 (22)	13 (21)
- nursing home	0 (0)	0 (0)	0 (0)
- hospital	0 (0)	2 (4)	2 (3)
- all institutional care	2 (18)	13 (26)	15 (24)
Living alone *	4/9 (44)	19/34 (56)	23/43 (53)
Marital status			
- married	2 (18)	4 (8)	6 (10)
- widowed	8 (73)	39 (76)	47 (76)
- single	1 (9)	8 (16)	9 (14)
Social class †			
- manual	6/10 (60)	27/47 (57)	33/57 (58)
- non-manual	4/10 (40)	20/47 (43)	24/57 (42)
Age left school †			
- aged 14 or less	6 (55)	30/49 (61)	36/60 (60)
- aged 15 or more	5 (45)	19/49 (39)	24/60 (40)

Denominators shown if not from the full sample

* Living alone: n = 43, excluding 17 women and 2 men in sheltered housing or institutional care

† Denominators for social class and age left school reflect missing baseline data

Figure 3.4.3.1 Cognitive impairment categorising by different MMSE cut-points in the latest survey compared with the same age-range at baseline

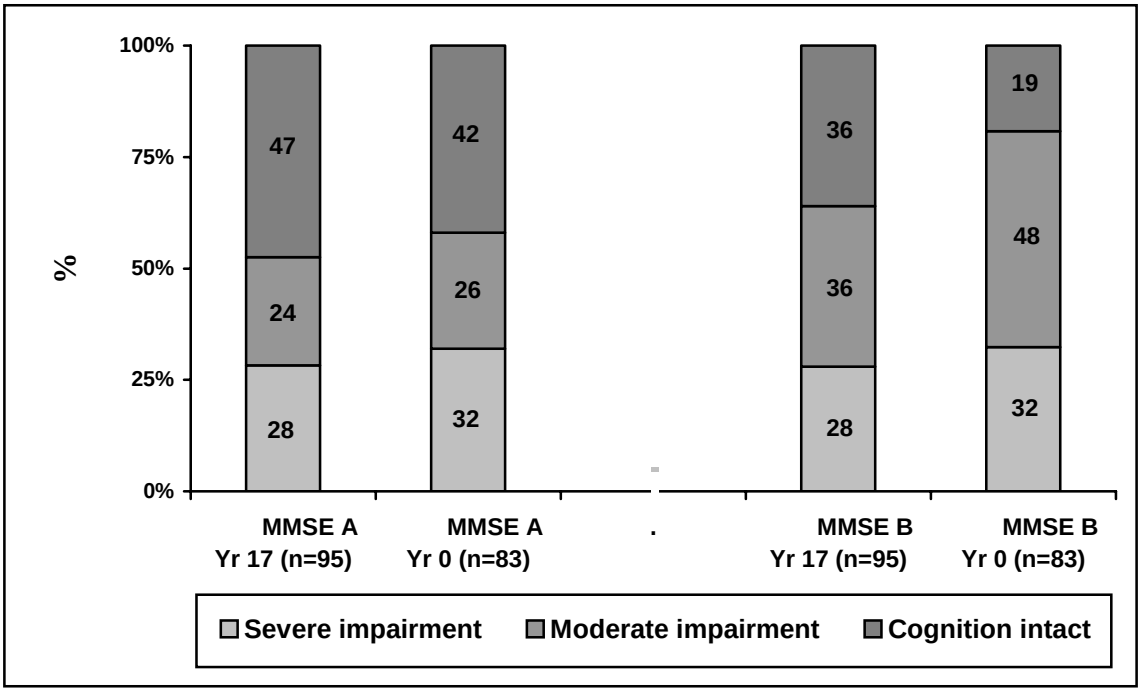


Table 3.4.3.2 Categories of cognitive impairment, by different MMSE cut-points: survivor participants compared with baseline sample of same age-range

	Men Yr 17 [n=18] n (%)	Men Yr 0 [n=11] n (%)	Women Yr 17 [n=77] n (%)	Women Yr 0 [n=51] n (%)	All Yr 17 [n=95] n (%)	All Yr 0 [n=62] n (%)
MMSE categories by cut-points A: 0/17, 18/21, 22/30						
Severely impaired (MMSE 0-17)	2 (11)	2 (18)	25 (32)	18 (35)	27 (28)	20 (32)
Moderately impaired (MMSE 18-21)	4 (22)	1 (9)	19 (25)	15 (30)	23 (24)	16 (26)
Cognition intact (MMSE 22-30)	12 (67)	8 (73)	33 (43)	18 (35)	45 (47)	26 (42)
χ^2_{2df}	p=0.7		p=0.7		p=0.8	
MMSE categories by cut-points B: 0/17, 18/23, 24/30						
Severely impaired (MMSE 0-17)	2 (11)	2 (18)	25 (32)	18 (35)	27 (28)	20 (32)
Moderately impaired (MMSE 18-23)	7 (39)	6 (55)	27 (35)	24 (47)	34 (36)	30 (48)
Cognition intact (MMSE 24-30)	9 (50)	3 (27)	25 (32)	9 (18)	34 (36)	12 (19)
χ^2_{2df}	p=0.5		p=0.2		p=0.08	

3.5 Discussion and summary

This chapter reports the losses to follow-up of the CC75C cohort and resultant levels of participation in the latest survey, then examines the question of whether the study sample can be regarded as a representative sample of men and women aged over 90 years old.

The high rate of participation achieved (84% of survivors) is encouraging for other future research with very old people. Even much younger old people have tended to be excluded from most medical research, particularly from treatment trials, a tendency that has contributed to the dearth of evidence regarding older people since neither epidemiological nor intervention study findings can be extrapolated to apply to older age groups[103;105;762]. The current regulatory climate is likely to pose even greater obstacles for future researchers[763], with research governance and ethics committees often applying conditions on research that are intended to protect groups perceived as potentially vulnerable[102]. Although guided by well-intentioned principles of research ethics[96], current practice may be over-riding the autonomy of older people to decide for themselves whether or not to take part in research[103]. Such protection of potential research participants from researchers is likely to have detrimental effects in terms of reduced validity and generalisability of findings due to sample selection. In the latest CC75C study ethical approval was only granted to contact study participants after first seeking GP approval to approach each of their patients in the study. Had this been the policy at baseline, it is most likely that a far less representative sample would have been recruited.

The low attrition rate in this latest CC75C survey confirms findings from other studies that even relatively disabled and especially older people are very willing to participate[131] in research when invited directly. The fact that almost half the sample re-recruited into this latest study had missed taking part in at least one earlier CC75C survey has interesting implications for the conduct of follow-up in longitudinal studies: refusal on one occasion need not imply subsequent refusal to participate again.

Given the rarity of studies that can examine extreme old age, it is important to know how representative such samples are of advanced ageing before any findings can be

interpreted or conclusions extrapolated to wider populations. Interpretation of any differences seen between the survivor population surveyed and their age-matched peers at baseline must clearly be limited by the small sample sizes when analysis is restricted to the small sample selected by age. Only gross differences can be detected as significant and it is impossible to draw conclusions from any suggestions of a trend, for example in residential status.

It is encouraging to note that no reduction in the proportion of people living in institutional care was found between the baseline age-matched group and the current study participants (24% vs. 26%), as this section of the population are often more easily lost to follow-up. Nationally the percentage of the oldest old living in care establishments has been declining – exactly comparable figures, in terms of age-range and dates, are not available but ONS statistics show that between 1991 and 2001 the proportion of men and women aged 85 and over who lived in communal settings dropped from 15% to 12% for men and from 26% to 23% for women. Although study numbers are too limited to infer with any certainty, the trebling of the proportion of people living in sheltered accommodation in the latest CC75C study compared with the baseline age-peers may also be a reflection of a policy shift in the intervening years towards a goal of enabling more older people to remain independent for longer[45].

The CC75C findings regarding living alone in the community are also in line with the proportions of the oldest old living alone nationwide: 71% of women and 40% of men aged 85 and over lived alone at the time of the 2001 census[2], comparable with this study's 69% in the 2002/3 survey.

Average decline in MMSE score with age has been variously estimated as approximately 2 points a year in older age people[764] to 3 points a year amongst over-90-year-olds[765], from which it might be expected that cognitive impairment would be more prevalent in later study waves than earlier ones. The fact that levels of cognitive impairment in the over-90s in the most recent survey were actually lower than at baseline may suggest that over time there has been greater attrition from the study amongst the cognitively impaired than the cognitively intact, in line with previous findings[766;767]. As a result of this suggested lower participation rate, the most recent

survey may be under-representing the least cognitively intact end of the spectrum of very old age.

The proportion of participants in the latest follow-up from non-manual social classes was only slightly higher than at baseline (48% vs 42%) and there was no difference in the percentages who had stayed in full-time education beyond the statutory school leaving age of 14. This lack of difference is worth noting in relation to the MMSE findings discussed below. Educational level has been reported to affect both attrition rates[131], with lower drop-out associated with higher education, and MMSE scores[768-770], because of the language component in the assessment, such that higher educational levels may disguise mild cognitive impairment.

The factors found in systematic review to be most consistently linked to drop out from longitudinal studies of ageing were increasing age and cognitive function[754;756;757]. By conducting this comparison using only the sub-sample of the same age at baseline, the age factor is not relevant here. There is a suggestion from these data that cognitive function has played a part in attrition, as would be expected from other studies. However, this analysis cannot confirm to what extent the loss to follow-up of some of the most cognitively impaired may have affected how representative the survivor sample are as this depends on how cognitive impairment is defined. In other respects it is encouraging to find comparability of the participants in the current study, the Year 17 follow-up survey, with their age-matched peers in the CC75C baseline interviews.

Summary points

Practical issues in maximising longitudinal cohort participation

- Studies of very old people need plenty of time to recruit potential participants, to allow for liaison, tracing, contacting, thorough explanation and the process of seeking informed consent.
- More than half the potential participants for this study had moved and / or changed GP surgery since last interview.
- Nearly half of the participants enrolled in this current study had not taken part in at least one earlier survey in the longitudinal study but had no objections to being invited again this time. The need to rely on proxy informants was no higher amongst this group than amongst the more consistent participants.

Levels of participation and completeness

- 88% of the known cohort survivors consented to participate.
- Flexible timing of interviews was important in achieving complete interviews with 79% of participants.
- Use of proxy informant interviews greatly reduced the extent of missing data.
- The vast majority of older people approached for this study were very willing to take part, because they were interested, enjoyed being interviewed or wanted to help research and thereby to help other people

Representative of population from which sample originally drawn

- There was little evidence of demographic differences between the older people who took part in this latest survey and people of the same age-range in the CC75C baseline interview, a representative population-based sample.
- Levels of cognitive impairment were found to be marginally higher in the baseline sample than in the current survivor sample, suggesting slightly higher loss to follow-up of the more cognitively impaired.

CHAPTER 4

CHARACTERISTICS OF THE STUDY SAMPLE POPULATION

4.1 Introduction

4.2 Methods

4.3 Results

- 4.3.1 Demographics
- 4.3.2 Family and social support
- 4.3.3 Activities, social participation and isolation
- 4.3.4 Cognitive function
- 4.3.5 Health
- 4.3.6 Medication
- 4.3.7 Activities of daily living and falls efficacy
- 4.3.8 Contact with health services and other support services

4.4 Discussion and summary

4.1 Introduction

This chapter gives an overview of the study population - the survivors of a long-running study of ageing now all in their tenth decade of life. Chapter 2 has already provided background information about this cohort – the Cambridge City over-75s Cohort (CC75C) – and introduced the methods used in this longitudinal study's most recent survey, which forms the basis of the current study. Chapter 3 described how cohort survivors were enrolled into this latest survey and, in assessing to what extent these still formed a representative sample of over-90-year-olds, reported just brief demographic information about these surviving participants.

The aim of this Chapter 4 is to further characterise the study's population-based sample of men and women aged over 90 years old. The sample will first be described in more detail with standard population descriptors, and then also in terms of a number of factors that are relevant to the study's main focus on falling and its consequences. Subsequent chapters will report the objective measures of functional performance (Chapter 5) and bone strength (Chapter 10) that the survey included along with the interviewer-delivered questionnaire. Here the interview data has been analysed to inform subsequent investigation (see Chapters 6 - 9) of the prospective falls and follow-up data gathered in the year after interview.

The focus is on factors previously identified in the literature to be associated with the risk of falling, as described in Chapter 1, section 1.2.5, such as cognitive impairment, medication and a number of health conditions, and factors that may affect the outcome of a fall, such as existing social and service support.

4.2 Methods

Data sources
Missing data

Data sources

Findings presented in this chapter are primarily from interview data collected in the latest CC75C survey conducted an average of 17 years after baseline interview. Most of the data are from self-reported or proxy-reported answers to the standardised CC75C interview schedule (see Chapter 2 and Appendix C). Supplementary sources have been used for some information, for example, medication (see Chapter 2) and age, which has been calculated using the dates of birth already confirmed at baseline against GP records. Place of residence was coded into six categories and the precise designation of care institutions was always checked with the institution itself. Living alone and reports of who a participant lived with are only reported for those living in the community. Social class and educational level had both been assessed at baseline in accordance with the Office of Population Census and Statistics classification at that time. The social class groupings routinely used were dichotomised into non-manual (Classes I to III non-manual) or manual social class (Classes III manual to V), and married or widowed women had been classified according to their husband's social class. A binary variable was created to indicate whether a respondent left full-time education aged 14 years old or less.

Activities of daily living, past medical history, disabling health conditions and use of health and social services were assessed with groups of questions as described before. The assessment of cognitive function included the Mini-Mental State Examination[725], embedded within the more extensive CAMCOG[726] interview. The methods used to report factors represented by a number of variables are described in the relevant sections below, along with the derivation of summary composite scores.

Missing data

Proxy information has been used where data are missing from participants, selecting interviews that maximise item response rates as the methods described in Chapter 2. However data was still incomplete for some variables, most notably the self-rated measures, as identified by the denominators shown.

4.3 Results

4.4.1 Demographics
4.4.2 Family and social support
4.4.3 Activities, social participation and isolation
4.4.4 Cognitive function
4.4.5 Health
4.4.6 Medication
4.4.7 Activities of daily living and falls efficacy
4.4.8 Contact with health services and other support services

4.3.1 Demographics

Age and sex
Place of residence
Social class and education level

Age and sex

There were far more women than men in the sample with a gender ratio of 4.5:1, as expected in a population of this age. This is just slightly higher than the female:male ratio nationwide (3.3:1 amongst people aged 90 or older[2;19]). Ninety women and 20 men took part and were aged from 91 to 105 years old, with both the mean and median ages around 94. There were no marked age differences in the sample by gender although the larger numbers of women gave a wider distribution (see Figure 4.3.1.1).

Place of residence

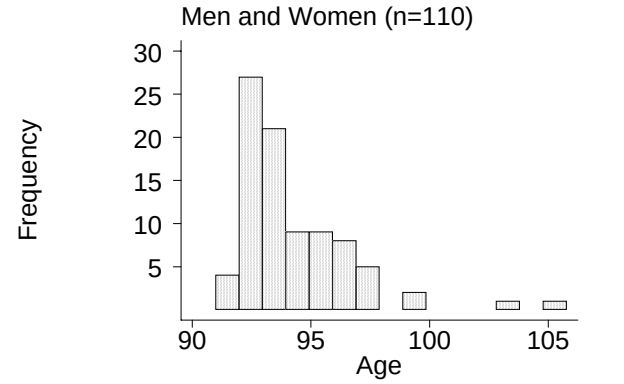
Table 4.3.1.1 summarises the participants' residential status at the time of interview. Over half the respondents (56%) were living in the community in a house, flat or granny flat at the time of interview. A quarter of those in the current survey were in some form of institutional care, most of these being in residential homes but also a small number in nursing homes (n=6) and long-stay hospital wards (n=3) at the time of interview. About three-quarters of the sample were not living in any care setting, those in sheltered accommodation making up almost a quarter of this more broadly defined non-institution-dwelling group. Almost all the men were living in the community (18/20, 90%) compared with half the women (44/90, 49%).

Social class and education level

Table 4.3.1.2 shows that when the social class categories ascertained at baseline were grouped as manual or non-manual the sample was almost equally divided between the two (52% manual and 48% non-manual). There were slightly more of the men (60%) in the manual category and fewer (40%) in the non-manual group. The majority had left school by the age of 14, the usual school leaving age at the time, with minimal difference between men (65%) and women (60%).

Figure 4.3.1.1 Age distribution

	All [n=110]	Men [n=20]	Women [n=90]
Age - mean (SD)	94.4 (2.4)	93.8 (1.7)	94.6 (2.5)
- median	93.8	93.1	93.9
- inter-quartile range	92.7 - 95.8	92.5 - 95.0	92.8 - 95.9
- range	91.6 - 105.8	92.0 - 97.5	91.6 - 105.8



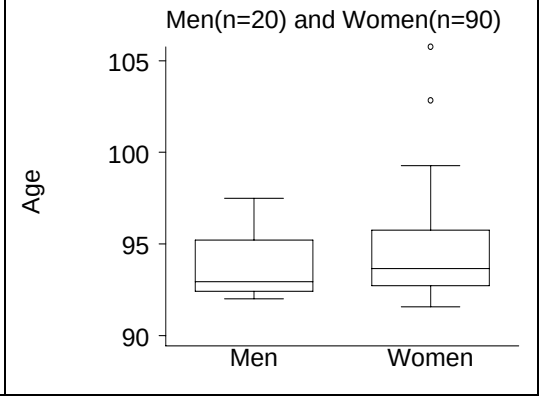


Table 4.3.1.2 Residential and marital status, social class and education

	Men [n=20] n	(%)	Women [n=90] n	(%)	All [n=110] n	(%)
Place of residence						
Living in the community						
- house/flat/granny flat	18	(90)	44	(49)	62	(56)
Supported living						
- sheltered housing	1	(5)	18	(20)	19	(17)
Living in institutional care						
- residential home	1	(5)	19	(21)	20	(18)
- nursing home	0	(0)	6	(7)	6	(6)
- hospital	0	(0)	3	(3)	3	(3)
- all institutional care	1	(5)	28	(31)	29	(26)
Living alone *	11/18	(61)	32/44	(73)	43/62	(69)
Living with somebody *	7/18	(39)	12/44	(27)	19/62	(31)
If so, who with…†						
- spouse	6/19		1/19		7/19	
- sister	1/19		1/19		2/19	
- son	4/19		0/19		4/19	
- daughter	4/19		0/19		4/19	
- niece	0/19		1/19		1/19	
- lodgers	0/19		1/19		1/19	
Marital status - married	6	(30)	1	(1)	7	(6)
- widowed	11	(55)	83	(92)	94	(86)
- single	3	(15)	6	(7)	9	(8)
Social class ‡ - manual	12	(60)	43/86	(50)	55/106	(52)
- non-manual	8	(40)	43/86	(50)	51/106	(48)
Age left school - aged 14 or less	13	(65)	54	(60)	67	(61)
- aged 15 or more	7	(35)	36	(40)	43	(39)

Denominators shown if not from the full sample
* Living alone or living with somebody: n = 62, excluding living in sheltered housing or institutional care
† If living with somebody, who with: n = 19 not living alone in the community
‡ Denominators for social class reflect missing baseline data on social class for n=4 women

4.3.2 Family and social support

Living alone
Family
Friends and neighbours
Perceived levels of support

Living alone

Over two thirds of those living in the community lived alone, and the same proportion of those in sheltered accommodation had no warden living on site (data not shown).

Four fifths of the sample overall were widowed and the vast majority of these had lost their spouse over ten years ago, about half over 20 years ago. All the women except one were widowed or single; six of the men still lived with their wives. Those who were living with someone else most commonly lived with a son or daughter, both equally likely. Details are tabulated in Table 4.3.1.1 with the residential demography.

Family

A quarter of the respondents had no children of their own and one in ten reported they had no relatives at all. Nearly three-quarters of those with children (57/80) had at least one child living in or near Cambridge, and the same proportion of the whole sample had relatives living in the area or within easy reach.

The survey revealed high levels of support from family or neighbours. The question "How often do you see any of your relatives to speak to?" was not asked of the 10% with no relatives and five others. Three-quarters of those asked saw someone in the family at least once a week (71/92), of whom over a third saw someone every day. More than half of the total see a relative at least two to three times a week. The person with whom there was most contact was mostly a female relative (68%) and was 2.5 times more frequently a daughter than a son.

Friends and neighbours

Well over half still had friends locally but nearly a third had been in contact with friends less than usual in the last year, mostly because more friends had died or moved away, for instance to be near family or into care homes. "I've out-lived them all" was a frequent comment.

Excluding those living in care settings, a quarter saw a neighbour every day and nearly two-thirds had neighbours who saw them at least once a week.

Perceived levels of support

Two-thirds of those asked (59/88) said they had as much contact with family and friends as they would like, but over a quarter would have liked more contact. Whichever way this question was answered, many people commented that they knew their families were very busy, it was difficult for them to get the time, and so on. Only one person wanted less contact.

The majority of the study participants tended to perceive their levels of support as good. Of the 88 respondents whom it was possible to ask 83% felt there was someone amongst their family or friends on whom they could definitely rely no matter what happened, 74% felt there was someone who would definitely see that they were taken care of if need be and 66% felt there was someone in whom they could definitely confide about anything worrying them. However, the converse interpretation of these figures is the sizeable minority who clearly felt to some extent unsupported.

4.3.3 Activities, social participation and isolation

Housebound
Social activities
Physical activity
Leisure activities in the home
Perceptions of well-being and loneliness

Housebound

Classic images of extreme old age portray a state of housebound isolation. What constitutes being housebound can be debated and the interviews attempted to elicit the study participants' own perceptions as well as assessing activity limitation. Responses to the question "In general, do you get out and about as much as you would like to?" were mixed, about half and half replying yes (48%) and no (52%). Three-quarters of respondents could no longer walk around their local area, and half of the study participants spent less than half an hour outdoors in an average week or didn't go out at all. Mobility and levels of physical function are reported in detail in Chapter 5, but the vast majority in the sample never went out unaccompanied.

Social activities

Levels of participation in any social activities were low. Fifteen per cent or fewer had had contact with any social clubs, organisations, church or church groups in the last week, and only a further 5% (that is 20% altogether) had in the last month. Only a minority had taken part in any form of activity outside the home in the previous month. One in four had been out for a meal or a drink, mainly with family, and one in eight described visiting a place of interest, but outings of any sort were generally rare.

Physical activity

Only a small minority managed any form of physical activity or exercise, the most commonly reported being gardening (23%), walking (14%) or "other" (23%) which was usually doing exercises at home, for example some given by a physiotherapist or "that I've always done". A third climb at least one flight of stairs a day, and a tenth climb a flight of stairs more than five times a day. One man still cycled, indeed had been given a mountain bike for his 90th birthday. He and one other man were the only respondents who owned cars and were still driving.

Leisure activities in the home

Reading was by far the most common leisure activity in the home: almost half the participants gave this response and often it was the first activity they mentioned. A quarter played games such as cards, board games or bingo, and a similar proportion reported they enjoyed other activities such as cross-words or jigsaws. Knitting or sewing was reported by less than 20%, though many more said they used to. Over a quarter watched more than four hours of television a day but a similar proportion reported they watched less than an hour a day, and of these half said they never watched it.

Perceptions of well-being and loneliness

Nearly two-thirds of those asked (63%) said that they enjoy life most of the time and more than half of those asked (55%) said that the things they do are as interesting to them as they ever were. On the other hand, more than half of those asked admitted to some degree of loneliness, with more than one in ten describing themselves as very lonely.

4.3.4 Cognitive function

Complete, incomplete and missing assessments
Prevalence of cognitive impairment

Complete, incomplete and missing assessments

Cognitive assessment using the CAMCOG[726] was conducted during a second visit for the vast majority of the sample, and 95 of the 99 respondents interviewed in person agreed to attempt this part of the interview. 91 of these 95 provided a complete Mini-Mental State Examination[725] score. The extent and reasons for missing cognitive assessment is summarised in Table 4.3.4.1

Of the four incomplete MMSE scores, one had only a single missing item and another had five missing values. For these two cases with less than 25% of data missing, imputation proportional to their completed score was used, following guidelines on missing data handling from the MRC-Biostatistics Unit, with resultant score changes of 1 and 3 points and only one shift between cognitive impairment categories. The remaining two incomplete MMSE assessments had been attempted but abandoned when the respondents were clearly too cognitively impaired to continue: although no MMSE score can be imputed for the missing items they have been counted in the severely cognitively impaired group. No MMSE could be administered with the one respondent interviewed by telephone, and three more did not complete the respondent interview because too busy or tired and subsequently did not wish to continue when re-visited.

It was possible to assign the full sample a cognitive category by using imputed MMSE, existing diagnosis of dementia or GP/proxy report for the participants without a full MMSE assessment: those with proxy informant interview data only (n=11), incomplete assessments (n=4), refusals (n=3) and phone interview (n=1). Information from GPs and care homes revealed that two-thirds of these had previously been diagnosed with dementia, although it was not always possible to ascertain a more precise diagnosis or details of the diagnostic criteria.

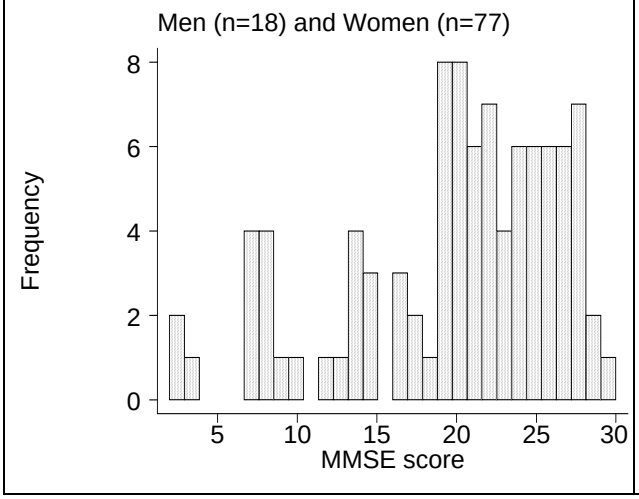
Figure 4.3.4.2 displays the MMSE score distributions graphically alongside tabulations of the summary statistics for these scores, including imputed values as described above, for 95 participants who undertook cognitive assessment.

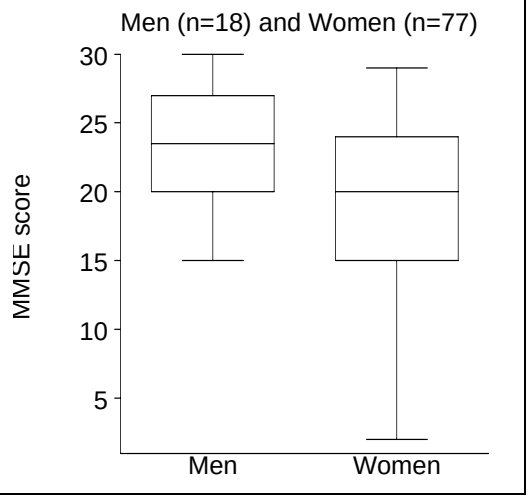
Table 4.3.4.1 Cognitive assessments completed, attempted and not done

	Men [n=20] n (%)	Women [n=90] n (%)	All [n=110] n (%)
MMSE complete	18	73	91
MMSE incomplete	0	4	4
MMSE not done - proxy interview only	1	10	11
- telephone interview	0	1	1
- refused second visit	1	2	3

Figure 4.3.4.2 Distribution of Mini-Mental State Examination (MMSE) scores

	All [n=95]	Men [n=18]	Women [n=77]
Mean (SD)	19.9 (6.8)	23.5 (4.4)	19.1 (7.0)
Median	21	23.5	20
Inter-quartile range	16 - 25	20 - 27	15 - 24
Range	2 - 30	15 - 30	2 - 29





n=95 excluding 2 men and 13 women with no cognitive assessment

Prevalence of cognitive impairment

Estimates of the prevalence of cognitive impairment based on MMSE scores will vary depending on how this semi-continuous score is split into categories. There is widespread agreement that a score of 17 or below is a fair indication of severe cognitive impairment[447;725]. In the current study 28% of participants met this criteria, scoring between 0 and 17 MMSE points. Figure 4.3.4.3 shows how defining an intermediate group is more problematic. Choosing different cut-points to categorise the data can give widely varying prevalence estimates. Taking a relatively restricted range (MMSE scores 18-21) from a classification that was in common use when earlier interview waves in CC75C were analysed gives the prevalence of moderate cognitive impairment as 24% (see "MMSE A" in the diagram). However, it has since been argued that this banding should be widened and the categorisation more commonly reported nowadays (MMSE scores 18-23) raises this estimate to 36%, as illustrated by "MMSE B" in the same figure and shown in more detail by sex in Table 4.3.4.4.

Excluding the incomplete assessments makes little difference: of 91 respondents with complete Mini-Mental State Examination scores, the proportion classified as having severe cognitive impairment was one percentage point less with the prevalence of other cognitive categories unaffected. Imputed values were used wherever possible in the categorisation of the full sample described below.

Adding information from sources other than the MMSE scores for those who did not complete the assessment, as described above, provides a broad categorisation of the full sample in terms of their cognitive status. Table 4.3.4.5 details the gender breakdown of cognitive status using the same MMSE categories as Table 4.3.4.4 plus additional information about the 15 participants with no MMSE score. Cognition is impaired in almost two-thirds of the sample – 32% severely and a further 32% moderately – using this classification method (B), as compared with just over half the sample – 32% severely and 22% moderately – if the alternative cut-points (A) are used.

Figure 4.3.4.3 Prevalence of cognitive impairment taking different MMSE cut-points

MMSE A) 0/17, 18/21, 22/30 **MMSE A + other cognitive status info**
MMSE B) 0/17, 18/23, 24/30 **MMSE B + other cognitive status info**

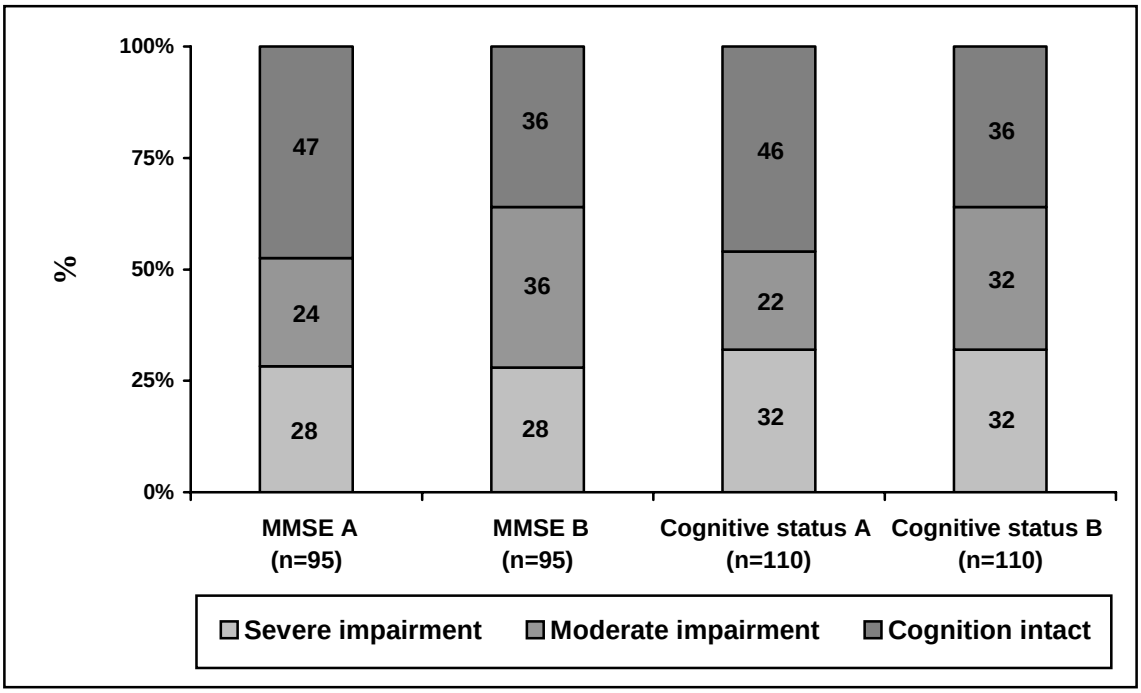


Table 4.3.4.4 Categories of cognitive impairment - by MMSE score

		Men [n=18] n (%)		Women [n=77] n (%)		All [n=95] n (%)	
Cognition intact	(MMSE 24-30)	9	(50)	25	(32)	34	(36)
Moderate impairment	(MMSE 18-23)	7	(39)	27	(35)	34	(36)
Severe impairment	(MMSE 0-17)	2	(11)	25	(32)	27	(28)
Any impairment	(MMSE 0-23)	9	(50)	52	(68)	61	(64)

Table 4.3.4.5 Cognitive impairment – all respondents and all sources

	Men [n=20] n (%)		Women [n=90] n (%)		All [n=110] n (%)	
Cognition intact	10	(50)	30	(33)	40	(36)
Moderate cognitive impairment	7	(35)	28	(31)	35	(32)
Severe cognitive impairment	3	(15)	32	(36)	35	(32)
Any cognitive impairment	10	(50)	60	(67)	70	(64)

4.3.5 Health

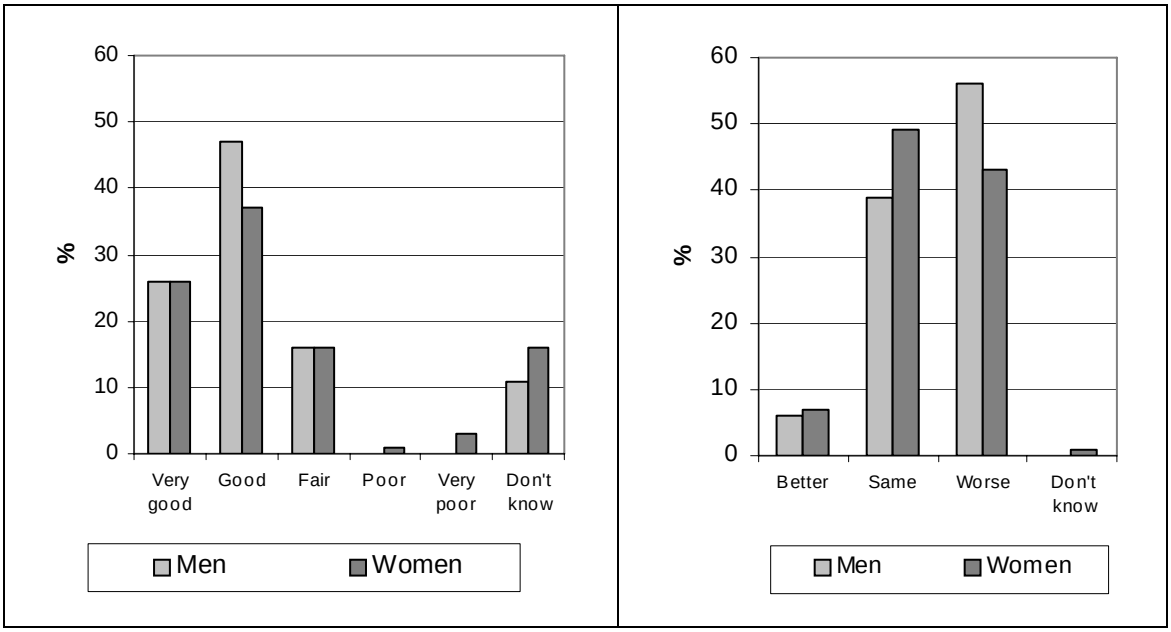
Self- rated health
Depressive symptoms
Physical symptoms
Hearing and visual impairment
Incontinence
Reported medical diagnoses
Multiple co-morbidity

Chapter 2 described the several approaches taken to measuring health, including questions asking for self-rating of overall health, depressive symptoms, reported health-related conditions and past medical history, including specific questions about any fractures in the past.

Self- rated health

The majority of participants interviewed in person were positive about their state of health. Two-thirds of those asked (65/92) rated their health as good or very good compared with others of the same age, but half rated their health as worse than it had been a year ago (see Figure 4.3.5.1). Similarly, nearly half thought they had more energy than most people their age (49% of those asked or 46% of the total), although two-thirds felt they had less energy than they had had a year ago.

Figure 4.3.5.1 Self-reported health compared with others and with a year ago



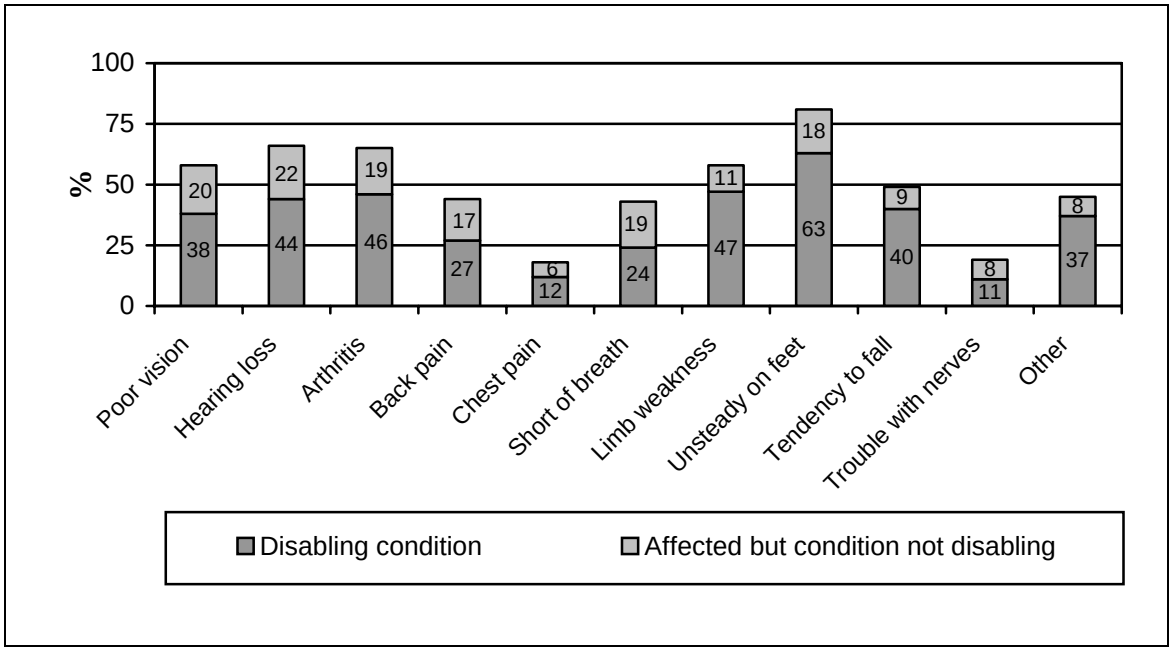
Depressive symptoms

The ten-item Depressive Symptoms Scale questions were obviously not asked of proxy informants and also proved impossible to complete with a further 13 participants who were too cognitively impaired. The scale ranges from 0-11, but none of the 86 people who answered all questions scored 11, the most depressed level. Scores were skewed to the lower (less depressed) end of the range, with two-thirds of the sample scoring 0-4: mean (SD) 3.9 (2.2), median (IQR) 4 (3-5). The question to which the majority answered "Yes" was "Do you feel you have less energy than a year ago?", perhaps not necessarily an indicator of depression in advanced old age.

Physical symptoms

Results for the question asking about a list of ten health-related conditions (described in Chapter 2.1.2.1) are presented in Figure 4.3.5.2. This shows how the prevalence of these long-term condition differs depending on whether or not the proportions include those who reported they had a given problem but that it was "not disabling". Of the two-thirds who responded to the question "How much do these health problems interfere with your life day-to-day?" there were 15% who replied that they were "Not at all" affected. The remaining responses were divided almost equally between the options "Slightly", "Moderately" and "Very much".

Figure 4.3.5.2 Prevalence of physical symptoms and associated disability



The conditions most commonly ranked as the most important interfering factor were "marked weakness in the arms or legs", "arthritis / rheumatism" (each rated the worst problem by a fifth of those who answered this question) and "poor vision" (rated the worst problem by one in six). Two of these – limb weakness and arthritis – also ranked in the top three most frequently reported disabling conditions, with being "unsteady on your feet" the most frequent complaint (81% or 63% including or excluding those who described this as not a disabling condition). "Hearing loss" was one of the top four most prevalent problems, whether counted as disabling or present to any degree. Participants who said they had a "tendency to fall" numbered almost two-thirds of the proportion described as "unsteady", either to a disabling degree or to any extent.

Hearing and visual impairment

The majority of the participants interviewed in person consented to have the brief assessments of hearing and of reading vision as described in Chapter 2, section 2.1.2.1 *Data collected*. These provide simple objective measures of the prevalence of these sensory impairments in addition to the reported frequency of "poor vision" and "hearing loss" described above.

Table 4.3.5.3 Hearing ability and disability levels

Able to hear …	n (%)	Unable to hear …	n (%)
… whispering accurately	9 (10%)	… whispering accurately	82 (90%)
… normal speech accurately but cannot hear whispering accurately	35 (38%)	… normal speech accurately	47 (52%)
… normal speech but not always accurately	18 (20%)		
… accurately only at shout volume	5 (6%)	… even shouting accurately	24 (26%)

n=91 of the 99 participants interviewed in person consented to hearing assessment with the Whisper Test

Table 4.3.5.3 presents both the levels of hearing competence and disability found from the Whisper Test carried out as part of 91 of the 99 respondent interviews. Just over half those tested met the criteria by which hearing impairment was defined: 52% were unable to hear normal speech accurately from one metre distance. One in ten retained very acute hearing but a quarter had hearing so affected that they could not accurately repeat either or both of the test phrases even at a shouting volume. Interestingly, the test ratings did not correspond well to the participants' perceptions of their condition severity. Of those unable to hear normal speech accurately almost half reported

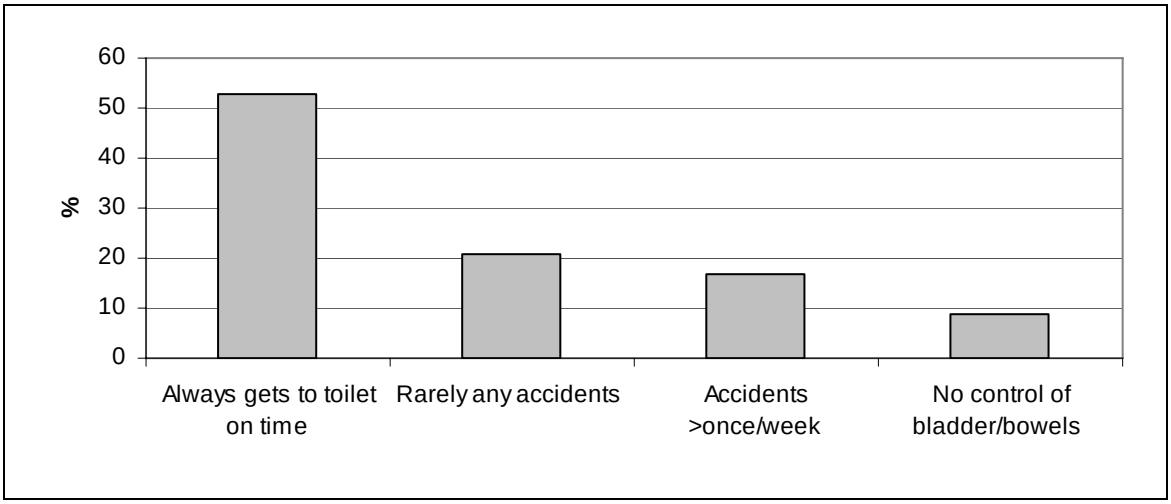
disabling hearing loss, yet 22% said they had hearing loss but it was not disabling and a third reported no hearing problems. Of the people who could hear normal speech accurately 28% also said they had disabling hearing loss.

The test of reading vision was attempted by 83 of the 99 participants interviewed. 22% of those tested could not read 3mm capital print size. However, as poor vision was the main reason for not carrying out this assessment, including those not tested for whom there were other sources of eyesight data increases the estimated prevalence of visual impairment to 34%. There was better concordance between these test results and participants' assessment of their sight problems than their hearing loss ratings. 83% of those unable to read the defined print size reported disabling poor vision, but a fifth who could read print this small also described their vision as poor and disabling.

Incontinence

An indication of the prevalence of incontinence in this sample of men and women over 90-years-old is derived from one of the activity of daily living questions "How do you manage with getting to the toilet on time?" (see Figure 4.3.5.4). Recoding dichotomised the sample into those who suffered regular episodes of incontinence – those with response options "accidents more than once a week" and "No control over bladder or bowels" – and those who described themselves or were reported as fully continent or only rarely having incontinent episodes. Figure 4.3.5.4 illustrates how just over half replied that they "always got to the toilet on time", a fifth had "rare accidents", about one in six reportedly were incontinent at least once a week, and almost one in ten individuals were regularly doubly incontinent.

Figure 4.3.5.4 Prevalence of incontinence



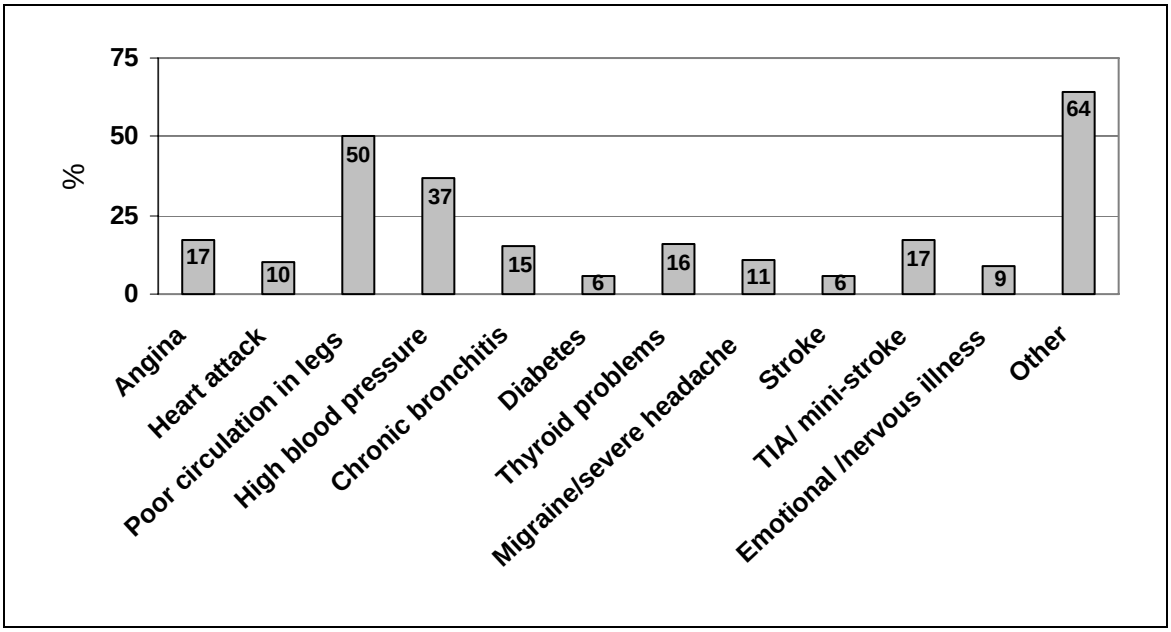
Reported medical diagnoses

Throughout the study a question about common diagnoses has been used to elicit any major illnesses: "Have you ever had or has a doctor ever told you that you have had...?" From the options listed as possible responses the most commonly reported diagnoses were "Problems with circulation in the legs" (50%) and "High blood pressure" (39%). In addition 64% reported that they had another health problem not listed. Any history of previous angina, heart attack, diabetes, chronic bronchitis, thyroid problems, migraine, TIA or stroke – the other options specifically elicited – was reported by fewer than one in five. Figure 4.3.5.5 shows the rates reported but it should be stressed that these are not confirmed diagnoses as these self-reported or proxy-reported medical histories were not checked against GP records.

Multiple co-morbidity

It was common to report suffering from several conditions. A summary co-morbidity score was calculated adding the number of physical symptoms and medical diagnoses reported. Despite this being a very crude measure, the fact that 4/5 scored more than five is indicative of the extent of multiple pathology at this age (see Figure 4.3.5.6).

Figure 4.3.5.5 Past medical history reported



Past medical history – previous fractures

The standard interview question above had not included fracture history in the earlier CC75C surveys. The additional questions described in Chapter 2 resulted in the data shown in Figure 4.3.5.7. Respondents were asked specifically whether they had ever broken a bone in the past, to assess fracture prevalence overall, not just those as a result of recent falls (detailed in Chapter 6).

Over half the respondents reported they had had a fracture, these 56 people reporting a total of 94 fractures between them, of whom 24 (43%) reported at least two previous fractures. It was impossible to accurately ascertain women's age of menopause, but asking whether aged over 50 or younger at the time of each fracture established that the vast majority (88%) of all those with fractures had sustained these when older (87% of fractures). Overall 45% of men as well as women had sustained a fracture when aged over 50.

Almost a fifth of the sample had suffered one or more hip fractures, accounting for a third of all fractures; the two with bilateral hip fractures were both women. Previous fractures, including hip fractures and other apparently age-related fractures, were as common in men as women.

Previous falls are reported fully in Chapter 6 but in the context of fractures – one of the most serious consequences of falling – it is noteworthy that 87% of the sample reported a fall in the past five years and nearly half of those asked said they were worried about falling again. Figure 4.3.5.8 shows the high proportions who gave as their reason for moving into sheltered housing and care homes having suffered a fracture or a fall, indicative of the devastating effect these can have on the rest of an older person's life. (Fuller description of fractures and other falls sequelae are to be found in Chapters 6-8)

Figure 4.3.5.6 Multiple co-morbidity: number of reported conditions or diagnoses

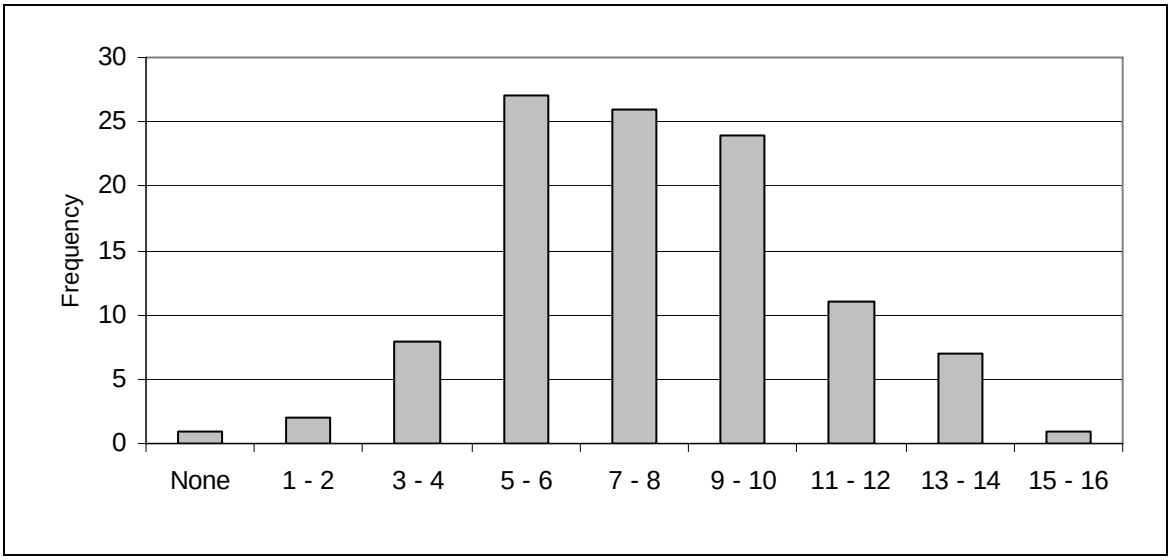
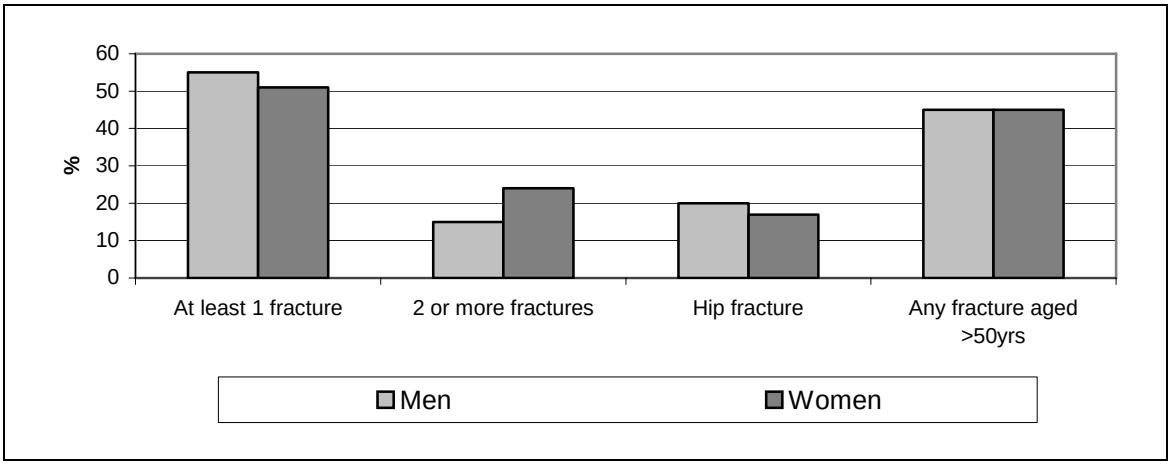
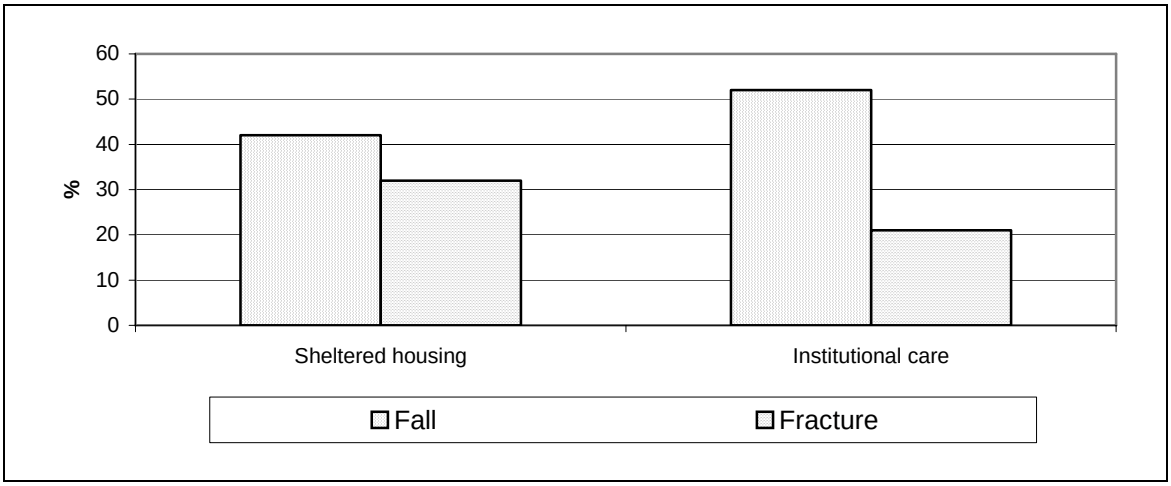


Figure 4.3.5.7 Reported previous fractures



* Reported past fractures: n=108 excluding 2 women with no data

Figure 4.3.5.8 Proportion of moves into more supported living arrangements known to have been prompted by falls and fractures



4.3.6 Medication

Medications reported to be risk factors for falls
Medication for bone health

Over half the study participants were taking at least four medications, women more than men but not significantly more. Table 4.3.6.1 summarises the data on medication groups of particular relevance to this study of falls and their consequences.

Medications reported to be risk factors for falls

One in three women was taking at least one, and 14% more than one medication from the groups of drugs identified in earlier research as associated with increased falls risk: benzodiazepines, anti-psychotics, anti-depressants, anti-epileptics, drugs for nausea/vertigo and digoxin (see Chapter 1, section 1.2.5.6). Out of the whole sample 24% were on psychotropic drugs. All but one of these were women, with just one man taking an anti-depressant. More than twice as many women living in institutional care or sheltered housing (39% in both) had been prescribed at least one psychotropic drug simultaneously compared with 18% of the other women living in the community.

Medication for bone health

Only a quarter of the sample were taking any form of calcium or vitamin D, including ten women who bought "over the counter" cod liver oil, thereby increasing their vitamin D intake (see Figure 4.3.6.2). Only 18% were on prescribed preparations, including one on calcium alone and three at a minimal calcium dose.

Only one woman was taking any other form of bone-protective medication, an anti-resorptive, prescribed whilst on treatment with corticosteroids for polymyalgia rheumatica. One other steroid user took calcium with vitamin D. Overall 13% percent were taking steroids (3 oral, 7 inhaled, 2 nasal sprays and 2 topical application). Two women had taken a bisphosphonate for a short time previously and 34% said they used to take cod liver oil at some time in the past, mainly when children.

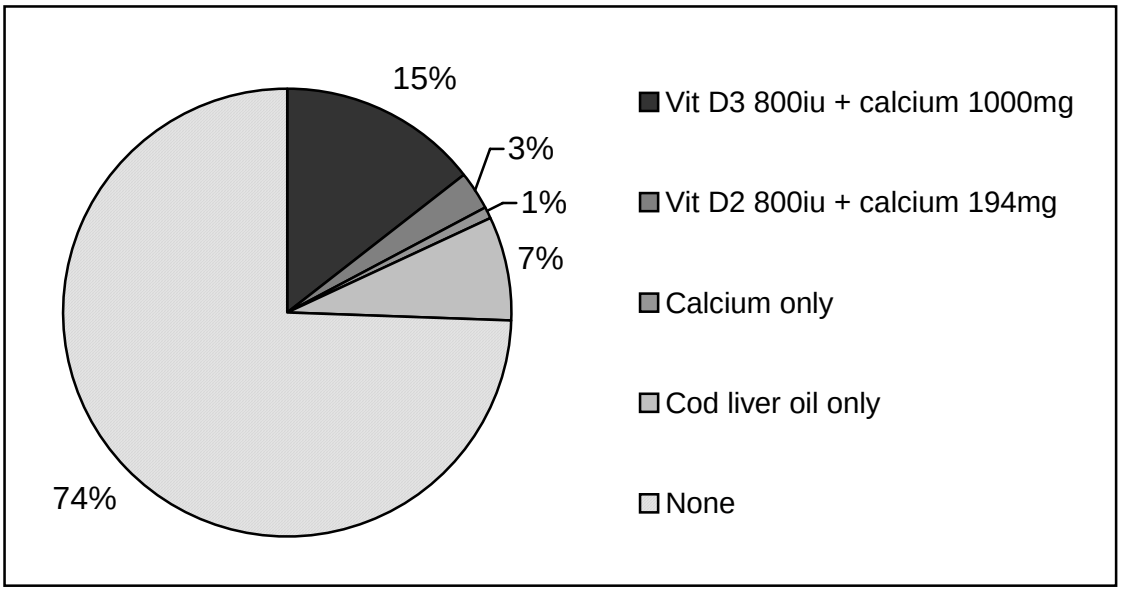
Prescriptions for any form of bone-protective agent were only slightly more common amongst those with past fractures (25%) and in those whose fractures had occurred over the age of 50 (26%).

Table 4.3.6.1 Use of medications associated with increased fall and fracture risk

	Women [n=90] n (%)		Men [n=20] n (%)		All [n=110] n (%)	
Medication associated with increased falls risk						
Taking ≥ 4 prescribed medications	54	(60)	7	(35)	61	(55)
Taking ≥ 1 benzodiazepine	14	(16)	0	(0)	14	(13)
Taking ≥ 1 anti-depressant	10	(11)	1	(5)	11	(10)
Taking ≥ 1 psychotropic medications	26	(29)	1	(5)	27	(24)
Taking digoxin	9	(10)	1	(5)	10	(9)
Taking ≥ 1 medication implicated in falls risk*	30	(33)	1	(5)	31	(28)
Taking ≥ 2 medication implicated in falls risk*	13	(14)	1	(5)	14	(13)
Medication associated with increased fracture risk						
Steroids †	12	(13)	2	(10)	14	(13)

* incl benzodiazepines, anti-depressants, anti-psychotics,anti-epileptics, drugs for nausea/vertigo, digoxin
† incl oral, inhaled, nasal spray and topical preparations

Figure 4.3.6.2 Use of medication associated with decreased fracture risk



4.3.7 Activities of daily living and falls efficacy

Activity limitation
Variability
Falls self-efficacy in activities of daily living
Worry about falling

Activity limitation

Most respondents reported at least some form of limitation or some degree of assistance needed to carry out at least a few activities of daily living (ADL). Figure 4.3.7.1 shows the proportions of respondents who reported difficulty in two or more of each of the elements comprising the ADL index of questions:

- 64% for basic activities of daily living
  (washing, grooming, dressing, using the toilet, eating)
- 75% for the mobility measures
  (walking distance, use of walking aids, use of wheelchair)
- 89% for instrumental activities of daily living
  (using the phone, shopping, money matters, preparing meals, housework, laundry, using transport, taking medicines)

Table 4.3.7.4 on the following page gives a full breakdown of the response distributions to the 16 questions asked, except for the questions about walking ability and the use of walking aids which are reported fully in the next chapter. The high reported levels of difficulty are hardly surprising given that physical function was limited for so many: as Chapter 5 describes in further detail 61% could not rise from a chair without using their arms, and 41% were unable to stand for as long as a minute.

Variability

Within the overall high rates of disability there was an enormous variation in levels of support needed to carry out daily activities. This ranged from complete independence in all instrumental activities of daily living (ADLs), such as shopping and housework, to total dependence in all basic ADLs: washing, dressing, using the toilet and eating. Such extremes formed only a minority of the sample: just two women described themselves as independent in all the activities questioned, and only five more reported they were minimally limited in just one ADL. At the opposite end of the spectrum, requiring assistance with all or almost all ADLs was more common although still relatively unusual: five participants needed help with every activity, six more with almost everything. As Figure 4.3.7.2 illustrates the distribution is skewed towards needing help with more activities. Figure 4.3.7.3 shows the extent to which this need for high levels of assistance was accounted for by the respondents with severe cognitive deficits.

Figure 4.3.7.1 Prevalence of reported difficulty in two or more basic, mobility and instrumental activities of daily living

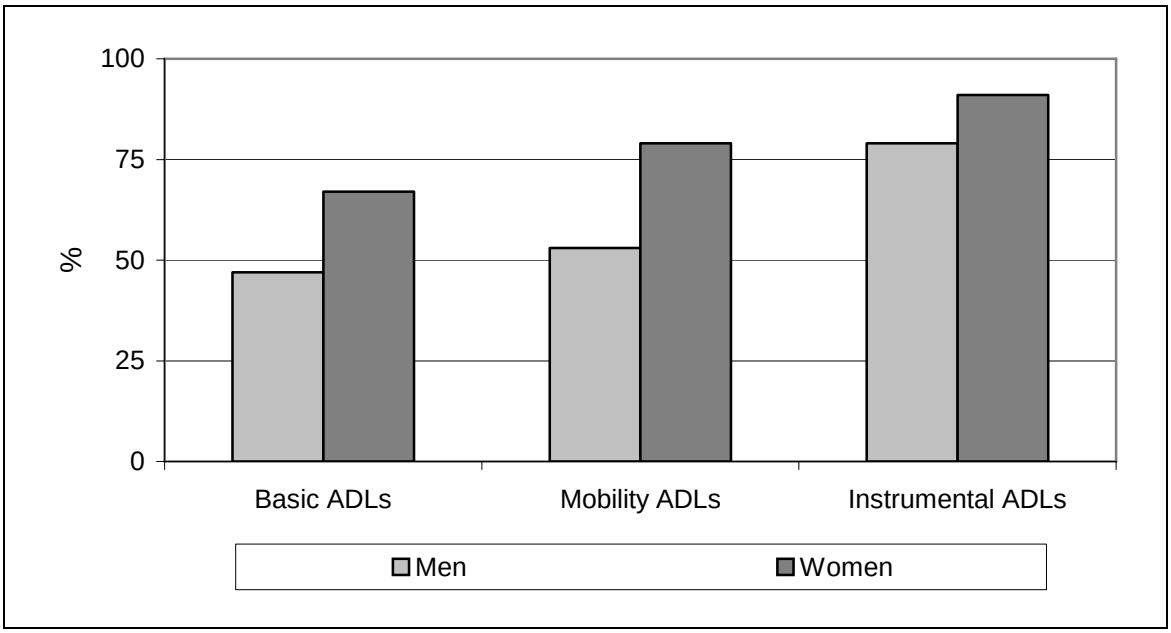


Figure 4.3.7.2 Number of respondents requiring Activities of Daily Living help by number of ADLs for which help was needed

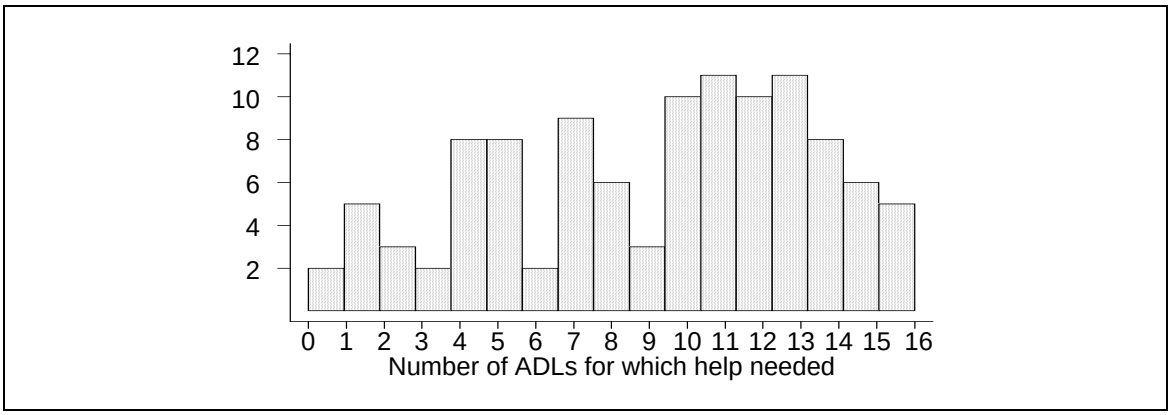


Figure 4.3.7.3 Number of respondents with severe cognitive impairment needing help with Activities of Daily Living by number of ADLs for which help was needed

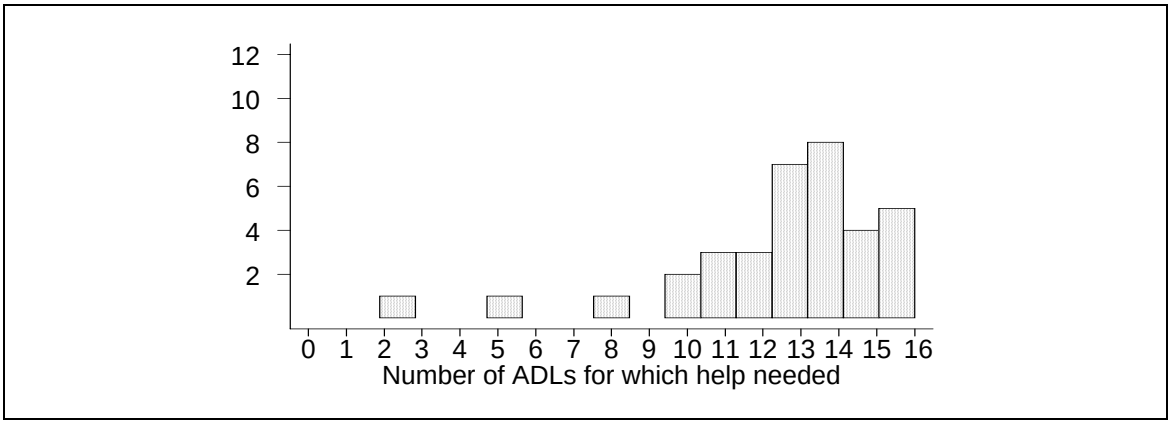


Table 4.3.7.4 Distribution of levels of reported difficulty in activities of daily living

	All [n=110] n (%)
Using telephone	
	52 (47)
Independently	24 (22)
Well-known numbers only	6 (5)
Answers but does not dial	13 (12)
Does not use at all	15 (14)
No phone within easy access	
Shopping	
	16 (15)
Independently	9 (8)
Small purchases only	19 (17)
Needs to be accompanied	66 (60)
Does not shop at all	
Finance / money matters	
Manages financial matters independently	44 (40)
Manages day to day purchases, needs help with banking	15 (14)
Incapable of handling money	51 (46)
Preparing meals	
Prepares all or nearly all meals independently	38 (35)
Prepares snacks only or heats up meals prepared by others	25 (23)
All meals and snacks must be prepared by others	44 (40)
Meals have always been prepared by spouse or others	3 (3)
Housework	
Independent apart from occasional help with heavy work	33 (30)
Performs only light daily tasks, e.g. dish washing, dusting,etc	19 (17)
Performs light daily tasks but cannot maintain acceptable level of cleanliness	5 (5)
All housework must be done by others	51 (46)
Housework has always been done by spouse or others	2 (2)
Transport	
Travels independently on public transport or drives own car or cycles	12 (11)
Arranges own travel via taxi only	21 (19)
Travels on public transport with assistance of others	2 (2)
Travel limited to taxi or with assistance of others only	57 (52)
Does not travel at all	18 (16)
Laundry	
Independent apart from occasional help with heavy work	33 (30)
Lauders only small items, e.g. stockings, underwear	20 (18)
All laundry must be done by others	55 (50)
Laundry has always been done by spouse or others	2 (2)
Use of wheelchair *	
Gets in and out and can propel self without help	2 (2)
Gets in and out without help, can't propel self	14 (13)
Needs help to get in and out, can't propel	22 (20)
Not applicable – does not use wheelchair	72 (65)

* Other mobility items are reported fully in Chapter 5

Continued on next page….

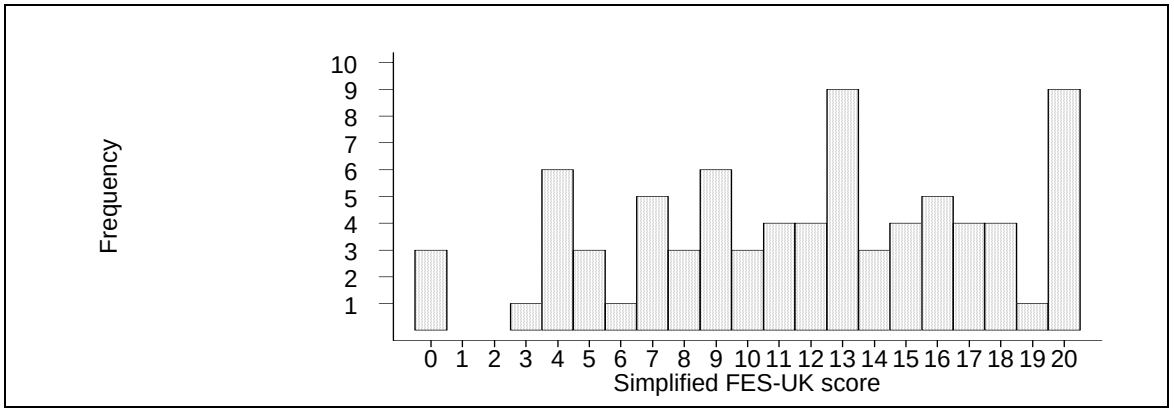
Table 4.3.7.4 continued….
Distribution of levels of reported difficulty in activities of daily living

	All [n=110] n	(%)
Bathing or showering		
Independent in bath, shower or strip-wash	55	(50)
Needs help getting in or out of bath or shower	23	(21)
Can wash face and hands only	6	(5)
Needs major assistance	26	(24)
Grooming		
Attends to grooming independently	28	(25)
Needs minor assistance, e.g. cutting toenails	65	(59)
Needs moderate assistance, e.g. shaving, brushing hair	5	(5)
Needs moderate and regular assistance	3	(3)
Needs grooming care but can remain well-groomed with help	9	(8)
Dressing and undressing		
Dresses and undresses independently	76	(69)
Needs minor assistance, e.g. tying shoelaces, buttons	8	(7)
Needs moderate assistance		
e.g. shoes, socks, arms in sleeves, selecting clothes	13	(12)
Needs major assistance	10	(9)
Unable to dress	3	(3)
Getting to the toilet on time		
Always gets to the toilet on time	56	(52)
Rare (weekly at most) accidents	22	(20)
Accidents more than once a week	17	(16)
No control of bladder or bowels	9	(8)
Not asked / No answer / Don't know	4	(4)
Eating		
Eats without assistance	100	(91)
Eats with some assistance at meal times	5	(5)
Feeds self with moderate assistance and is untidy	3	(3)
Requires extensive assistance for all meals	2	(2)
Taking medicines		
Responsible for taking medicines	64	(58)
Medication must be put out in advance by others	4	(4)
Medication must be administered by others	38	(34)
Takes no medication at present	4	(4)

Falls self-efficacy in activities of daily living

Along with the questions on ADLs participants were also asked 10 questions from the Falls Efficacy Scale (UK version) about how confident the were about managing a range of daily activities without falling (see Chapter 2 *Study Methodology*, section 2.2.1.3). Figure 4.3.7.5 illustrates the distribution of scores derived from these question responses, showing wide dispersion. Tertiles of this score categorised the respondents into three groups with the lowest scores representing those who felt least confident (n=28 FES score 0-49), an intermediate group (n=27 FES score 50-75) and the highest scores representing those most confident (n=23 FES 76-100).

Figure 4.3.7.5 Falls efficacy in activities of daily living: simplified FES-UK scores



Worry about falling

As well as the ten questions on falls efficacy in relation to ADLs, the single question "Are you worried about falling (again)?" [156;737] was put to 78 of the 99 participants interviewed in person after taking a history of recent falls. Nine people said they did not know or could not give a clear response and more than half those asked (43/78 or 55%) said they were not worried about falling.

4.3.8 Contact with health services and other support services

Hospital admissions
Primary care
Social care

Hospital admissions

Reported admissions to hospital portray a minority as relatively frequent users of secondary care, whilst almost half are very infrequent users.

A quarter of the study participants reported being in hospital in the last year, and more than a third (39%) reported hospitalisation at least once in the previous three years. A tenth of the sample reported being admitted at least twice in the last year.

On the other hand a third of the sample said they had not been in hospital for at least five years, including 20% of all participants who reported that it was over 10 years since they had been. Nine per cent said they had never been an in-patient and 8% could not remember how long ago it was they last were.

Primary care

As would be expected, primary care consultations were reported much more commonly: 42% (45/107) had seen a GP in the last month and over two-thirds had within the last year. 56% (45/80) were under the care of a chiropodist, usually being seen every 2 to 3 months. Contact with community nursing services was prevalent, with one in six reporting having seen either a district nurse or practice nurse in the previous week. Of those living at home it was 11%, in sheltered housing 16% and in residential care 29%.

Social care

There was a dichotomous distribution of care in the community. Most of those living at home (48/62, 77% of those living "in a house, flat or granny-flat") had received no input from care assistants in the past week. In sheltered accommodation this proportion was lower (10/19, 53%). Men and women in any community setting reported no contact with care assistants in equal proportions: 74% of men (14/19) and 71% of women (44/62).

But almost all the remaining community-dwellers (20/23 including those in sheltered housing, 87%) who did have help from care assistants received care at least every weekday. There was no difference in the proportion of men and women living in the community who had seen care assistants at least six times in the preceding week. Twenty-six per cent of men (all five of those with care assistants of the 19 not in care) and 24% of women (15/62) had had care assistants visiting at least five times in the week before interview. Five per cent of the women (3/62) had seen a care assistant just once or twice in the previous week. Besides the support of care assistants, 24% (15/62) of those living at home in the community and 47% (9/19) of those in sheltered housing had had some private domestic help in the last week. In some cases a respondent reported that they had had both forms of help at home.

25% (20/81) of those not living in institutional care received either meals on wheels or deliveries of cook-chill meals or both.

Only 6 people living in the community attended a day centre, including 2 who lived in sheltered accommodation. Four more who lived in a residential home that had a day centre attached also attended this centre.

Contact with voluntary agencies was minimal – fewer than one in 15 people had any and no-one living in the care sector had. Voluntary sector involvement was either attendance at an Age Concern lunch club or supply of talking books from a local charity for the blind.

Table 4.3.8.1 provides details of the service use summarised above and Figure 4.3.8.2 illustrates the extent of reported recent use of these services for all those living in any community setting. Table 4.3.8.3 shows the extent to which those living in the community are not in regular contact with any of the services mentioned above, again separated into those living at home and those in sheltered housing. More than half of those not living in care had had no contact in the past week with care assistants, community nursing services, meal deliveries, day centres or voluntary agencies. Almost three-quarters of these (32/44, 72%) had not had any private domestic help in the last week either.

Table 4.3.8.1 Service contact in the past week

	Community [n=62] n (%)	Sheltered [n=19] n (%)	All non-institution [n=81] n (%)	Institution [n=29] n (%)	All [n=110] n (%)
District / practice nurse	7/61 (11)	3 (16)	10/80 (13)	7/24 (29)	17/104 (16)
Care assistant					
- none	48 (77)	10 (53)	58 (72)	0	58 (53)
- once or twice	3 (5)	0	3 (4)	0	3 (3)
- > four times	11 (18)	9 (47)	20 (25)	29 (100)	49 (44)
Meals on wheels / cook chill meals	13 (21)	7 (37)	20/81 (25)	-	-
Day centre	4 (6)	2 (11)	6 (7)	4 (14)	10 (9)
Voluntary agency	4 (6)	3 (16)	7 (9)	0	7 (6)

Figure 4.3.8.2 Service contact in the past week if not living in any care institution

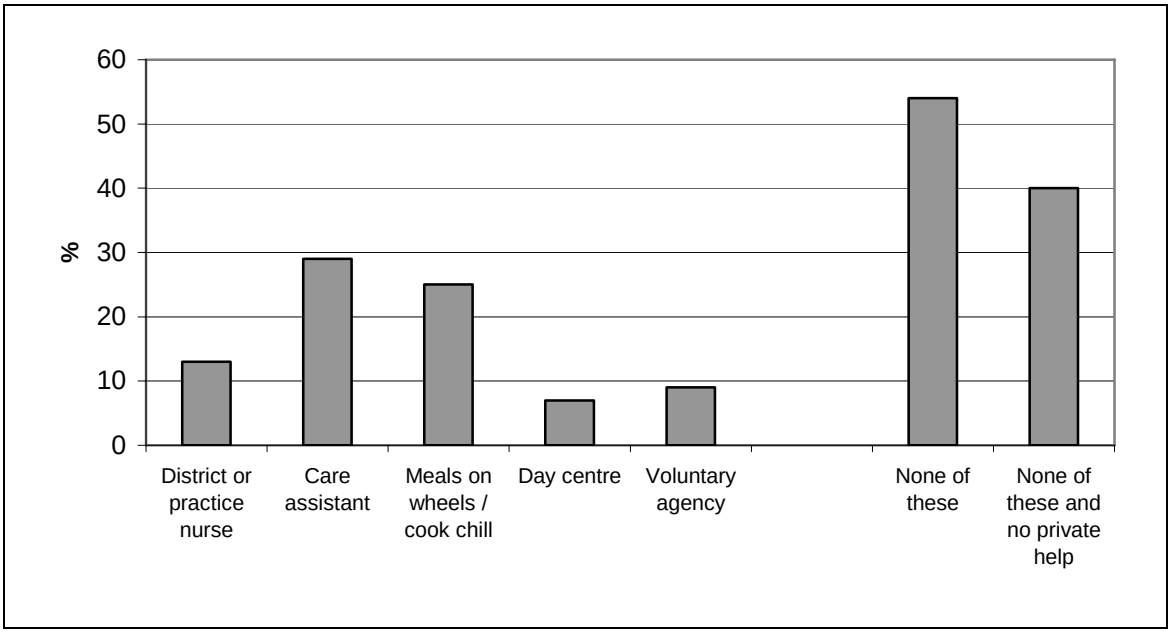


Table 4.3.8.3 No service contact in the past week amongst those not living in care

	Community [n=62] n (%)	Sheltered [n=19] n (%)	All non-institution [n=81] n (%)
No contact in the past week with any…… community nursing, care assistants, meals on wheels/cook chill delivery, day centres or voluntary agencies	38 (62)	6 (32)	44 (54)
No contact in the past week with above nor with any private domestic help	29 (47)	3 (16)	32 (40)

4.4 Discussion and summary

Strengths and limitations
The findings in context
Relevance to study objectives

These results show large proportions of a population of advanced age apparently coping without regular use of the formal care sector. The findings are surprising given the high prevalence measured of self-reported disability, activity restriction, cognitive and sensory impairment, health conditions including previous fractures, and the use of multiple medications including psychotropic drugs. As presented above, the survey also found high levels of social support from the informal care sector – family, friends and neighbours.

Strengths and limitations

The study methodology adds strength to its findings, despite the possible limitations discussed below, ensuring extremely low levels of missing data from a population-based sample with unusually high rates of continued study participation, as Chapter 3 describes.

The findings largely rely on reported data, mainly self-reported but using proxy informant reports for additional information and corroboration in about a third of cases. Only reports of medication were routinely checked against other sources – prescriptions and packaging if available or GP information. One previous validation study found that between a half and four-fifths of older people reported their medications accurately, but that inaccuracies were more common amongst those in poorer health[771] so it was important to avoid this level of unreliable data. It was unrealistic in the study timescale to attempt full examination of medical records, so clearly there may be under- or mis-reporting of diagnoses. Previous researchers have reported good agreement between medical records and middle-aged or older people's reports at interview of well-known chronic diseases and health care utilisation[122;772], but also suggested that agreement declined with age and frequency of health service contacts[122]. However, other researchers have found that the accuracy of self-reported diagnoses was unrelated to age[740], and one study that validated factual information obtained from interview with older people against a range of other sources found a suggestion that older old people reported some information more accurately than younger old people[121]. Non-medical

information also could not always be confirmed: levels of social support for example might be inaccurate due to a variety of factors – memory, reluctance to admit a need or wish for more contact with family or service support.

The findings in context

The characteristics of this study sample need to be viewed in the context of what is known about the over-90-year-old population in general. The 4.5:1 female to male ratio is higher than but close to UK national figures: 23.5% of people aged 90 in 2003 were men, 76.5% women[2]. Chapter 3's discussion of whether such a long-running cohort can still be considered as representative of the general population drew further demographic comparisons from which it can be summarised that this sample reflects the current living situations of the oldest old in marital status and living situation, including the proportions living alone and living in care.

The levels of family support are also broadly in line with other findings nationally and beyond. In the UK half of older people with at least one child alive see them at least once/week[42]; the higher proportion in CC75C (77%) may reflect the higher age-range. A third of these people with family contact at least weekly saw a relative every day, about a quarter of the overall sample. The European SHARE study reported the proportion of over-80-year-old parents who have daily contact with a child is 70% in Italy, Spain and Greece but less than 40% in northern European countries[773]. Other studies of the very old, such as the East London studies[79] and other UK researchers drawing international comparisons[44;45;774], have also found relatives providing a great deal of regular help as well as social contact, and reported extremely low levels of participation in any activities, particularly those outside the home. The extent of loneliness found in the current study (more than half said they were lonely at least sometimes) is comparable or perhaps even higher than reported elsewhere, although different measures and meanings of loneliness[775] complicate comparisons between, for example, being "very"/ "moderately" lonely, "often" / "quite often" / "sometimes" / "at least sometimes" lonely giving estimates ranging from 32 – 66% in different old age ranges in UK, US and European studies[776-779].

The high levels of physical health problems and disability found in the current study are also not unexpected. MRC-CFAS[41] found 85% of men and 93% of women aged 90 or

more reported at least one physical disorder, and very similar levels of restriction across the range of activities of daily living have been reported amongst over-85-year-olds both in the Leiden 85-plus[780] and the East London[79] studies. Swedish studies also report a similar inter-relation of cognitive impairment with ADL and IADL disability[781-783]. Given the increased dependency and residual disability reported amongst hip fracture survivors[341;784], the 20% prevalence of previous hip fractures in the CC75C sample is important – higher than the 13% reported amongst over-85-year-old Americans in the Women's Health and Aging Study[785] but the same as found amongst Swedish men and women in the Umeå 85+ study[95]. There were even higher rates of primary care consultations in East London: four-fifths reported seeing their GP in the past year, compared with two-thirds in the latest CC75C survey. The UK's largest trial of geriatric assessment – the MRC study of the "over-75s screening" – used the identical whispered voice test as the current study and reported that a quarter of those screened failed the test, as compared with almost half in CC75C's over-90-year-olds[786]. Eyesight was assessed with the same criteria in the Swedish Umeå 85+ study as in CC75C. Pooling rates reported for their 90-year-olds and over-95-year-olds gives lower prevalence of visual impairment in this not quite comparable age-group: just over a quarter compared with about a third respectively in the current study[88]. It was anticipated that the 26% prevalence of incontinence taken from the CC75C question about "getting to the toilet on time" might be an under-estimate, but similar rates have been reported from some of the larger studies: 23% of older men and 31% of older women in a UK primary care survey[787] and a quarter of older US women[174]. Levels of poly-pharmacy in the elderly are high nationwide – 38% of over-75-year-olds take at least four medications[109] – but were found to be even higher (55%) amongst the over-90-year-olds in the study.

To put the findings on cognitive function presented in this chapter in context, comparisons with other research studies to date are informative. Slightly higher rates of severe cognitive impairment than the 32% found in CC75C (15% of men and 36% of women) were reported by the largest UK study of dementia, the MRC-Cognitive Function and Ageing Study, in which 18.4% of men and 40.5% of women aged 90 or older scored under 18 in the MMSE[41]. Severe and severe/moderate cognitive impairment were both reported to be markedly less prevalent by another large-scale UK study, the MRC trial of assessment and management of older people in the

community[747]. Taking the equivalent MMSE cut-point to MRC-CFAS and CC75C for severe impairment they found only 13.3% of those aged 90 or more had MMSE scores 0-17 (10.3% of men and 14.2% of women). Their categorisation for severe/moderate impairment (0-23 / 24-30) is the same as "method B" described in this chapter by which 64% of the CC75C sample met this broad definition of cognitive impairment, but they report lower rates of impairment at this level too: 46.5% of all those aged 90 or older (38.3% of men and 49.1% of women). Although missing MMSE data was less than 3% in this study, the effects on these cognitive impairment prevalence estimates of the 72% trial recruitment rate cannot be underestimated.

However, other investigators have also reported levels of cognitive impairment both lower and higher than CC75C rates, although caution is needed in cross-national comparisons, especially with studies using different methods. Lower rates for severe cognitive impairment are reported from the Netherlands – 17% of 85-year-olds participating in the Leiden study (86% response rate) scored 18 or less on the MMSE test (20% of women and 9% of men)[780]. By contrast, the Umeå 85+ study found higher MMSE scores in their sample of the oldest old in Sweden[88]. They report MMSE means (IQRs separately) for the different sub-samples – n=73 aged 90: 25 (20-28) and n=40 aged 95-103: 23 (17-27), both higher than found in CC75C. A recent Japanese study[788]comparing cognitive function in the oldest old with younger old people reported mean MMSE scores of 25.9 for men and 25.0 for women aged 85-100, but these were physically independent community-dwelling older people in a survey which achieved only 68% response rate. In marked contrast, an Italian study of nonagenarians and centenarians, with similar sample size and age range (90-106) to the latest CC75C survey, reported even higher levels of cognitive impairment – the only study found with no gender difference in prevalence: 90% of men and 89% of women had MMSE scores less than 24[81].

The high levels of cognitive impairment found are important. A proxy source who knew the participant's situation well was usually available for those with marked dementia, but this was not always the case for those with lesser degrees of impaired cognition. This may result in under-estimation of the contribution of milder cognitive impairment where information could not be gathered.

The extent of cognitive impairment reported here relies largely on the Mini-Mental State Examination, and supplementary sources were also used so as not to under-represent the extent of impairment amongst those without MMSE assessment, as described above. It is recognised that the categorisation of cognition used in subsequent analyses may be an imperfect approximation. MMSE scores represent a spectrum of cognitive function and any cut-points used to subdivide this continuous data necessarily over-simplify the picture. There is an extensive literature[82;769;789-791] on the interpretation of MMSE scores from which it has been shown that no cut-point gives perfect discrimination of levels of cognitive impairment and the diagnosis of dementia should involve fuller assessment. Nonetheless, the MMSE has been so extensively used that its utility for broad categorisation is accepted, although there is still debate on the ideal score cut-points to use.

Relevance to study objectives

In relation to the main focus of the current study of falls, these findings describing the CC75 Cohort provide a picture of an over-90-year-old population at high levels of risk for falls and fractures from a range of perspectives. Where people live is an important descriptor given the higher incidence of falls in institutional settings[172;242;792] and the suggestion that living alone may increase the risk of falls or serious complications from falls[793]. Cognitive impairment has been reported to be associated with increased risk of fracture[452;456;459;794] in some studies as well as falls[450;451;453;457]. Various visual impairments[463;467;468;475;483] have been linked to increased falls risk but the evidence on hearing loss is less clear[176;476;477] although a link has also been made between conductive hearing loss, osteoporosis and Colles fracture[486]. Many classes of drugs have been investigated for their possible effects on falls, some with conflicting findings, but there is substantial evidence of association of falls with various psychotropics and the suggestion that multiple medications also indicate increased risk[352;540;545;552;561;601]. A history of recent falls constitutes one of the highest risk factors for falling again[147;164;168;170;180;224;354]and the risk of a subsequent fracture approximately doubles after any previous fracture[795]. These risk factors were found to be highly prevalent in the study sample, and for many people multiple factors compounded the risks.

Nonetheless, positive attitudes towards health and life in general perhaps contribute to this generation's calling on support services less than might be expected. More positive

ratings of well-being and general health than might be expected from the high levels of disability have been found by other researchers. For instance, in the Leiden 85+ study[796] 45% reported optimal well-being scores despite only 13% attaining optimal functional scores and in the Danish 1905 Cohort Study[92] 56% of nonagenarians considered their health was excellent or good, despite a relatively high prevalence of disability. In the current CC75C study the two-thirds who rated their health as good or very good was an even higher proportion, but it should be remembered that not all respondents were able to answer this question. Earlier analysis of the CC75C data[723] found a similar trend, with 70% of respondents in the sixth year of follow-up reporting their overall health as good or very good. This was shown to be despite an increase in reported physical symptoms at that stage compared with the previous interview three to four years earlier.

It is beyond the scope of this thesis to fully present the qualitative material that was gathered in the form of verbatim transcriptions of respondents' comments in reply to questions that they could not answer with the response options given. However, additional remarks from study participants concerning independence and autonomy supported quantitative findings presented in this chapter.

The interplay of these many factors is complex and in many cases the support networks that helped to maintain a frail older person in their own home were finely balanced. As previous researchers have identified[155;177;181] and Figure 4.3.6.5 confirms, all too often it is a fall that triggers a cascade of events that unbalanced these structures. This chapter's detailed picture of the study participants is therefore important background information that contributes to a better understanding of subsequent chapters that report the prospective study of falls and their consequences in this very old population.

Summary points

- The survey reveals high prevalence of
  - self-reported disability and activity restriction
  - cognitive and sensory impairment
  - reported history of previous fracture
  - multiple long-term conditions
  - multiple medications including psychotropic drugs
- Nonetheless, levels of formal support were low
  - Only a quarter lived in long-term institutional care
  - Well over half were living in the community, or almost ¾ if those in sheltered housing are included
  - Two-thirds of those living in the community lived alone
- Support from the family network, neighbours and friends was high
- Positive responses predominated for questions rating health and well-being
- Only 1 in 6 people had been prescribed bone-protective medication; only 1 in 4 people who had already sustained fractures over the age of 50 years had been prescribed bone-protective medication

CHAPTER 5

MOBILITY IN THE TENTH DECADE: REPORTED AND OBSERVED MEASURES

5.1 Introduction

5.2 Methods
- 5.2.1 Measures of reported mobility and physical activity
  - 5.2.1.1 Self-report and proxy report
  - 5.2.1.2 Walking, stair-climbing and other physical activity
- 5.2.2 Measures of observed mobility
  - 5.2.2.1 The Simple Physical Performance Battery core protocol
  - 5.2.2.2 Other functional measures in addition to the SPPB

5.3 Levels of mobility and physical activity reported at interview
- 5.3.1 Walking distance
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5.4 Observed measures of mobility – physical function performance tests
- 5.4.1 Static balance tests
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5.5 Associations between reported mobility and observed functional performance
- 5.5.1 Does functional testing reflect reported day-to-day mobility?
- 5.5.2 How do reported mobility levels relate to observed function?

5.6 Discussion and summary

5.1 Introduction

This chapter presents findings that describe levels of mobility, physical activity and function of over-90-year-old men and women in the study sample. The different methods of assessment used are described after an introductory explanation of why the study has examined these factors. Reported measures of mobility gathered from relevant questions in the interview schedule, observed measures of physical function from performance testing and how these two groups of measures relate are presented in sections 5.3, 5.4 and 5.5 respectively, with discussion of all three sets of results at the end of the chapter.

5.2 Methods

5.2.1 Measures of reported functional mobility
5.2.2 Measures of observed functional mobility

Functional mobility in this study sample of the very old can be described with measures taken using two different methods in current survey:

- reported measures: questions already in the standard CC75C interview schedule
- observed measures: physical function performance tests

5.2.1 Measures of reported functional mobility

5.2.1.1 Self-report and proxy report
5.2.1.2 Walking, stair-climbing and other physical activity

5.2.1.1 Self-report and proxy report

The standard CC75C interview schedule has included a number of questions relating to mobility and physical activity. These cannot accurately be described as self-reported measures, as information from proxy informants has been used as well.

5.2.1.2 Walking, stair-climbing and other physical activity

As the overview of the CC75C study methodology explains in Chapter 2, the interview section assessing function in a range of activities of daily living included questions on maximum walking distance and use of walking aids. These two questions relating to mobility were worded "How do you manage with walking?" and "Do you use a walking stick or other aid?" (see Appendix C Interview schedule questions 78h) and 78i) for response options). Two sets of responses were recorded to the latter question to reflect information provided about the different use of walking aids indoors and outdoors, with the latter treated as not applicable if a participant never went out. Chapter 2 also describes the development of physical activity questions in earlier CC75C interviews (section 2.1.2.1) and the addition of a new question about stair climbing for the current study (sections 2.2.1.1).

5.2.2 Measures of observed functional mobility

5.2.2.1 The Simple Physical Performance Battery core protocol
- Standing balance tests
- Gait speed
- Chair stands
- Measurements as continuous data, count scores or dichotomous ratings

5.2.2.2 Other functional measures in addition to the SPPB
- Static balance – Timed unsupported stand
- Dynamic balance – 180° turn, functional reach
- Muscle strength – hand grip dynamometry

Chapter 1 (section 1.2.6) overviews performance measures and Chapter 2.2.1 discusses the criteria determining selection of measurement instruments (see Appendix D *CC75C functional test protocol*) for the current study of over-90-year-olds. Only a summary of the measures used is provided in that section of the chapter on methods, as the details are given below (sections 5.2.2.1 and 5.2.2.2) prior to reporting findings from these objective tests of mobility later in this chapter (sections 5.4 and 5.5).

5.2.2.1 The Simple Physical Performance Battery (SPPB) core protocol

Standing balance tests
Gait speed
Chair stands
Measurements as continuous data, count scores
or dichotomous ratings

The Simple Physical Performance Battery (SPPB) [246;628] (see Appendix E: *SPPB protocol*) was chosen as the core component of this study's protocol because it includes three key elements of function that related to falls risk: standing balance, gait speed and rising from a chair. It has been extensively tested in epidemiological studies of older people (Established Populations for Epidemiologic Studies of the Elderly (EPESE)[246;362;631;632;638], Women's Health and Aging Study[628]), although the numbers of advanced old age were generally limited in these studies. This thoroughly validated measurement battery has provided detailed reports of test administration time, acceptability reliability and sensitivity to change[628;629], consistency across studies with different populations[638] and has been shown to relate to a number of outcomes relevant to our study of the consequences of falls – self-reported disability[246], incident disability[362] and declining function[631], hospitalisation[632], admission to nursing homes[246] and mortality[246]. It has not been examined directly in relation to falls risk, so its use in the current study provides new data.

The study setting and the advanced age of the current study sample, compared with most of the older populations in which SPPB has been used before, affected decisions made on the administration of each of the three elements of the SPPB protocol:

Standing balance tests

Static balance is assessed in the SPPB by demonstrating three progressively more difficult standing positions (feet side by side, in semi-tandem and heel-to-toe tandem) and timing how long participants can successfully hold each position, scoring a point for over 10 seconds in the first two tests and one or two points for over 3 seconds or over 10 seconds in the tandem test. As even the simplest stance could be challenging for some frailer participants, it was decided to use the Timed Unsupported Stand (TUSS – see below) in effect as a screening test before deciding whether it was safe to move on to the SPPB stand tests.

Gait speed

The SPPB gait speed test had been validated using different distances - both 3m and 2.4 m options are available. As the current study ideally needed to be manageable within the limited space of a typical front room, the shorter "8 foot walk" version was chosen. Participants are instructed to start walking from a starting line (feet positioned to toes just touching the line) and to walk all the way past the 8 foot mark before stopping. In the CC75C study coloured tape on the floor was used for a starting line and to mark out the distance at which stop-watch timing ended, with participants asked to "walk all the way across the room/down the hall" and to "take no notice of the other piece of tape". Two timed walks are recorded, the second following the same procedure coming back.

Chair stands

The SPPB chair stand test measures the time participants take to stand up from a chair and sit down five times without using their arms. The protocol requires that a single un-timed chair stand is attempted first but this is not part of the SPPB scoring system. In the CC75C study, as many of the participants would be unable to attempt the repeated chair rising, success or failure in this single chair stand itself was to be a useful measure, one that has been widely used on its own as an indicator of lower limb muscle strength and reported to be associated with falls risk[164;168;169;270;273;301;477;597].

Measurements as continuous data, count scores or dichotomous ratings

The SPPB scoring system for the two timed measures – gait speed and the time to complete five chair rises – is based on rating an individual's performance against extensive data on older-population-wide levels of performance, assigning a score of up to 4 points according to quantile cut-points in the population data. As all the CC75C sample are from one extreme of the age distribution this scoring approach would be expected to assign the majority of the sample the same lowest quartile scores. Although the SPPB score system is thus not applicable to the CC75C study, the SPPB measures themselves were expected to provide useful new data on a population of advanced age and the continuous measures can be summarised into categories by other methods. The cut-point chosen to dichotomise the gait speed measurements was 0.6m/sec, the level below which the Study of Osteoporotic Fractures reported an increased risk of recurrent falls[168]. As it was anticipated that many respondents would not be able to complete five

chair rises, this measure was to be dichotomised in the same way as the single chair rise assessment, simply to identify those who could and could not complete the test.

Standing up from a chair is a complex manoeuvre that involves both dynamic balance and lower limb muscle strength. As it was anticipated that a high proportion of the study population would be unable to manage the chair stand test, it was decided to add additional measures to the core SPPB protocol both of dynamic balance and of muscle strength (as well as the extra static balance test already mentioned).

5.2.2.2 Other functional measures in addition to the SPPB core protocol

Static balance – Timed Unsupported Stand
Dynamic balance – 180° turn, functional reach
Muscle strength – hand grip dynamometry

Static balance – Timed Unsupported Stand

The TUSS[619] is widely used in clinical practice as an initial assessment tool, for example in specialist falls clinics, developed from items within the more extensive Rivermead Mobility Index[797], Performance Oriented Assessment of Mobility (or Tinetti balance scale)[622] and the Berg Balance Scale[626]. The participant is shown how to stand with feet positioned parallel to each other and hip width apart and the assessor explains that she will time how long the participant can stand without support in this position when he/she is ready to let go. In the CC75C study participants stood behind a chair for safety, holding onto the chair-back for support while getting into position, and were told they could reach for it for support as soon as they felt they needed it. The stop-watch was started from the moment they let go of the chair and stopped after 60 seconds if the participant had not already needed support. It was planned to follow the approach used in the SPPB stand tests to score this test as a dichotomous measure: able to stand 60 seconds or not, thus avoiding difficulties with analysing data skewed by the possible ceiling effect of the time limit.

Dynamic balance – 180° turn

The first of the two additional measures of dynamic balance included in the CC75C survey was the 180˚ turn[117;643]. This is another common clinical assessment that it is often feasible to record even when a participant is unable to stand up without assistance

as the test begins with the participant already standing. The number of steps taken to turn around a full 180˚ are counted; repeatability and inter-observer agreement are both reported as high, with no more than one step discrepancy in step count[117]. Amongst older people attending a day centre, the number of steps taken was found to be significantly higher for those who had fallen in the previous year than those who had not[117]. The test also has predictive validity: taking five or more steps to complete the 180˚ turn was associated with a two-fold increase in risk of multiple falls amongst community-dwelling elderly people who had fallen previously[168]. Although the test asks participants to perform the turn with hands by their sides, instructions include "if you really must you can hold onto [the chair/table/frame]" and for frailer participants these are positioned within reach. The number of times the participant touches any support is also recorded. It was anticipated that a high proportion of CC75C participants could not complete the turn without support so the second score (number of times support was needed) was only to be useful as a dichotomised measured: able to turn 180˚ without support or not.

Dynamic balance – functional reach

The functional reach test [363]is another assessment commonly used in clinical practice because of its reported association with falls risk[641]. Standing beside a wall, but not leaning against it, the participant raises their right arm until horizontal at shoulder level and is asked to "reach as far forward as you can without losing your balance or taking a step". The distance between the position of the third metacarpal when standing normally and when reaching forward is recorded from a tape measure attached horizontally to the wall at shoulder height. The best of three attempts is taken as the functional reach measurement.

The seminal study that reported increased falls risk associated with decreased functional reach was performed in elderly American men[641]. In that population the odds ratios for suffering 2 or more falls in the following 6 months was 2-fold, 4-fold and 8-fold amongst though who reached between 6 and 10 inches, who were unable to reach more than 6 inches, and who were unable to reach at all compared with those who reached over 10 inches. As functional reach data on the very old is scarce, and the relevance of these cut-points to this age-group unknown, it was planned both to record the exact measures and categorise the data using the previously reported cut-points.

Muscle strength – hand grip dynamometry

Many measures of muscle strength or power were not considered because of their unsuitability for this study sample. Direct measures of lower limb muscle were deemed impossible because of the need for laboratory measures using complex, expensive, non-portable equipment. At the opposite end of the test spectrum, problems were also anticipated with a frail elderly group in using any of the simple methods that involve an element of subjectivity on the part of the assessor. Routinely used clinical musculo-skeletal assessments or dynamometers that attempt to quantify such approaches, for example measuring leg extensor force applied against resistance, can be subject to serious variability dependent on the resistance offered by the assessor.

A reliable validated alternative was to use handgrip as an overall muscle strength indicator. It has been shown to relate well not only to the strength of other muscle groups but also to the risk of falling, recurrent falling[168], fall injuries[270], and many other aspects of ageing that are closely related – disability[377], functional decline[644], admission to care[648].

Hand grip strength was measured in the CC75C survey using the digital Takei Grip Strength Dynamometer (Takei Kiki Kogyo 5401, Tokyo, Japan). This model has an adjustable stirrup for comfortable use and was proffered in different settings to men and women, then adjusted to each individual's hand size so that grip was attempted from comparable positions. Measurements were recorded in this study with participants seated, holding the dynamometer level on their knee or otherwise supported such that the elbow was at a right angle at their side. Readings are displayed in kilogram force to one decimal point within a recordable range of 5 to 100 kg. Results present the best score of three attempts for each hand and analyses use the mean of both hands, unless only one measurement was possible.

5.3 Levels of mobility and physical activity reported at interview

5.3.1 Walking distance
5.3.2 Use of walking aids
5.3.3 Stair climbing
5.3.4 Reported physical activities

Data sources and completeness of data

Data presented in this section are findings from questions in the standard CC75C interview schedule (see earlier in this chapter: section 5.2.1 *Methods*) asked again of the nonagenarian participants in the recent survey.

As detailed in Chapter 3, section 3.2, there were 11 study participants for whom only proxy data could be collected, but an additional 24 interviews were conducted with relatives or closely involved carers of 24 of the 99 other respondents. Interview data on mobility and physical activity was self-report by the study participants themselves in 80% of cases in these analyses as it was necessary to use proxy informant reports for only 18 out of the 90 who had functional performance testing. In practice there was virtually no discrepancy on these interview items between information from study participants themselves and proxy informants where both sets of data were available. Data on physical activity could be obtained from neither participant nor proxy in only one case.

5.3.1 Walking distance

With the question "How do you manage with walking?" the interviewer offers a range of responses and the participant says which options matches the distance s/he is able to walk. Figure 5.3.1.1 portrays the gender differences found in these reported maximum walking distances.

The responses can be viewed from two perspectives. The breakdown of the sample in Table 5.3.1.2 shows how mobile they were reported to be, while Table 5.3.1.3 presents the extent of reported mobility disability. Three-quarters of the participants reported they could no longer walk around their local area, and a third could not walk outdoors. Extreme disability affected men and women in similar proportions with about ten percent able to walk no more than a few steps, half of them unable to walk at all. The proportion of men able to walk around their neighbourhood was double that of women (40% of men, 20% of women), while the proportions of women able to walk only as far as the gate (26%) and only indoors (23%) was well over double the 10% of men reporting these levels of walking limitation. It appears that, apart from the most severely affected minority, men reported less disability in walking than women although the sample is too small to test this formally.

Figure 5.3.1.1 Proportions of men and women able to walk different distances

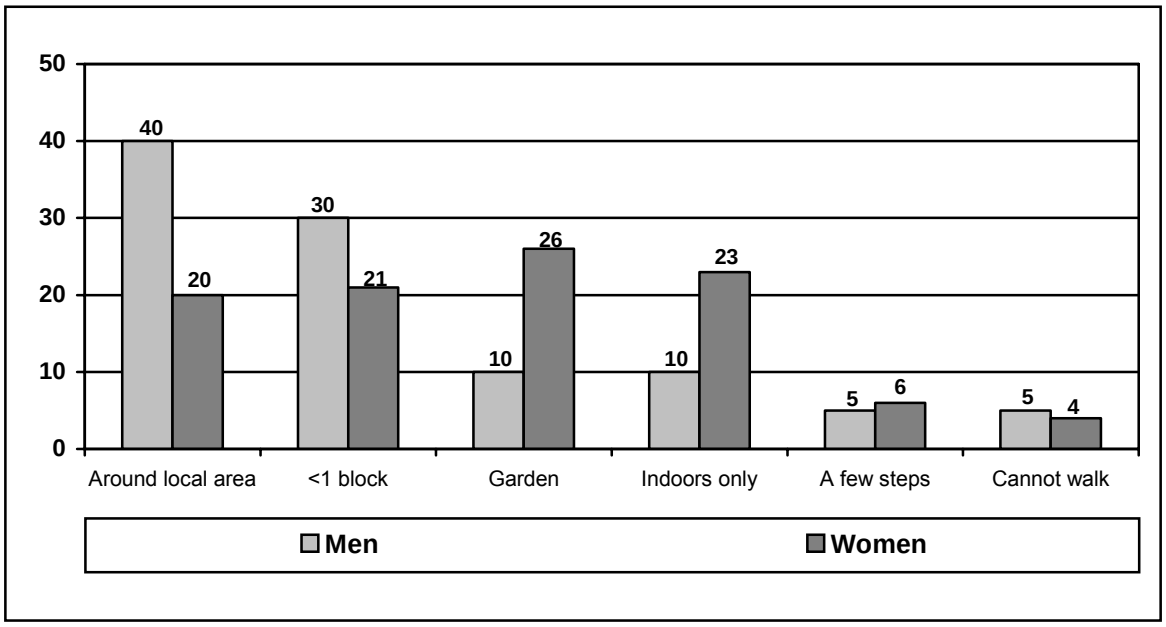


Table 5.3.1.2 Reported measures of mobility
- reported ability to walk different distances

	Men [n=20]		Women [n=90]		All [n=110]	
	n	(%)	n	(%)	n	(%)
Able to walk round town, suburb or village	8	(40)	18	(20)	26	(24)
Able to walk down the street	6	(30)	19	(21)	25	(23)
Able to walk outdoors only to garden gate	2	(10)	23	(26)	25	(23)
Able to walk indoors only	2	(10)	21	(23)	23	(21)
Able to walk only a few steps	1	(5)	5	(6)	6	(5)
Chair-bound or bedridden	1	(5)	4	(4)	5	(5)

Table 5.3.1.3 Reported measures of mobility disability
- reported inability to walk different distances

	Men [n=20]		Women [n=90]		All [n=110]	
	n	(%)	n	(%)	n	(%)
Unable to walk round town, suburb or village	12	(60)	72	(80)	84	(76)
Unable to walk down the street	6	(30)	53	(59)	59	(54)
Unable to walk outdoors at all	4	(20)	30	(33)	34	(31)
Unable to walk indoors more than a few steps	2	(10)	9	(10)	11	(10)
Unable to walk even a few steps i.e. chairbound / bedridden	1	(5)	4	(4)	5	(5)

5.3.2 Use of walking aids

Outdoors
Indoors

Tables 5.3.2.1-2 present data gathered from the interview question "Do you use a walking stick or other aid?", showing findings separately for use outdoors and indoors.

Outdoors

Only a minority of study participants walked outdoors without any aid: 12% of the sample overall. However, this was significantly more frequently reported amongst men than women (30% and 8% respectively, p=0.01). Almost half managed to get out using walking aids (28% with walking sticks, 14% with a frame), a few did not use walking aids but would only walk outdoors taking someone else's arm for support, 3 out of 10 needed a wheelchair to go out, and 1 in 10 never went out any more.

Indoors

The reported need for support to walk was much less indoors than outdoors. Only a handful (5%) depended on a wheelchair to get about indoors, and about three times as many people said they needed no aid at all (35% indoors, 12% outdoors). The levels of walking stick use were identical but the 25% who reported using walking sticks outdoors were not the same people as the 25% using them indoors, the latter often using frames or wheelchairs when they went out. Gender differences in the use of walking aids were less indoors, reflecting the pattern noted above of minimal differences in more severe walking disability.

5.3.3 Stair climbing

The interview question "How many times do you climb up a flight of stairs (approximately 10 steps) each day?" offered four response choices. However, as only one respondent selected the highest category (climbing a flight of stairs more than ten times a day), this result is grouped with the 10% who reported climbing 6 to 10 flights a day in a combined "over 5 times/day" category. As Table 5.3.3.1 shows, about ¾ of the women said they climbed stairs less often than once/day, a category that included those who never climbed stairs or who were unable to do so. The equivalent figure for the study sample as a whole was almost 2/3, but 60% of the men reported climbing a flight of stairs at least daily. Figure 5.3.2-3 illustrates this and walking aid use.

Table 5.3.2.1 Reported measures of mobility
- use of walking aids or other assistance with mobility outdoors

	Men [n=20]		Women [n=90]		All [n=110]	
	n	(%)	n	(%)	n	(%)
No walking aid to walk outdoors	6	(30)	7	(8)	13	(12)
Walking stick(s) outdoors	8	(40)	23	(26)	31	(28)
Walking frame outdoors	1	(5)	14	(16)	15	(14)
Wheelchair outdoors	2	(10)	30	(33)	32	(29)
Assistance of another person needed	0	(0)	8	(9)	8	(7)
Does not go outdoors at all	3	(15)	8	(9)	11	(10)

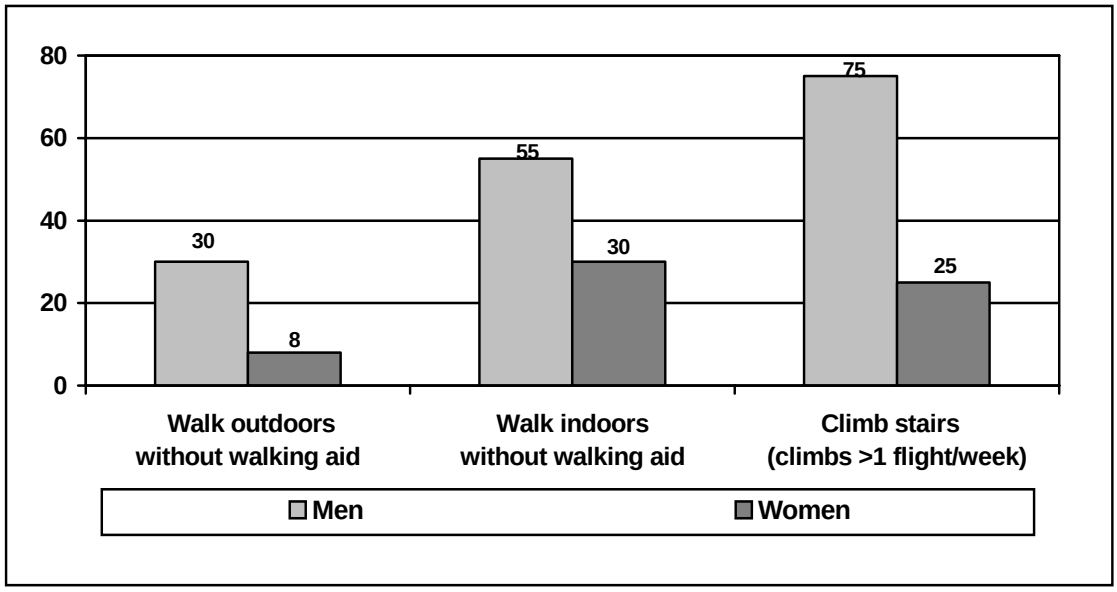
Table 5.3.2.2 Reported measures of mobility
- use of walking aids or other assistance with mobility indoors

	Men [n=20]		Women [n=90]		All [n=110]	
	n	(%)	n	(%)	n	(%)
No walking aid to walk indoors	11	(55)	27	(30)	38	(35)
Walking stick(s) indoors	7	(35)	20	(22)	27	(25)
Walking frame indoors	0	(0)	36	(40)	36	(33)
Wheelchair indoors	0	(0)	5	(6)	5	(5)
Assistance of another person needed	1	(5)	2	(2)	3	(3)
Bedridden	1	(5)	0		1	(1)

Table 5.3.3.1 Reported measures of mobility - stair climbing

	Men [n=20]		Women [n=90]		All [n=110]	
	n	(%)	n	(%)	n	(%)
Climbs a flight of stairs < once/day or cannot	5	(25)	67	(75)	72	(65)
Climbs a flight of stairs 1 – 5 times/day	12	(60)	14	(16)	26	(24)
Climbs a flight of stairs > 5 times/day	3	(15)	9	(10)	12	(11)

Figure 5.3.2.3 Proportions of men and women able to walk without aids and up stairs



5.3.4 Reported physical activity

Half the options given with the question "Do you manage any physical activity or exercise?" evinced very few positive responses (see Table 5.3.4.1). About one in five said they managed either gardening or other forms of physical activity, which was generally doing some exercises on their own, sometimes "from the physiotherapist" or "exercises that I've always done". The next most frequently reported activity was walking – for exercise rather than of necessity – but only 15% described themselves in this way. Fewer than half the participants described themselves as taking any form of physical activity or exercise.

Table 5.3.4.1 Reported measures of mobility
"Do manage to do any physical activity or exercise?"

	Men [n=19]		Women [n=90]		All [n=109]	
	n	(%)	n	(%)	n	(%)
Keep fit	1	(5)	2	(2)	3	(3)
Walking	5	(26)	11	(12)	16	(15)
Gardening	9	(47)	15	(17)	24	(22)
DIY	5	(26)	0		5	(5)
Cycling	1	(5)	0		1	(1)
Other	4	(21)	20	(22)	24	(22)
Any physical activity or exercise	11	(58)	36	(40)	47	(43)

Excluding n=1 man not asked these questions

5.4 Observed measures of mobility – physical function performance tests

5.4.1 Static balance tests
5.4.2 Chair stand tests
5.4.3 Dynamic balance tests
5.4.4 Gait speed
5.4.5 Muscle strength
5.4.6 Overview of physical function performance tests

Of the 99 participants who were interviewed in person n=90 (17 men, 73 women) agreed to functional performance testing, a 91% uptake rate of this optional element of the survey. This was 82% of the full survey sample, including the 11 participants for whom it was only possible to collect proxy informant interview data. In most cases these measurements were made during a second visit as it was felt that the main interview was long enough on its own, but a few who were not already tired by the interview preferred to "get it all done". This also had to be arranged in advance with four participants who had moved to other parts of the country.

Not everyone attempted every test as the protocol was structured such that failure to complete certain tests would lead to skipping some of the subsequent more challenging tests, but this meant that at least a minimum assessment of functional capacity in each domain could be made. Table 5.4.0 below shows reasons why 20 individuals had no functional testing. Then each of the following sections presents findings for different domains of physical function showing both the results of measurements taken and the reasons why measurements were not successfully taken, with the final section summarizing the levels of functional limitation found across all assessments in the physical function performance testing protocol.

Table 5.4.0 Reasons why n=20 participants had no functional performance testing

	Men [n=3]	Women [n=17]	All [n=20]
Died between interview and appointment for 2nd assessment visit	1	1	2
Participant refused	1	6	7
Relative refused permission for 2nd assessment visit	1	0	1
Proxy informant interview only – advised inappropriate	0	9	9
Participant lived too far away – telephone interview only	0	1	1
Total	3	17	20

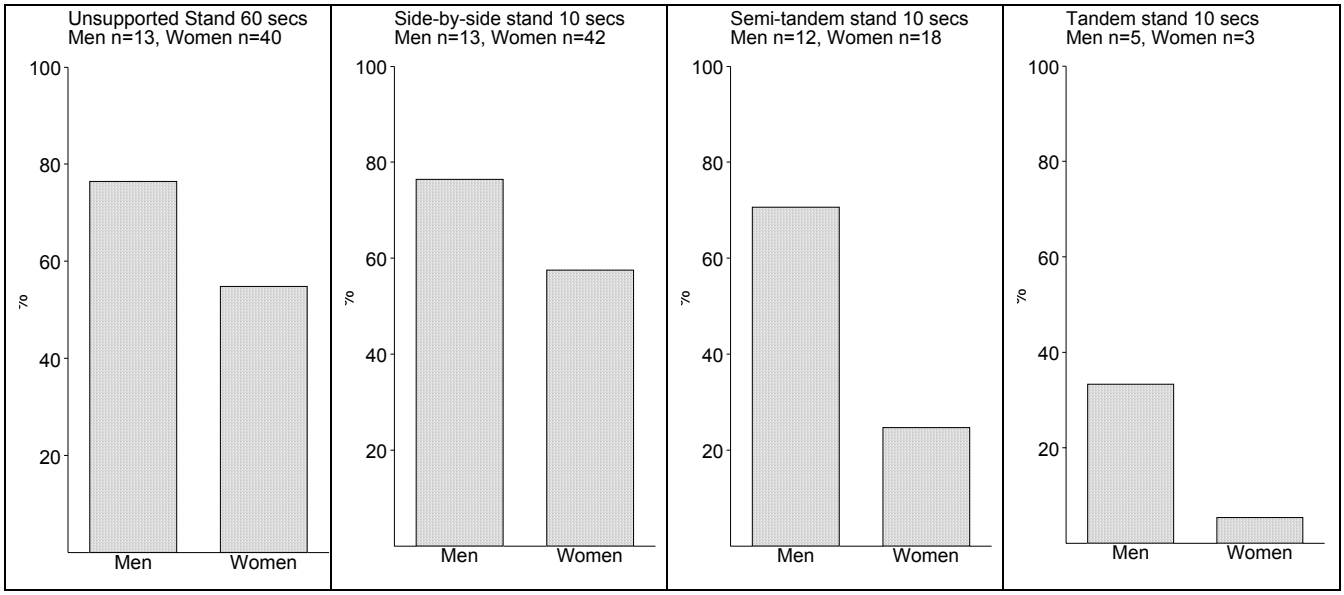
5.4.1 Static balance tests

Timed Unsupported Stand
Side-by-Side Stand
Semi-Tandem Stand
Tandem Stand

Static balance was assessed with a series of progressively more difficult standing positions. Figure 5.4.1.1 shows how the proportions able to complete each test drop with the more challenging stances, although there is no difference in levels of performance of the first and second tests. The first graph shows the proportions of men and women assessed who could manage an unsupported stand with feet apart for a full minute, which proved to be no easier than holding the less stable side-by-side stance for the shorter period of 10 seconds: overall 59% and 61% successfully held the maximum time in these first two tests respectively. Exactly a third of the full sample who had functional assessments completed the semi-tandem stand test and only 9% could hold 10 seconds with their feet in the heel-to-toe tandem position.

Figure 5.4.1.1 also shows clearly how in this sample standing balance was better in men than in women at all levels of difficulty. There was a ceiling effect on the continuous measures of time held in the easier positions in which the majority succeeded in maintaining balance for the maximum test time. The TUSS is timed up to a minute and the last three (SPPB) tests were run up to a maximum of 30 seconds. The gender differences in length of time each position was held (see Tables 5.4.1.2-5) only reached statistical significance with the semi-tandem stand ($p=0.01$, Mann-Whitney rank sum). However, using the SPPB scoring system showed that significantly higher proportions of men than of women could hold the more challenging stances up to the number of seconds needed for the score cut-points: 10 seconds in semi-tandem ($p=0.001$, Fisher's Exact test), 3 seconds or 10 seconds in tandem ($p=0.005$ for both, Fisher's Exact test).

Figure 5.4.1.1 Static balance – proportions of men and women able to complete each test*



*TUSS n=71(14m+57w) Side-by-side n=65(13m+52w) Semi-tandem n=51(13m+38w) Tandem n=22(9m+13w) attempted the above four stand tests. Each figure shows numbers who completed each test above the plots of the proportions of men and women who completed out of the total who had the functional testing.

Table 5.4.1.2 Static balance tests – Timed Unsupported Stand: n=71 measured *

	Significance of gender difference Mann-Whitney	Men [n=14]	Women [n=57]	All [n=71]
TUSS static stand – feet apart (secs)	p=0.08			
- median		60	60	60
- IQR		60 – 60	42.4 – 60	54.1 – 60
- range		23.5 – 60	0.5 – 60	0.5 – 60

* excluding 3 men and 16 women who did not do this test.

Table 5.4.1.3 Static balance tests – Side-by-Side Stand: n=65 measured *

	Significance of gender difference Mann-Whitney	Men [n=13]	Women [n=52]	All [n=65]
SPPB static stand – feet side-by-side (secs)	p=0.08			
- median		30	30	30
- IQR		30 – 30	14.7 – 30	21.2 – 30
- range		25.4 – 30	1.2 - 30	1.2 – 30

* excluding 4 men and 21 women who did not do this test.

Table 5.4.1.4 Static balance tests – Semi-Tandem Stand: n=51 measured *

	Significance of gender difference Mann-Whitney	Men [n=13]	Women [n=38]	All [n=51]
SPPB static stand – feet semi-tandem (secs)	p=0.01			
- median		30	8.3	13.4
- IQR		12.8 – 30	3.9 – 30	5.6 – 30
- range		8.6 – 30	1.7 – 30	1.7 – 30

* excluding 4 men and 35 women who did not do this test.

Table 5.4.1.5 Static balance tests – Tandem Stand: n=22 measured *

	Significance of gender difference Mann-Whitney	Men [n=9]	Women [n=13]	All [n=22]
SPPB static stand – feet in tandem (sec.s)	p=0.07			
- median		15	4.7	6.9
- IQR		4.2 – 30	3.2 – 9.6	3.2 – 15
- range		2.3 – 30	0.8 – 28.9	0.8 – 30

* excluding 8 men and 60 women who did not do this test.

Tables 5.4.1.6-9 detail the reasons why some participants did not provide data in the preceding tables. The numbers precluded from proceeding to the next test increased with the increasing failure rate of the test before.

Table 5.4.1.6 Static balance tests - TUSS: reasons why n=19 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	2	11	13
Participant thought unsafe to attempt	1	4	5
Participant unable to understand instructions	0	1	1
Total	3	16	19

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

Table 5.4.1.7 Static balance tests - Side-by-Side Stand: reasons why n=25 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	2	16	18
Participant thought unsafe to attempt	2	3	5
Participant unable to understand instructions	0	1	1
Tried but unable	0	1	1
Total	4	21	25

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

Table 5.4.1.8 Static balance tests - Semi-Tandem Stand: reasons why n=39 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	3	29	32
Participant thought unsafe to attempt	1	3	4
Participant unable to understand instructions	0	2	2
Tried but unable	0	1	1
Total	4	35	39

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

Table 5.4.1.9 Static balance tests - Tandem Stand: reasons why n=68 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	5	53	58
Participant thought unsafe to attempt	3	5	8
Participant unable to understand instructions	0	2	2
Total	8	60	68

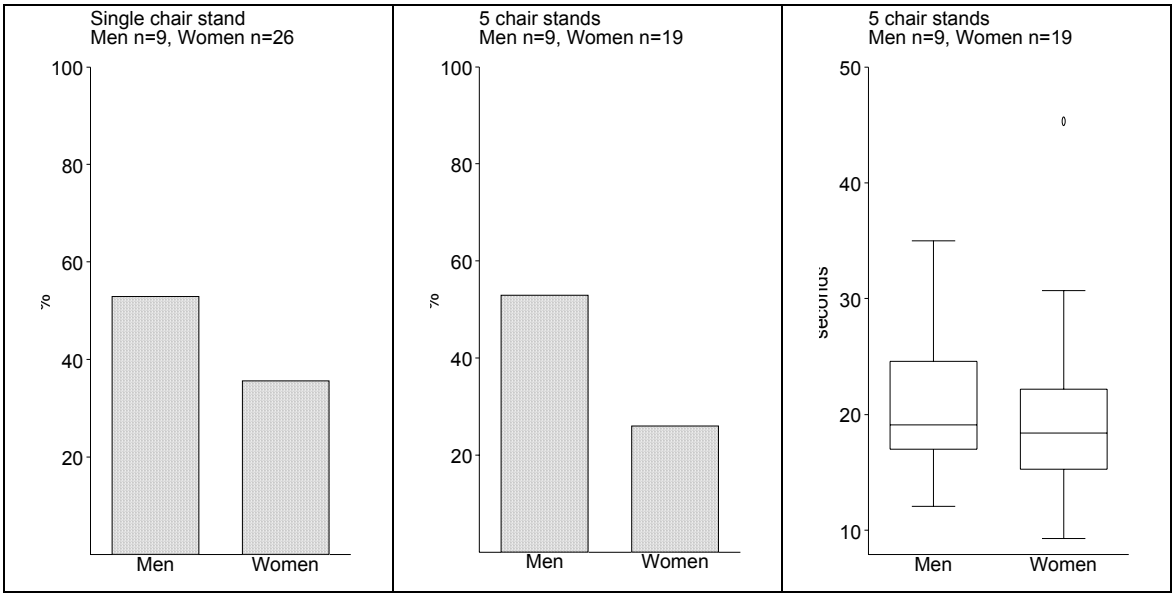
* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

5.4.2 Chair stand tests

Single chair stand
Five repeated chair stands

Just over half the men and just over a third of the women (39% overall of those assessed) were able to stand up from a chair without using their arms to help themselves up (Table 5.4.2.2). Approximately three-quarters of both men and women who actually attempted this measurement could manage a chair rise (Table 5.4.2.3). As Figure 5.4.2.1 shows, all the men who did the single chair stand then went on to do five repeated rises, but fewer women could complete five chair stands (21%) than could do the single chair stand (36%). Of those who did manage the repeated chair rising, there was no difference in the time taken to complete the five stands (Table 5.4.2.4). Reasons for non-completion of the single and repeated chair stand tests are shown in the first and last tables of this section (Tables 5.4.2.2 and 5.4.2.5).

Figure 5.4.2.1 Chair stands – % able to rise from a chair without arms once * or 5 times † – time taken to stand up from a chair and sit down 5 times



* Single chair stand: n=48 † 5 chair stands: n=28

Table 5.4.2.2 Single chair stands: n=90 assessed *

	Men [n=17]	Women [n=73]	All [n=90] *
Able to stand up from a chair without using arms	9 (53)	26 (36)	35 (39)
Unable to stand up from a chair without using arms	8 (47)	47 (64)	55 (61)
Single chair stand test not attempted because…	5 (29)	37 (51)	42 (47)
Interviewer thought unsafe to attempt	4	28	32
Participant thought unsafe to attempt	1	8	9
Participant unable to understand instructions	0	1	1
Single chair stand test attempted but unable….	3 (18)	10 (14)	13 (14)
Able to stand up only by using arms to help	1	3	4
Tried but unable to stand up from a chair at all	2	7	9

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

Table 5.4.2.3 Single chair stands: n=48 who attempted the chair stand test *

	Men [n=12]	Women [n=36]	All [n=48] *
Able to stand up from a chair without using arms	9 (75)	26 (72)	35 (73)
Single chair stand test attempted but unable….	3 (25)	10 (28)	13 (27)
Able to stand up only by using arms to help	1 (8)	3 (8)	4 (8)
Tried but unable to stand up from chair at all	2 (17)	7 (19)	9 (19)

* excluding 5 men and 37 women who did not do this test

Table 5.4.2.4 Five repeated chair stands without using arms: n=28 measured *

	Significance of gender difference Mann-Whitney	Men [n=9]	Women [n=19]	All [n=28]
Time to perform 5 chair stands (sec.s)	p=0.5			
- median		19.1	18.4	18.7
- IQR		17.0 – 24.6	15.3 – 22.2	15.6 – 23.4
- range		12.1 – 35.0	9.3 – 45.3	9.3 – 45.3

* excluding 8 men and 54 women who did not do this test

Table 5.4.2.5 Five repeated chair stands: n=90 assessed *

	Men [n=17]	Women [n=73]	All [n=90] *
Able to stand up from a chair 5 times without using arms	9 (53)	19 (26)	28 (31)
Unable to stand up from a chair 5 times without using arms	8 (47)	54 (74)	62 (69)
Repeated chair stands test not attempted because…	8 (47)	52 (71)	60 (67)
Interviewer thought unsafe to attempt	8	46	54
Participant thought unsafe to attempt	0	4	4
Participant unable to understand instructions	0	2	2
Repeated chair stands attempted but completed only 2 chair stands	0 (0)	2 (3)	2 (2)

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

5.4.3 Dynamic balance tests

180° turn
Functional reach

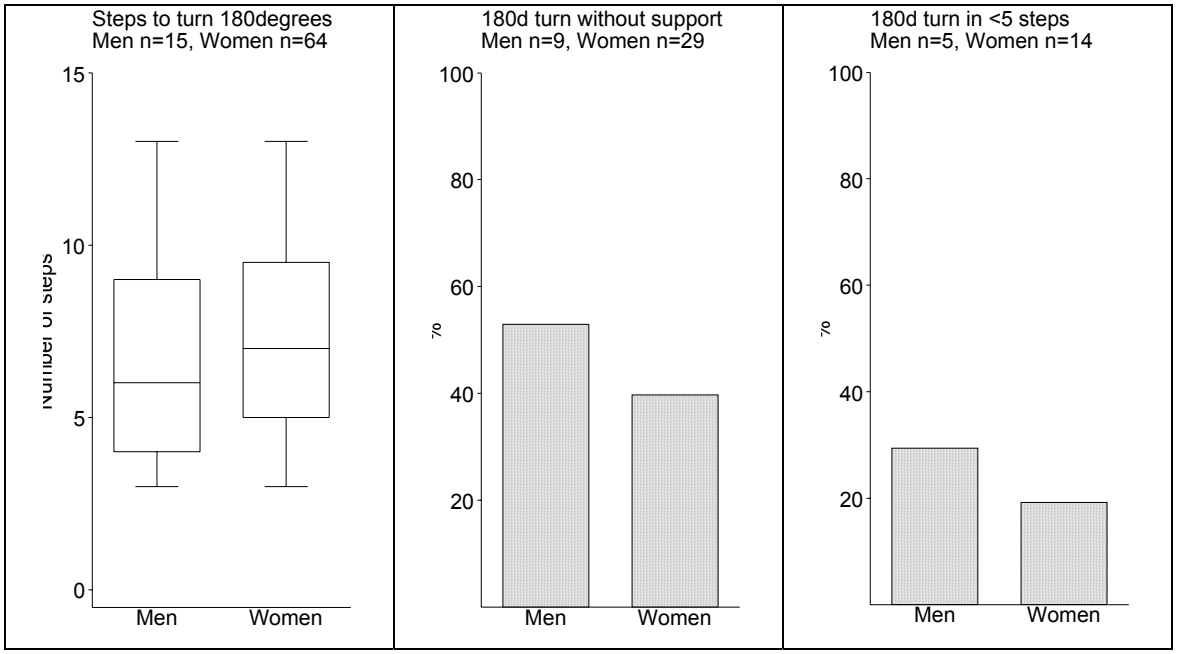
Dynamic balance plays a part in the ability to rise up from a chair (see previous section 5.4.3) but lower limb muscle strength also affects performance. Two other measures were therefore used to assess dynamic balance – the 180° turn and the functional reach test – both assessed from when already standing, so these assessments could be attempted even by those who would need to use their arms to stand up.

180° turn

Almost all the participants assessed for functional mobility were able to attempt the 180° turn (89%), though well under half (42%) managed to complete the turn without needing to reach for the support of furniture, their frame or the project nurse standing by. As Figure 5.4.3.1 and Table 5.4.3.2 show, the number of steps taken to turn the full 180° ranged from 3 to 13, with no gender difference in the medians (6 steps for men, 7 steps for women). The most common reason for this test not being attempted (see Table 5.4.3.3) was the respondent's inability to walk without support.

Although this was one of the tests most readily attempted, only a fifth of those assessed could complete the 180° turn taking fewer than five steps. Taking five steps or more is the level identified in previous research (see Chapter 1, section 1.2.5.2) as indicating increased falls risk[168]. There was little gender difference in the proportions who took more steps than this cut-point: 71% of men and 81% of women.

Figure 5.4.3.1 Dynamic balance tests – 180° turn: n=79 measured *



* excluding 2 men and 9 women who did not do this test.

Table 5.4.3.2 Dynamic balance tests – 180° turn: n=79 measured *

	Significance of gender difference Mann-Whitney	Men [n=15]	Women [n=64]	All [n=79]
Number of steps to turn 180°	p=0.2			
- median		6	7	7
- IQR		4 – 9	5 – 9.5	5 – 9
- range		3 – 13	3 – 13	3 – 13

* excluding 2 men and 9 women who did not do this test.

Table 5.4.3.3 Dynamic balance tests – 180° turn: reasons why n=11 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	2	7	9
Participant thought unsafe to attempt	0	1	1
Participant unable to understand instructions	0	1	1
Total	2	9	11

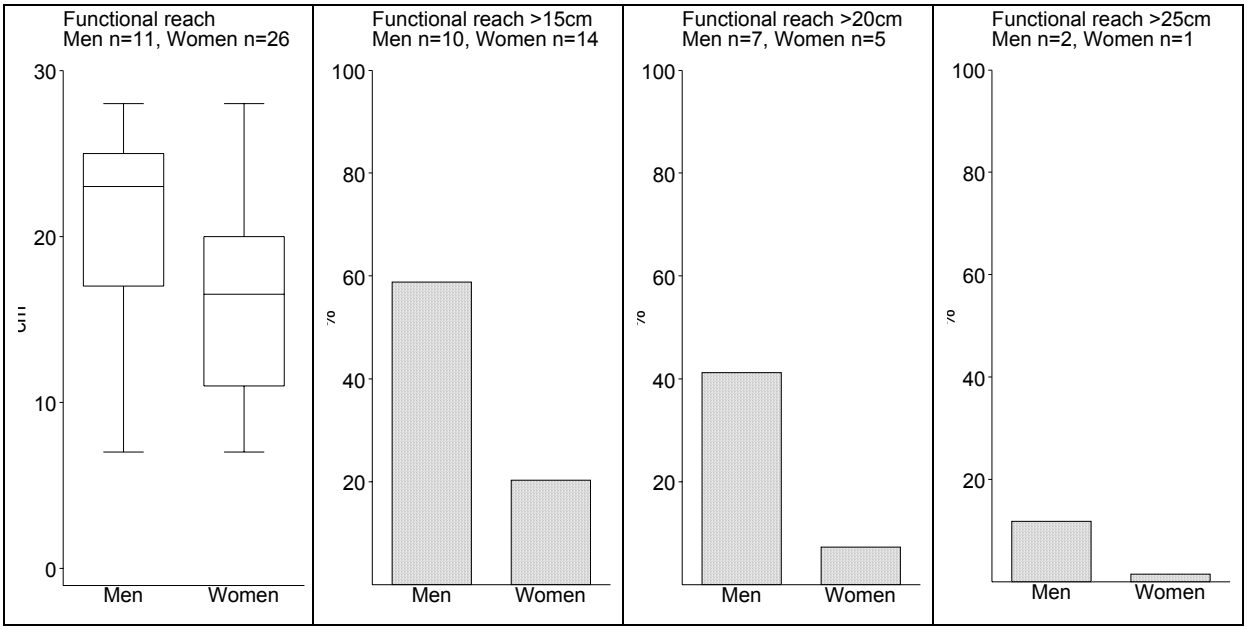
* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

Functional reach

Fewer than half of those who attempted the 180° turn did the functional reach test. The protocol specified that anyone who could not hold the side-by-side stance for 30 seconds should not be offered the functional reach assessment, so in all almost two-thirds of the women and just over a third of the men who could be assessed for this test were deemed physically or cognitively incapable of attempting it (see Table 5.4.3.7).

More men retained their balance for a further reach than women, whether comparisons are made on the actual distance reached or using different cut-points as shown in Figure 5.4.3.4. There was a significant gender difference in the median functional reach, taking the best of three measurements (p=0.01 Mann-Whitney – see Table 5.4.3.5) and a highly significant trend in the proportions unable to perform the test and reaching different distances (p=0.003 Score test for trend – see Table 5.4.3.6).

Figure 5.4.3.4 Dynamic balance tests – functional reach: n=37 measured *



* excluding 6 men and 47 women who did not do this test.

Table 5.4.3.5 Dynamic balance tests – functional reach: n=37 measured *

	Significance of gender difference Mann-Whitney	Men [n=11]	Women [n=26]	All [n=37]
Maximum (cm) of 3 measurements	p=0.01			
- median		23	16.5	17
- IQR		17 – 25	11 – 20	12 – 23
- range		7 – 28	7 – 28	7 – 28

* excluding 6 men and 47 women who did not do this test.

Table 5.4.3.6 Dynamic balance tests – functional reach: n=86 assessed *

	Men [n=17]		Women [n=69]		All [n=86] *	
Unable to attempt functional reach test	6	(36)	43	(62)	49	(57)
Functional reach < 15 cm / < 6 inches	1	(6)	12	(17)	13	(15)
Functional reach 15 – 25 cm / 6 – 10 inches	8	(47)	13	(19)	21	(24)
Functional reach > 25 cm / > 10 inches	2	(12)	1	(1)	3	(3)

* excluding 4 women who could not be assessed due to lack of available clear wall space
p=0.003 (Score test for trend)

Table 5.4.3.7 Dynamic balance tests – functional reach: reasons why n=53 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	3	33	36
Participant thought unsafe to attempt	3	4	7
Participant unable to understand instructions	0	6	6
Other: no clear wall space available	0	4	4
Total	6	47	53

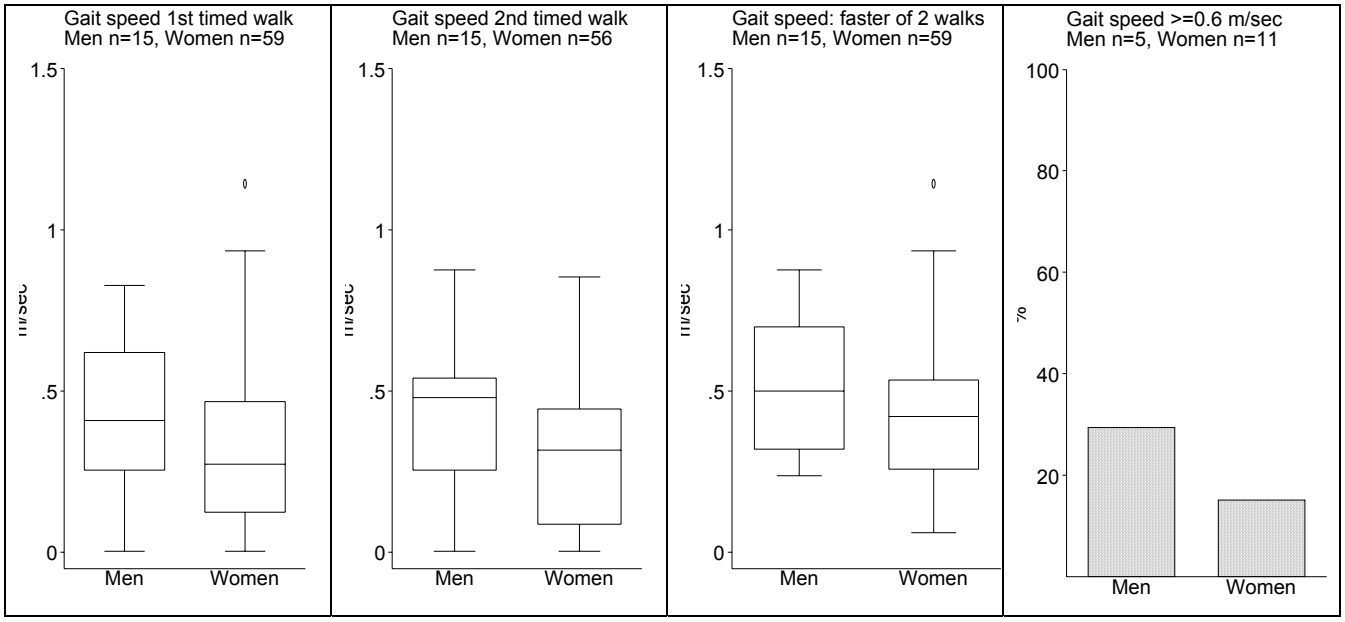
* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

5.4.4 Gait speed

Timed 8 foot walk

Participants were timed walking 8 foot/2.4m twice and subsequent analyses use whichever was the faster of the two for each participant. There was no significant difference between times taken on the first and second walk, and wide variability in gait speeds recorded. As Figure 5.4.4.1 and Table 5.4.4.2 show, median gait speed was non-significantly higher in men (p=0.1 Mann-Whitney), and the proportion of men who walked 0.6m/sec or faster was almost double that of women. This previously reported cut-point for increased falls risk categorised 71% of men and 85% of women in this sample as at risk of recurrent falls, a non-significant gender difference (p=0.2 Fisher's exact test). The 2 men and 14 women whose gait speed could not be measured (see reasons in Table 5.4.4.3) are counted as slower walkers in the calculation of these proportions.

Figure 5.4.4.1 Gait speed – timed 8 foot walk: n=74 measured *



* excluding 2 men and 16 women who did not do this test.

Table 5.4.4.2 Gait speed – timed 8 foot walk: n=74 measured *

	Significance of gender difference Mann-Whitney	Men [n=15]	Women [n=59]	All [n=74]
Gait speed (m/sec) from faster walk	p=0.1			
- median		0.50	0.42	0.42
- IQR		0.32 – 0.70	0.26 – 0.53	0.28 – 0.56
- range		0.24 – 0.88	0.06 – 1.14	0.06 – 1.14

* excluding 2 men and 16 women who did not do this test.

Table 5.4.4.3 Gait speed – timed 8 foot walk: reasons why n=16 not measured

	Men [n=17]	Women [n=73]	All [n=90] *
Interviewer thought unsafe to attempt	2	10	12
Participant thought unsafe to attempt	0	3	3
Participant unable to understand instructions	0	1	1
Total	2	14	16

* Of 90 who attempted other tests: excluding 17 women and 3 men with no functional performance tests

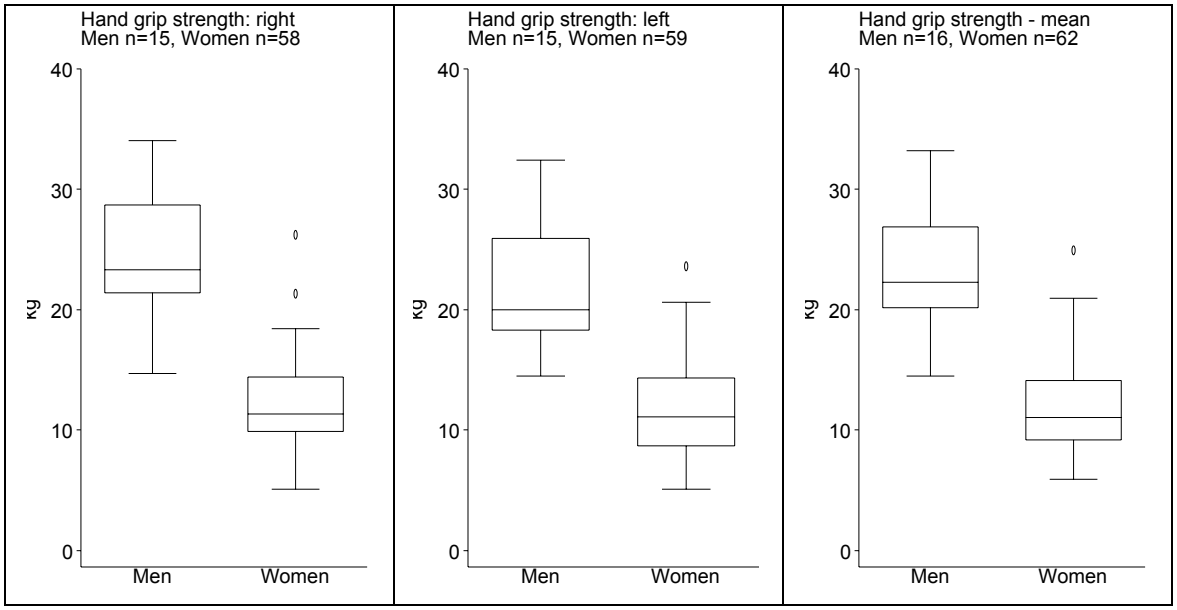
5.4.5 Muscle strength

Hand grip strength

Participants gave three hand-grip dynamometer readings from each hand unless their first attempt caused any pain or discomfort, in which case the test was stopped and only that single reading could be used. Table 5.4.5.3 details why numbers measured on each hand differ. There were no significant differences overall between right hand and left hand tests (the 1st and 2nd diagrams in Figure 5.4.5.1 shows the maximum of three readings on each hand), nor between dominant and non-dominant hands. The mean of the maximum readings from each hand (illustrated in the 3rd diagram in Figure 5.4.5.1) was used for between gender comparisons and in subsequent analyses.

Hand grip strength measurements showed wide variation, ranging from 33.2 kg force down to un-measurable readings below the minimum 5 kg below which the dynamometer could not register any force applied. All of the five participants whose grip was too weak to be recorded were women. The women's grip strength measures were within a markedly lower range and gender differences were highly significant ($p<0.001$ Mann-Whitney – see Table 5.4.5.2).

Figure 5.4.5.1 Hand grip strength – left, right and mean of both hands: n=78 measured *



* Hand grip strength: n=78 of the 90 who consented to physical function performance tests provided grip strength data from at least 1 hand, excluding 11 women and 1 men who could not use the dynamometer

Table 5.4.5.2 Hand grip strength – mean of left and right hands: n=78 measured *

	Significance of gender difference Mann-Whitney	Men [n=16]	Women [n=62]	All [n=78]
Grip strength (kg): mean of max left and max right hand	p<0.001			
- median		22.3	11.5	12.4
- IQR		20.2 – 26.9	9.2 – 14.1	10.2 – 16.4
- range		14.5 – 33.2	5.9 – 24.9	5.9 – 33.2

* Hand grip strength: n=78 of the 90 who consented to physical function performance tests provided grip strength data from at least 1 hand, excluding 11 women and 1 men who could not use the dynamometer

Table 5.4.5.3 Hand grip strength: reasons why measurements not made *

	Men [n=17]	Women [n=73]	All [n=90]
Interviewer thought unsafe to attempt (severe hand arthritis, shingles nerve pain, arm fracture)			
- right hand	1	6	7
- left hand	1	5	6
- both hands	0	1	1
Participant unable to understand instructions			
- right hand	1	5	6
- left hand	1	5	6
- both hands	1	5	6
Attempted but unable to register any reading			
- right hand	0	4	4
- left hand	0	4	4
- both hands	0	5	5
Total - both hands	1	11	12

* n=17 right hand measurements and n=16 left hand measurements could not be made, n=12 missing both

5.4.6 Overview of physical function performance tests

The functional performance test protocol of assessments carried out with 90 of the study's participants showed that in these men and women aged over 90-years-old the prevalence of mobility limitation was very high (see Figure 5.4.6.1 and Table 5.4.6.1). The initial assessment measure was too challenging for many of them: 41% were unable to stand unsupported for one minute. When gait speed measurements were dichotomised at the 0.6 m/sec cut-point identified in the Study of Osteoporotic Fractures as indicating increased risk of recurrent falls, 84% could not walk at that speed. 61% could not rise from a chair without using their arms, confirming findings both from the muscle strength testing of hand-grip and of other dynamic balance measures. Maintaining balance whilst moving appeared to pose the greatest difficulty: only 12% were able to turn round without support and more than half were unable to attempt reaching forward without support. Men were more mobile than women on most measures but only significantly so in semi-tandem stance ($p=0.01$) and functional reach ($p=0.01$), and their hand-grip strength was markedly stronger ($p<0.001$).

Figure 5.4.6.1 Proportions of men and women unable to perform each functional test

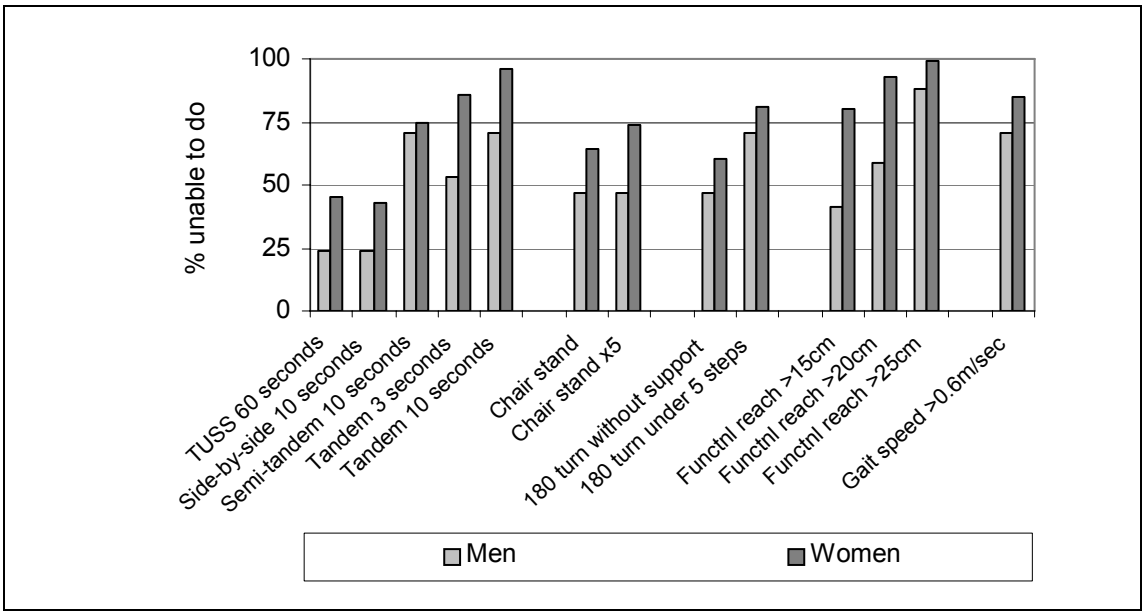


Table 5.4.6.1 Prevalence of limited functional mobility – all physical function performance measures dichotomised: n=90 assessed

	Men [n=17] n	(%)	Women [n=73] n	(%)	All [n=90] n	(%)
STATIC BALANCE						
TUSS timed unsupported stand						
Unable to stand 60 secs unsupported feet apart	4	(24)	33	(45)	37	(41)
SPPB static stands						
Unable to stand 10 secs with feet side-by-side	4	(24)	31	(43)	35	(39)
Unable to stand 10 secs with feet semi-tandem	12	(71)	55	(75)	60	(67)
Unable to stand 3 secs with feet in tandem	9	(53)	63	(86)	72	(80)
Unable to stand 10 secs with feet in tandem	12	(71)	70	(96)	82	(91)
DYNAMIC BALANCE						
Chair standing						
Unable to rise from a chair without arms	8	(47)	47	(64)	55	(61)
Unable to perform 5 chair rises without arms	8	(47)	54	(74)	62	(69)
180° turn						
Unable to attempt 180° turn without support	2	(12)	9	(12)	11	(12)
Attempted but unable to complete without support	6	(35)	35	(48)	41	(46)
Unable to do 180° turn (not tried + needed support)	8	(47)	44	(60)	52	(58)
Unable to turn 180° in fewer than 5 steps	12	(71)	59	(81)	71	(79)
Functional reach test						
Unable to perform functional reach test *	6	(35)	43	(62)	49	(57)
Unable to reach more than 15cm (< 6 inches)	7	(41)	55	(80)	62	(72)
Unable to reach more than 20cm (< 8 inches)	10	(59)	64	(93)	74	(86)
Unable to reach more than 25cm (> 10 inches)	15	(88)	68	(99)	83	(97)
GAIT SPEED						
8 foot timed walk						
Gait speed < 0.6 m/sec or unable to walk	12	(71)	62	(85)	74	(82)
MUSCLE STRENGTH						
Hand grip strength						
Unable to attempt hand grip dynamometry	1	(16)	6	(8)	7	(8)
Unable to grip dynamometer enough to record test †	0/16		5/67	(7)	5/83	(6)
Grip strength below sample mean or (13.3 kg)	0/16		47/67	(70)	47/83	(57)
Chair standing (see under Dynamic Balance above)						

Denominators shown when this is not the full n = 90 who consented to functional assessments:
* Functional reach: n = 86,excluding 4 women who did not attempt the test due to lack of clear wall space
† Hand grip strength: n = 83, excluding 1 man and 6 women unable to attempt hand grip dynamometry

5.5 Associations between reported mobility and observed functional performance

5.5.1 Does functional testing reflect reported day-to-day mobility?
Static balance tests
Dynamic balance tests
Gait speed
Grip strength
5.5.2 How do reported mobility levels relate to observed function?
Walking distance
Use of walking aids
Stair climbing
Other reported physical activities

This section examines the associations between levels of mobility reported at interview and the observed measures of functional performance. These can be considered from two viewpoints – whether the functional test results reflect day-to-day mobility levels, and whether self-report or proxy-report of mobility levels is reliable in terms of observed function. Findings are therefore also presented in two ways.

Firstly the relationship of different observed measures to reported measures are graphed in sections reflecting the groups of functional tests, as described in Section 5.4 of this chapter (static balance, dynamic balance, gait speed and grip strength). Then the odds ratios for being able to perform each functional test associated with reported mobility levels are tabulated in the same grouping of measures as Section 5.3 followed to describe reported mobility. The last table summarises all these associations and the key findings identified are discussed further in the following Section 5.6

5.5.1 Does functional testing reflect reported day-to-day mobility?

Static balance tests
Dynamic balance tests
Gait speed
Grip strength

The proportions of those who achieved different levels in the functional assessments are plotted in Figures 5.5.1.1-4, split by their reported mobility levels given in answer to the three interview questions relating to walking ability and four other physical activity questions. Denominators for each sub-group are reported in earlier sections of this chapter.

The figures that follow in this section show graphically the trends of association between all the functional test results and all but the last of the reported measures.

Static balance tests

The increasing challenges to stability posed by the progressively harder SPPB standing tests, following on from the Timed Unsupported Stand (TUSS), are clearly reflected in Figure 5.5.1.1's graphs. There is obvious construct validity in the ceiling effect seen in the measures of reported walking limitation: very few of the most disabled attempted even the simplest stance.

Interestingly, the protocol used the feet apart TUSS as a pre-test before the first SPPB side-by-side stand, but it proved as hard or harder to maintain the easier TUSS position for a whole minute than the side-by-side stance for just 10 seconds. It is worth noting that the TUSS results cannot be interpreted as part of one spectrum with the SPPB tests, since other factors besides balance, such as endurance, come into play with the longer stand, although its use with this age group is nonetheless advisable for reasons of safety.

All the stand tests were achieved by a higher proportion of people who reportedly climbed stairs at least once a day, though the differences between them and those who could not or did not use stairs regularly was less for the more difficult tandem stand. The standing balance tests also distinguished between those who reported they managed some physical activity in the form of walking for exercise and gardening and those who did not. However, none of these tests showed any relation to reporting "other" forms of physical activity.

Figure 5.5.1.1 Static balance tests in relation to reported walking ability

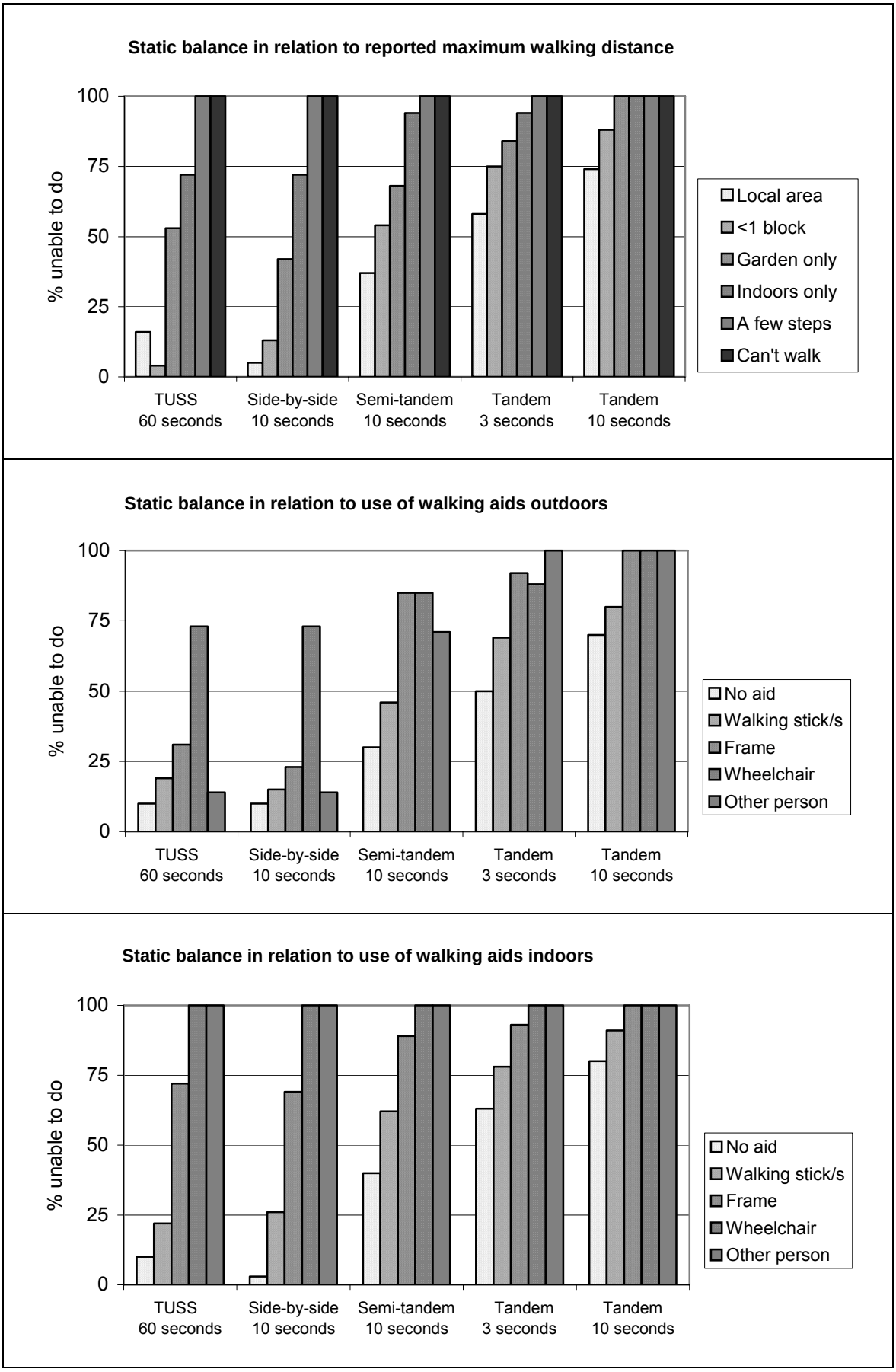
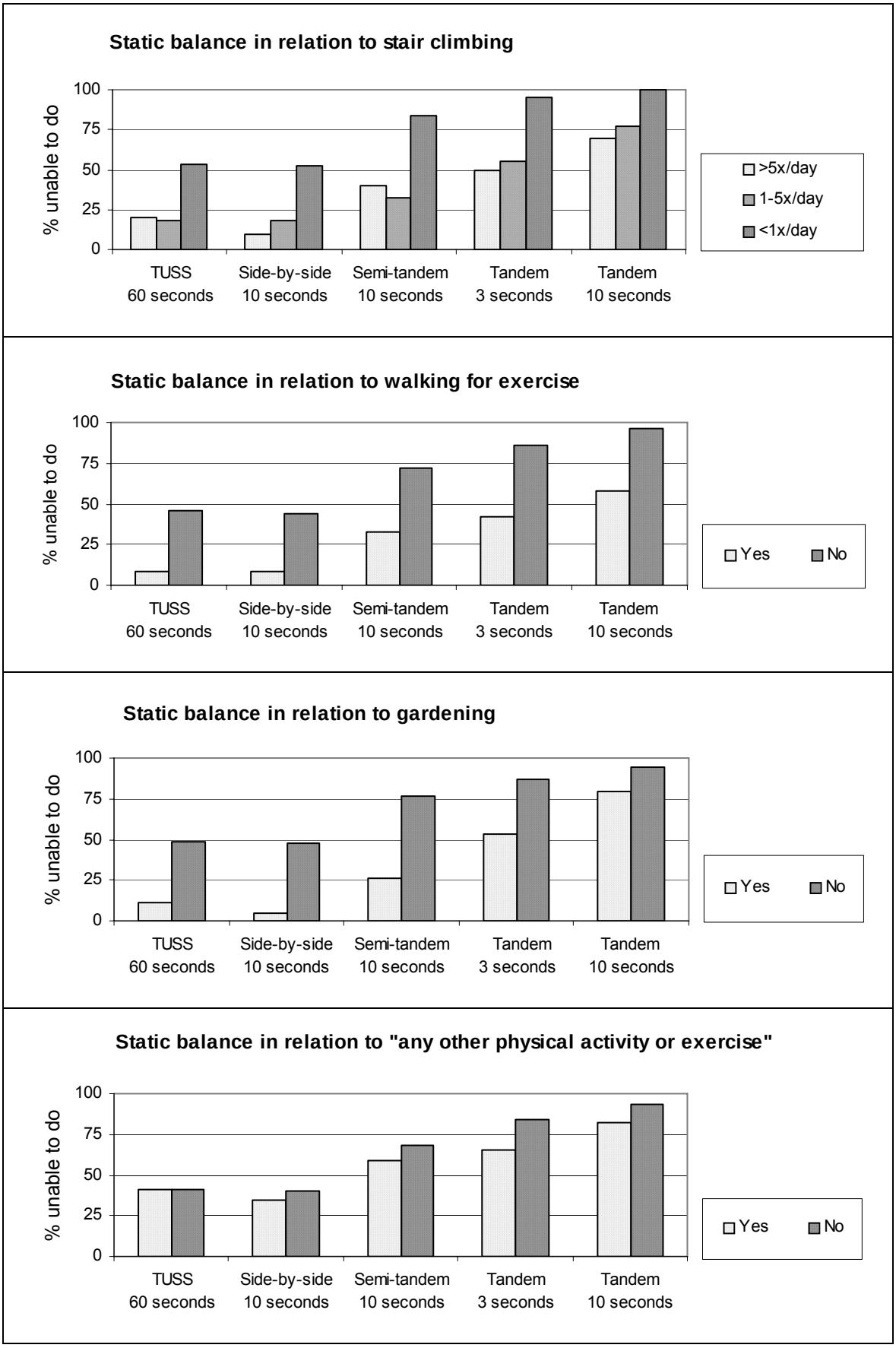


Figure 5.5.1.1 cont. Static balance by reported stair climbing and other physical activity



Dynamic balance tests

Reported mobility levels were also reflected in the results from progressively harder targets of each dynamic balance test – multiple rather than single chair rises, turning 180° with minimal steps rather than just without holding on, and stretching further in the functional reach test (see Figure 5.5.1.2).

Again, with only a small minority able to manage the harder tests, their usefulness in distinguishing between categories of reported mobility was less than the easier tests. However, both the single chair stand and 5 repeated stands showed a marked trend across categories of walking (excluding those who cannot or can barely walk) and frequency of climbing stairs, and in the physical activity questions distinguished walkers and gardeners.

The chair rise and 180° turn tests confirm the picture implied by the less demanding standing tests that those who report they do not walk outdoors without help from somebody else achieve functional mobility scores comparable to or better than users of walking sticks or frames. Reportedly needing someone else's help to walk outdoors can reflect a variety of factors, such as confidence or cognitive impairment, and may not necessarily imply worse balance, dynamic or static.

Figure 5.5.1.2 Dynamic balance tests in relation to reported walking ability

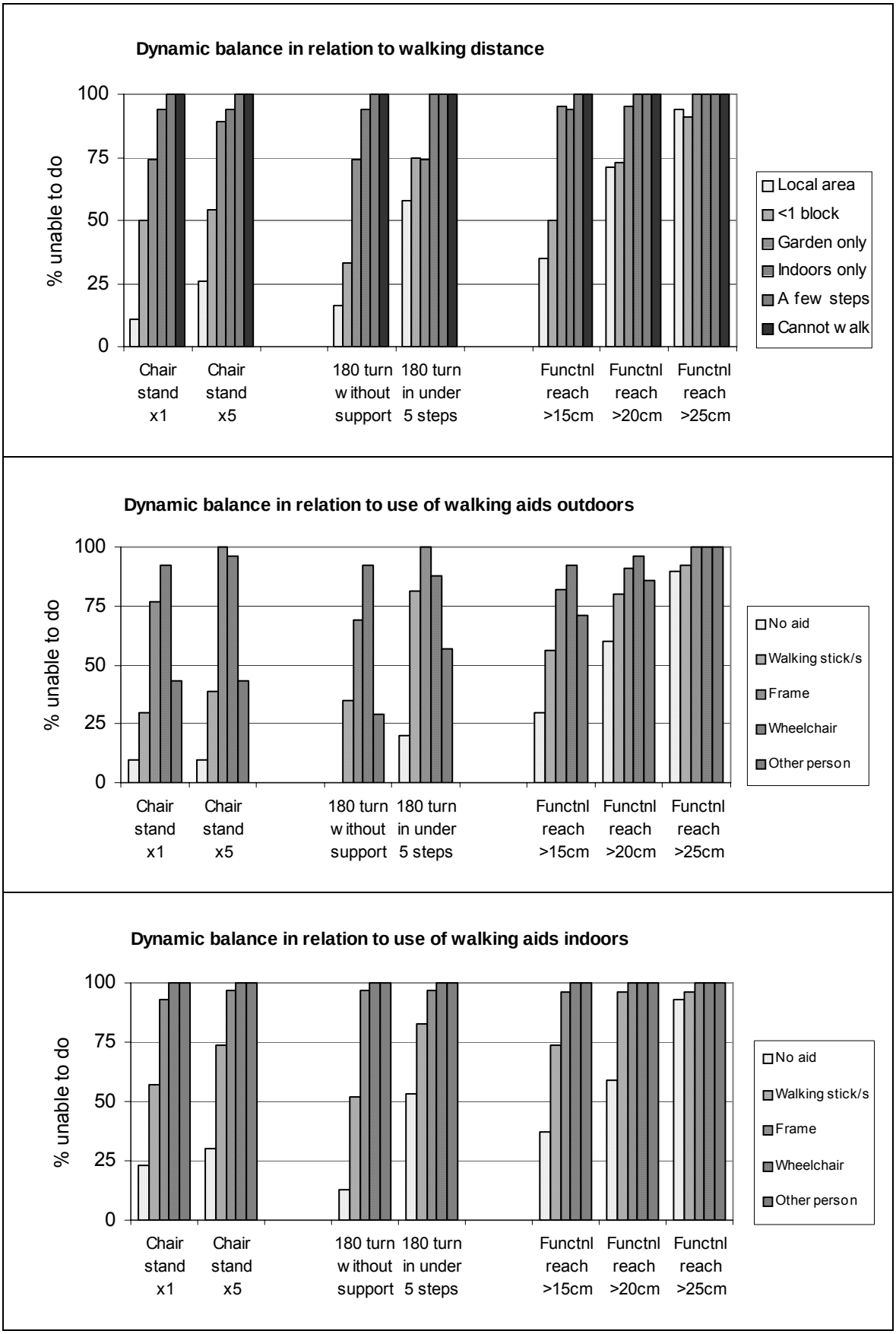
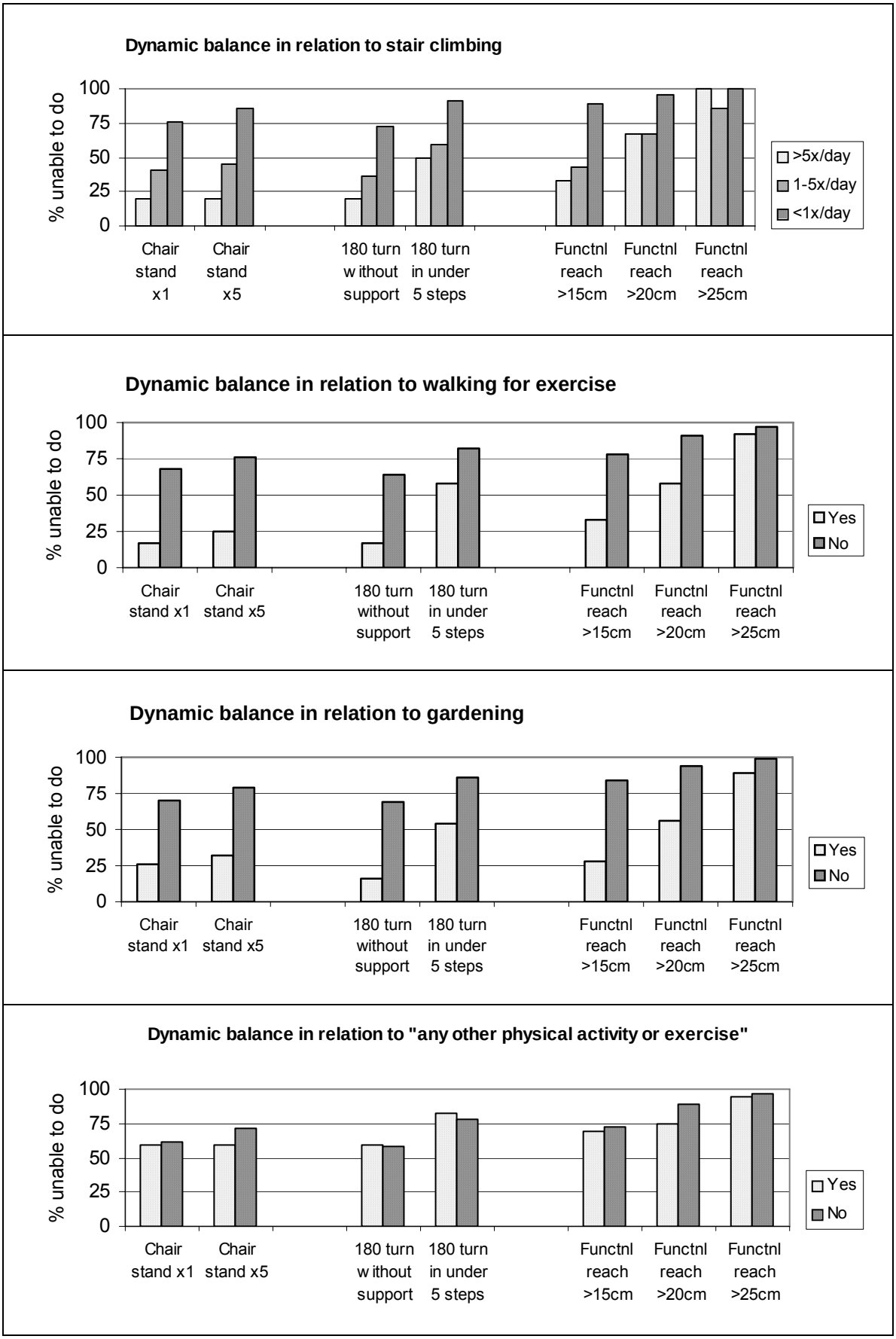


Figure 5.5.1.2 cont. Dynamic balance by reported stair climbing and other physical activity



Gait speed

The graphs in Figure 5.5.1.3 illustrate how gait speed (from the faster of two timed eight foot walks at normal pace) relates to reported mobility in two ways. Dichotomising this using the cut-point 0.06m/sec gives clear trends across categories of reported mobility in the proportions unable to walk at this speed. Box plots show how gait speed itself declines with decreasing maximum walking distance and with increasing dependence on walking aids, and is higher amongst those who climb stairs more often, garden and walk for exercise. Again, as seen with the dynamic and static balance tests, higher results were recorded for the people reported only to walk outdoors with someone else's help than for those needing sticks or frames.

Grip strength

Figure 5.5.1.4 graphs hand grip strength only as continuous data. It is striking how the patterns shown by these box plots in relation to all the reported mobility measures are very similar to those described above. However, unlike the other functional tests, grip strength ranked those unable to walk outdoors without help on a par with the more disabled who relied on wheelchairs or did not go out at all.

Most of the reported mobility questions involved lower limb function and, whilst hand grip clearly has no direct bearing on this, the figures lend support to arguments for its value as a general indicator of muscle strength.

Mean grip strength was significantly higher amongst men than women (see section 5.4), thus dichotomising the broad range of continuous grip strength measures at the mean or median over-simplifies the picture to the extent that it is not appropriate to graph these two categories.

Figure 5.5.1.3 Gait speed in relation to reported walking

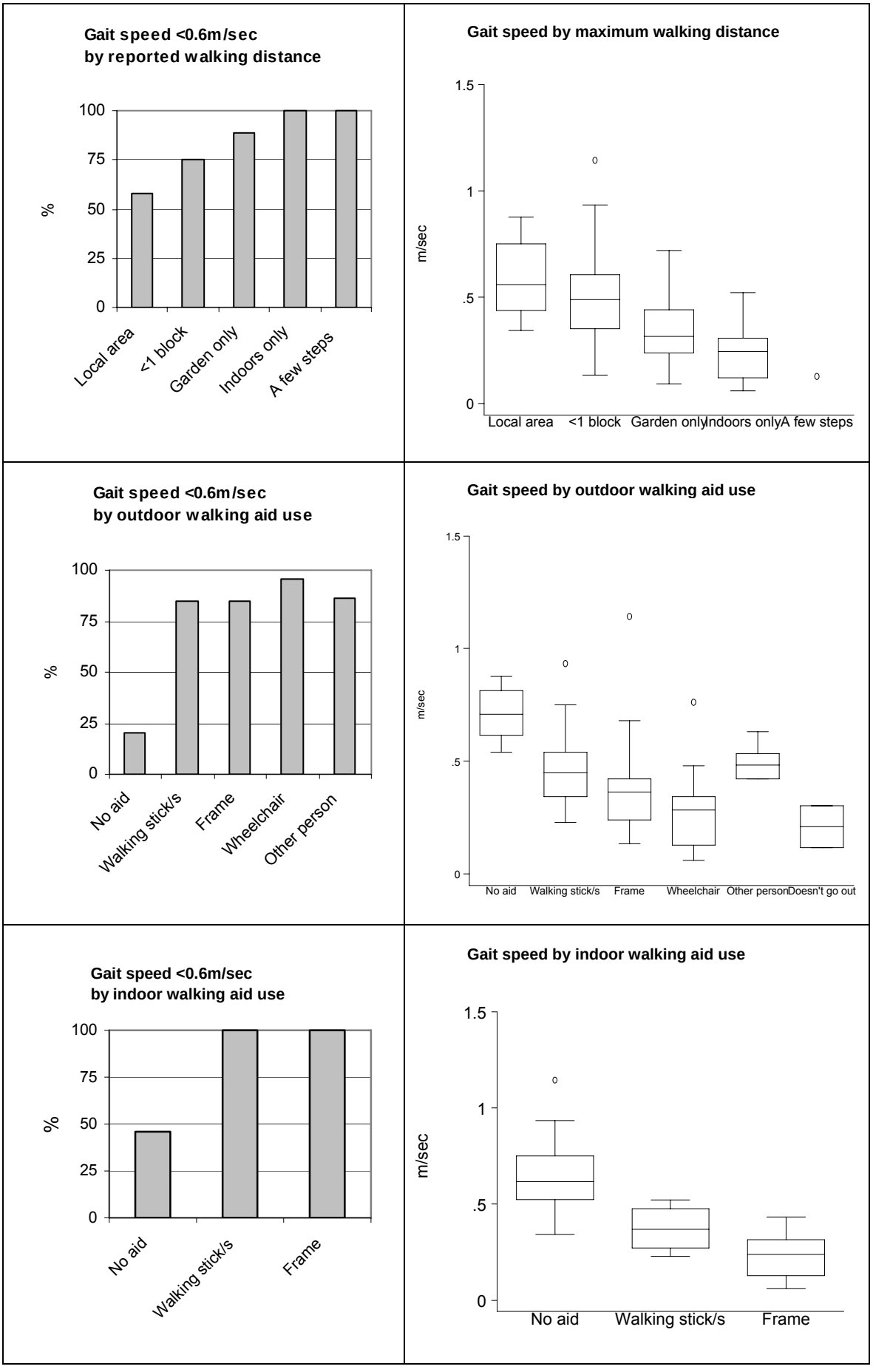


Figure 5.5.1.3 cont. Gait speed in relation to reported stair climbing / other physical activity

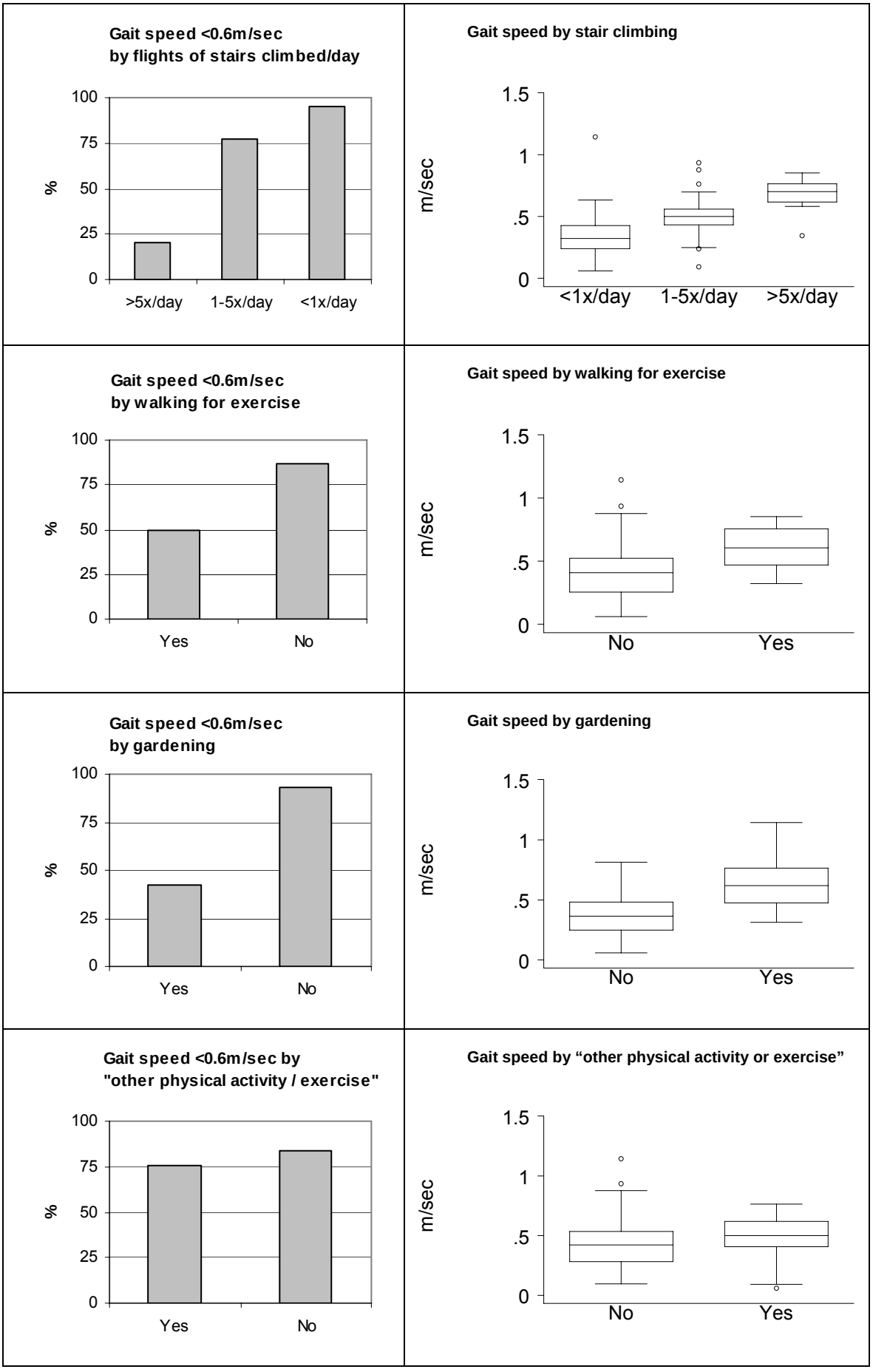


Figure 5.5.1.4 Grip strength in relation to reported walking

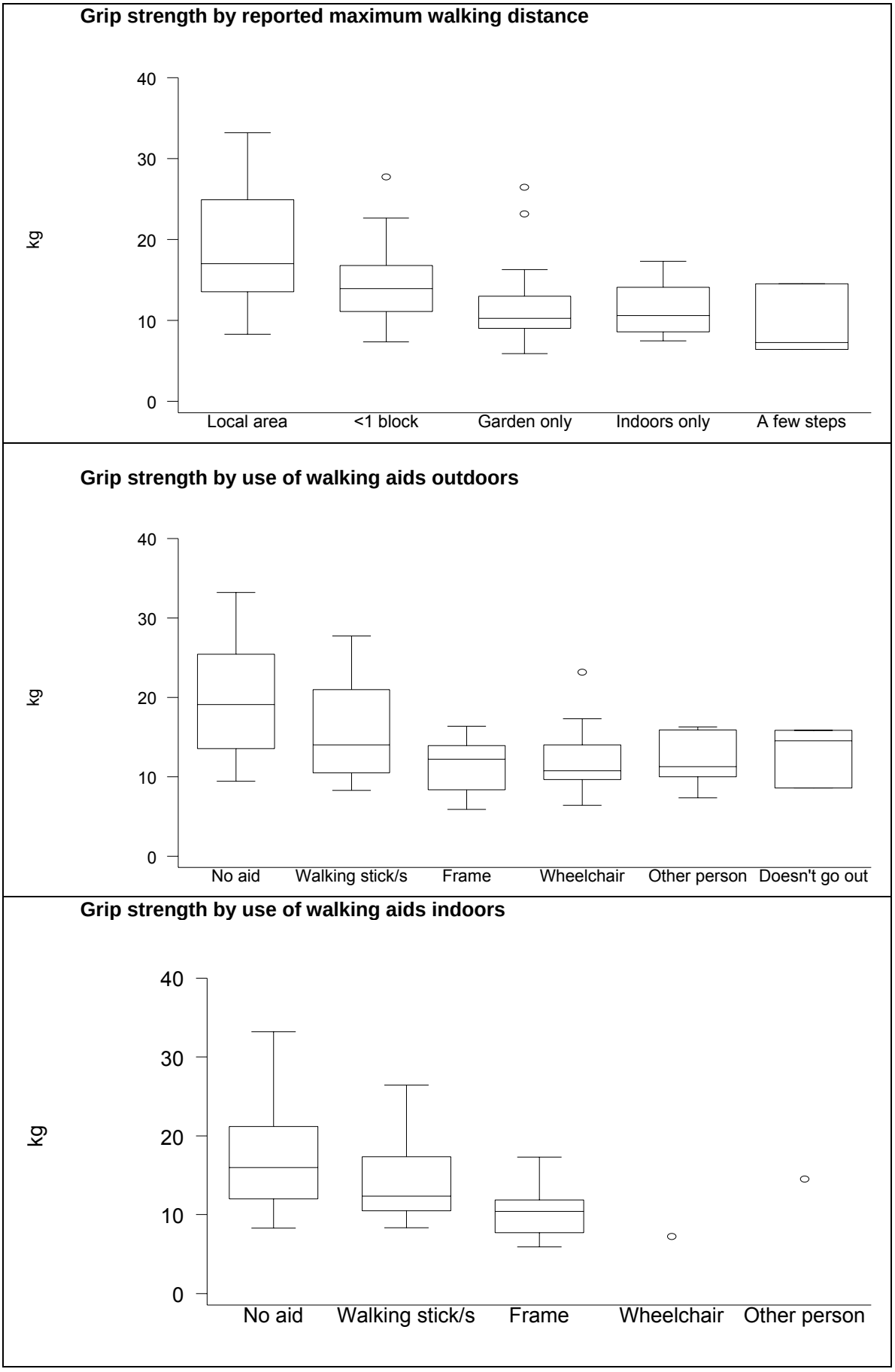
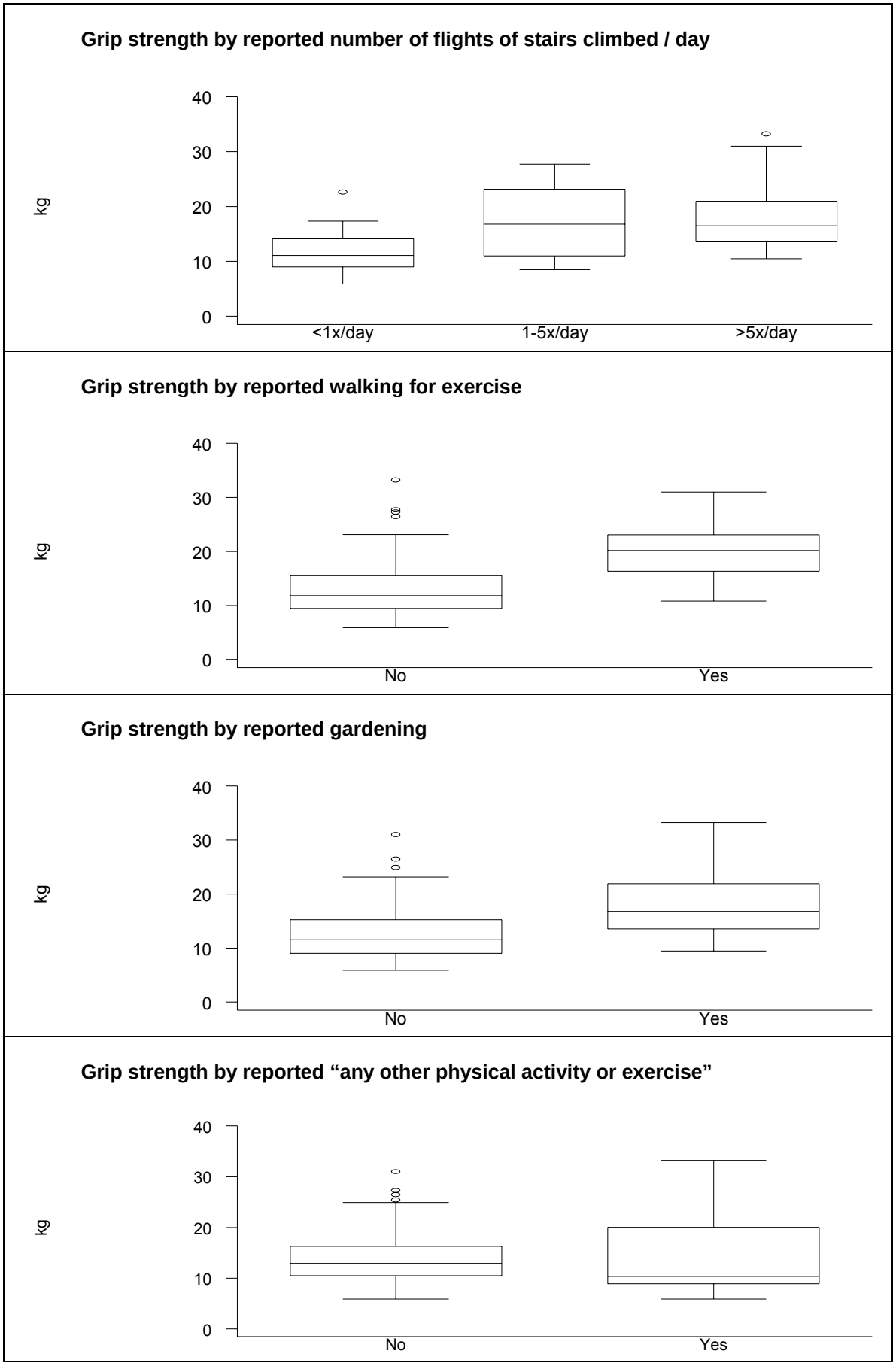


Figure 5.5.1.4 cont. Grip strength in relation to reported stair climbing/other physical activity



5.5.2 How do reported mobility levels relate to observed function?

The strength of associations between reported and observed mobility measures are quantified in Tables 5.5.2.1-8. These show the odds ratios associated with different reported mobility levels for being able to manage different performance testing targets. For example, for those reportedly able to walk around the local area the odds of being able to complete ten seconds of the semi-tandem stand test are increased five fold (Table 5.5.2.1: OR 5.0, 95% C.I. 1.7 – 14.8), while the odds of being able to complete the same test are decreased to a fifth for those who report needing any aid to walk outdoors (Table 5.5.2.3: OR 0.2, 95% C.I 0.05 – 0.87).

Walking distance

Whether the range of walking distance categories are dichotomised to identify those who can walk around their local area or a broader group who are able to walk down the street at least, the odds ratios almost all strongly favour being able to perform the functional tests. The exceptions are the most difficult levels of performance – the 10 second tandem stand and 10 inch functional reach – attained by so small a minority that confidence intervals are too wide to be significant.

Use of walking aids

Reporting the need to for any aid to walk indoors was consistently associated with lower levels of observed mobility in functional testing, except again for the hardest stand and reach positions.

Reported need of outdoor walking aid – highly prevalent in this population sample (see section 3.4) – showed weaker associations with functional test outcomes, although the effect sizes were similar to those found with indoor walking aid use. Many people who used a walking stick to go out were able to manage the simpler balance tests without difficulty, hence the non-significant relation between these measures.

Table 5.5.2.1 Associations between reported ability to walk around the local area and observed functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	4.9	1.3 – 18.3	p=0.02
Side-by-side stand feet together 10 seconds	16.5	2.1–130.7	p=0.008
Semi-tandem stand 10 seconds	5.1	1.7 – 14.8	p=0.003
Tandem stand 3 seconds	4.4	1.4 – 17.7	p=0.01
Tandem stand 10 seconds	12.3	2.2 – 70.0	p=0.005
Chair stand x1	25.0	5.3 –119.1	p<0.001
Chair stand x5	11.4	3.5 – 40.0	p<0.001
Functional reach>15cm	7.9	2.5 – 25.3	p<0.001
Functional reach>20cm	3.7	1.0 – 13.6	p=0.05
Functional reach>25cm	2.0	0.2 – 24.6	p=0.56
180˚ turn without needing support	11.9	3.1 – 45.0	p<0.001
180˚ turn in fewer than 5 steps	4.0	1.3 – 12.5	p=0.02
Gait speed >0.6 m/sec	5.7	1.8 – 18.5	p=0.003
Grip strength above mean	7.7	2.3 – 26.0	p=0.001

Table 5.5.2.2 Associations between reported ability to walk down the street <1 block and observed functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	23.0	6.9 – 76.6	p<0.001
Side-by-side stand feet together 10 seconds	18.9	5.7 – 62.3	p<0.001
Semi-tandem stand 10 seconds	6.6	2.4 – 17.9	p<0.001
Tandem stand 3 seconds	5.2	1.6 – 17.4	p=0.007
Tandem stand 10 seconds *	–	–	–
Chair stand x1	14.2	4.9 – 41.2	p<0.001
Chair stand x5	20.4	5.5 – 76.0	p<0.001
Functional reach>15cm	21.9	6.2 –137.4	p<0.001
Functional reach>20cm	18.0	2.4 –147.6	p=0.007
Functional reach>25cm	–	–	–
180˚ turn without needing support *	19.9	6.6 – 59.5	p<0.001
180˚ turn in fewer than 5 steps	4.1	1.3 – 12.5	p=0.02
Gait speed >0.6 m/sec	10.9	2.3 – 51.4	p=0.003
Grip strength above mean	5.8	2.2 – 15.3	p<0.001

* No-one who was unable to walk down the street could hold the tandem stance for 10 seconds, nor could they turn 180˚ without needing support.

Table 5.5.2.3 Associations between reported need for any aid to walk outdoors * and observed functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	0.18	0.02 – 1.50	p=0.1
Side-by-side stand feet together 10 seconds	0.20	0.02 – 1.71	p=0.1
Semi-tandem stand 10 seconds	0.20	0.05 – 0.87	p=0.03
Tandem stand 3 seconds	0.21	0.05 – 0.86	p=0.03
Tandem stand 10 seconds	0.32	0.05 – 1.92	p=0.2
Chair stand x1	0.06	0.01 – 0.54	p=0.01
Chair stand x5	0.04	0.01 – 0.36	p=0.004
Functional reach>15cm	0.16	0.04 – 0.67	p=0.01
Functional reach>20cm	0.21	0.05 – 0.93	p=0.04
Functional reach>25cm	0.29	0.02 – 3.54	p=0.3
180˚ turn without needing support †	–	–	–
180˚ turn in fewer than 5 steps	0.05	0.01 – 0.24	p<0.001
Gait speed >0.6 m/sec	0.03	0.01 – 0.19	p<0.001
Grip strength above mean	0.15	0.03 – 0.76	p<0.02

* excluding n=11 of those who had functional assessments but who do not go outdoors at all
† no-one who reported needing any walking aid outdoors could turn 180° without support

Table 5.5.2.4 Associations between reported need for any aid to walk indoors and observed functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	0.09	0.02 – 0.32	p<0.001
Side-by-side stand feet together 10 seconds	0.03	0.00 – 0.21	p=0.001
Semi-tandem stand 10 seconds	0.17	0.06 – 0.45	p<0.001
Tandem stand 3 seconds	0.23	0.08 – 0.69	p=0.008
Tandem stand 10 seconds	0.18	0.03 – 0.97	p=0.05
Chair stand x1	0.08	0.03 – 0.22	p<0.001
Chair stand x5	0.58	0.02 – 0.18	p<0.001
Functional reach>15cm	0.08	0.03 – 0.25	p<0.001
Functional reach>20cm	0.26	0.01 – 0.21	p=0.001
Functional reach>25cm	0.22	0.02 – 2.53	p=0.2
180˚ turn without needing support	0.04	0.01 – 0.13	p<0.001
180˚ turn in fewer than 5 steps	0.11	0.03 – 0.33	p<0.001
Gait speed >0.6 m/sec *	–	–	–
Grip strength above mean	0.13	0.05 – 0.36	p<0.001

* no-one who reported needing any walking aid indoors could walk faster than 0.6m/sec

Stair climbing, walking for exercise, gardening and "other" forms of physical activity
The reported number of flights of stairs climbed per day was strongly associated with observed mobility: the greater the frequency the higher the proportion successfully completing each functional test.

Reporting walking or gardening showed the same patterns described above, but those who fell in the "other" category in response to "Do you manage any physical activity or exercise?" were no different in their observed functional measures from those who did not.

Table 5.5.2.5 Associations between reported climbing at least one flight of stairs/day and observed functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	5.0	1.8 – 13.9	p=0.002
Side-by-side stand feet together 10 seconds	5.8	2.0 – 17.1	p=0.002
Semi-tandem stand 10 seconds	10.4	3.8 – 28.8	p<0.001
Tandem stand 3 seconds	16.2	4.2 – 62.6	p<0.001
Tandem stand 10 seconds	–	–	–
Chair stand x1	6.0	2.3 – 15.4	p<0.001
Chair stand x5	10.4	3.7 – 29.3	p<0.001
Functional reach>15cm	12.5	4.1 – 38.3	p<0.001
Functional reach>20cm	13.5	2.7 – 67.1	p=0.001
Functional reach>25cm *	–	–	–
180˚ turn without needing support	5.8	2.2 – 14.8	p<0.001
180˚ turn in fewer than 5 steps	8.2	2.6 – 26.1	p<0.001
Gait speed >0.6 m/sec	12.5	3.2 – 48.8	p<0.001
Grip strength above mean	5.8	2.2 – 15.3	p<0.001

* no-one who reported they climbed stairs less often than once/day could reach further than 25cm nor could they hold the tandem stand for 10 seconds.

Table 5.5.2.6 Associations between reported walking for exercise and functional tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	9.4	1.2 – 76.6	p=0.04
Side-by-side stand feet together 10 seconds	8.5	1.0 – 69.1	p=0.05
Semi-tandem stand 10 seconds	5.1	1.4 – 18.6	p=0.01
Tandem stand 3 seconds	8.5	2.3 – 32.0	p=0.001
Tandem stand 10 seconds	27.1	4.4–166.4	p<0.001
Chair stand x1	10.6	2.2 – 52.0	p=0.004
Chair stand x5	9.3	2.3 – 38.0	p=0.002
Functional reach>15cm	7.3	1.9 – 27.2	p=0.003
Functional reach>20cm	6.8	1.7 – 27.4	p=0.007
Functional reach>25cm	3.3	0.3 – 39.2	p=0.3
180˚ turn without needing support	8.9	1.8 – 43.7	p=0.007
180˚ turn in fewer than 5 steps	3.3	0.9 – 11.8	p=0.07
Gait speed >0.6 m/sec	6.8	1.8 – 25.3	p=0.004
Grip strength above mean	8.7	1.8 – 42.6	p=0.008

Table 5.5.2.7 Associations between reported gardening and functional mobility tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	8.3	1.8 – 38.4	p=0.007
Side-by-side stand feet together 10 seconds	16.5	2.1–130.1	p=0.008
Semi-tandem stand 10 seconds	9.6	3.0 – 30.8	p<0.001
Tandem stand 3 seconds	6.2	2.0 – 19.4	p=0.002
Tandem stand 10 seconds	3.2	0.6 – 15.5	p=0.2
Chair stand x1	6.7	2.1 – 20.9	p=0.001
Chair stand x5	8.1	2.6 – 24.9	p<0.001
Functional reach>15cm	13.5	4.0 – 45.5	p<0.001
Functional reach>20cm	12.8	3.2 – 50.5	p<0.001
Functional reach>25cm	8.4	0.7 – 98.2	p<0.09
180˚ turn without needing support	11.9	3.9 – 45.0	p<0.001
180˚ turn in fewer than 5 steps	5.5	0.2 – 3.0	p=0.003
Gait speed >0.6 m/sec	18.2	5.0 – 65.7	p<0.001
Grip strength above mean	7.7	2.3 – 26.0	p=0.001

Table 5.5.2.8 Associations between reported other physical activity and functional tests

	Odds Ratio (unadjusted)	95% C.I.s	Significance (Wald test)
Unsupported stand feet apart 60 seconds	1.0	0.3 – 2.9	p=1.0
Side-by-side stand feet together 10 seconds	1.2	0.4 – 3.6	p=0.7
Semi-tandem stand 10 seconds	1.5	0.5 – 4.5	p=0.4
Tandem stand 3 seconds	2.8	0.9 – 8.9	p=0.1
Tandem stand 10 seconds	3.7	0.7–18.4	p=0.1
Chair stand x1	1.1	0.4 – 3.3	p=0.8
Chair stand x5	1.7	0.6 – 5.2	p=0.3
Functional reach>15cm	1.2	0.4 – 4.0	p=0.7
Functional reach>20cm	2.6	0.7–10.0	p=0.2
Functional reach>25cm	2.3	0.2–26.7	p=0.5
180˚ turn without needing support	0.9	0.3 – 2.8	p=0.9
180˚ turn in fewer than 5 steps	0.8	0.2 – 3.0	p=0.7
Gait speed >0.6 m/sec	1.6	0.4 – 5.6	p=0.5
Grip strength above mean	0.6	0.2 – 1.9	p=0.4

Table 5.5.2.9 summarises the tables above into one cross-tabulation of each interview question related to mobility or physical activity against each functional performance measure with just the levels of significance of their inter-relationships graphed in the preceding sets of figures. These associations were analysed using Pearson's chi squared test adjusted where appropriate with Fisher's exact method for comparison of proportions and the Score test for trend across categorical variables, and the Kruskal-Wallis test for non-parametric between-groups comparison of the continuous variables.

From both the figures and tables above it can be seen that associations are highly significant between most of the observed functional measures and reported mobility.

The only category of observed physical function that showed no significant association with reported mobility was that of being able to reach more than 25 cm (10 inches) on the functional reach test – a level which only three participants achieved. Reported levels of mobility and physical activity from the interview questions related strongly to observed function except for the last option in the question "Do you manage any physical activity or exercise?": no functional performance tests showed any significant association with the response option "Other".

Table 5.5.2.9 Associations between reported and observed functional mobility measures

	Walking distance	Walking aid used outdoors	Walking aid used indoors	Stair climbing	Walking for exercise	Gardening	Other physical activity
Score test for trend					Pearson χ^2 (+ Fisher's exact test)		
TUSS	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔	✔ ✔	–
Side-by-side	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔	✔ ✔ ✔	–
Semitandem	✔ ✔ ✔	✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔	✔ ✔ ✔	–
Tandem	✔ ✔	✔	✔	✔ ✔ ✔	✔ ✔ ✔	–	–
Chair stand x1	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔ ✔	–
Chair stand x5	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔ ✔ ✔	–
F reach>15cm	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔ ✔ ✔	–
F reach>20cm	✔ ✔	✔	✔ ✔ ✔	✔ ✔ ✔	✔	✔ ✔ ✔	–
F reach>25cm	–	–	–	–	–	–	–
Kruskal-Wallis test							
180˚ turn	✔ ✔	✔ ✔	✔ ✔ ✔	✔ ✔	✔	✔ ✔ ✔	–
Gait speed	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔	✔ ✔ ✔	–
Grip strength	✔ ✔ ✔	✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	–

✔ ✔ ✔	p<0.001
✔ ✔	p<0.01
✔	p<0.05
–	p≥0.05

5.6 Discussion and summary

Reported mobility
Observed mobility
Gender differences
Relation between reported and observed measures
Usefulness of functional testing in advanced old age

The study found high levels of restricted mobility in this population-based sample of men and women aged over 90, both by their own self-report or the reports of closely involved carers and when assessed with objective functional performance testing.

Reported mobility

Reported measures revealed wide variation between participants but overall painted a picture of extensive limitation in mobility levels. Three-quarters of the participants reported they could no longer walk around their local area, a third could not walk outdoors and one in ten people said they never went out. Fewer than half the participants described themselves as taking any form of physical activity or exercise and almost two-thirds did not climb stairs regularly or could not climb stairs at all.

In the pioneering East London study[79] 45% of over-85-year-olds in the baseline interview reported they were housebound, with a further 6% getting out only with severe difficulty, and by the follow-up survey three years later half of the remainder had deteriorated in mobility. Given the not quite comparable age range and question phrasing, this implies a level of mobility broadly in line with the current study's finding that 31% could not get outdoors at all and 54% could not manage to walk down the street even less than 1 block. Half the Swedish men and women aged 90 or more in the Umeå 85+ study were "able to walk outside independently", double the proportion of CC75C participants who reported they could walk around the neighbourhood but comparable to the 46% who reported they could manage to walk no more than a block. The "90+" groups in the Umeå 85+ study had identical levels of severe disability: 90% of them were "able to walk" and in CC75C 10% could not walk more than a few steps[88]. This level of severe mobility disability was equally common in men and women but others have reported markedly higher levels in women: more Danish nonagenarian and centenarian women than men were found unable to walk indoors (24% vs 10% of 90 – 94-year-olds, 39% vs 20% of 100-year-olds)[91]. One Swedish study has reported on the use of assistive devices amongst 90-year-olds[798]: 23%

managed without any mobility aid, a figure mid-way between the proportion who needed no walking aid outdoors (12%) and none indoors (35%) in the current study.

Observed mobility

Observed mobility from thorough functional assessments also showed a large range of capabilities but poor mobility function overall. These were generally well below reported levels in younger populations, as would be expected[634], but such comparisons as can be drawn with previous work in older age-groups show function in the current study to be similar or only slightly worse.

The measures of balance used in the current study showed performance levels in line with previous reports from other studies of the very old. Others have also reported a ceiling effect with the Timed Unsupported Stand even amongst very frail participants and very similar values for the number of steps taken to turn 180°[244]. However, both static and dynamic measures indicated women in the CC75C study had markedly worse balance than reported from other samples with slightly younger age-ranges. More of the CC75C women aged over 90 years were unable to hold the side-by-side stand position (43%) than of the disabled women aged 85 or more in the Women's Health and Aging Study (34%)[799] and 80% of the CC75C women had a functional reach less than 15cm (6 inches) compared with only 23% of the WHAS women[799]. Much greater reach has been recorded with even younger samples of just community-dwelling women: 30cm amongst women aged 65-86 years[620] and 34cm amongst 70 – 79-year-olds[800]. However, amongst sheltered housing residents with a mean age of 79 half of whom had fallen the previous year, mean functional reach – 13cm for those recalling any fall, 21cm for those reporting none – was closer to the CC75C range[251].

Almost two-thirds of the women and nearly half the men in the current study were unable to stand up from a chair without using their arms, comparable to figures reported from the Women's Health and Aging Study (40%)[799] and the Elderly Population Health Status Survey (EPHSS)[801]. Other studies of the oldest old have not reported chair rising ability in exactly comparable formats. In Sweden 32% of the men and women in the Umeå 85-plus study were unable to perform three chair stands[88], and in the Danish 1905 Cohort (aged 92-93 on assessment) 60% of men and 49% of women could stand up from a chair "without fatigue" but this category could include using arms to stand[92].

95% of Dutch women in the Leiden 85-plus study regularly stood up from a chair without another person's help[780].

Gait speeds recorded in the CC75C survey averaged 0.5m/sec for men and 0.4m/sec for women, these medians falling in same range but slightly lower than the mean gait speed reported from the Danish nonagenarians (0.64 m/sec and 0.52 m/sec for men and women respectively)[92], lower than over-85-year-old community-dwelling men and women in the Cardiovascular Health study (0.75 m/sec and 0.6 m/sec respectively)[802], but the disabled women aged 85 or more in the Women's Health and Aging Study had equivalent gait speed (0.4m/sec)[799] to the CC75C women.

Hand grip strength amongst nonagenarian men and women in the CC75C study (median 22.3 kg and 11.5 kg respectively) was close to the mean grip strength of Danish 92 – 93-year-olds (22.8 kg for men and 13.4 kg for women), slightly lower than found amongst ≥85-year-olds in the EPHSS population sample (25.7 kg for men and 14.5 kg for women)[801] and considerably lower than reported for ≥85-year-olds in the Cardiovascular Health Study which included only community-dwelling men and women (48 kg and 28 kg respectively) [802].

The careful identification of reasons for inability to perform different tests is important as a source of meaningful information on function and disability[92;799]. These measures also appear comparable to studies in similar populations, for example in the Umeå 85-plus study the percentage unable to walk 2.4 metres[88] was identical (18%) to the proportion of the current study for whom no gait speed measure could be obtained.

Gender differences

Higher proportions of men than women reported better levels of mobility, with the proportion of men able to get around their local area double that of women and the proportion of women unable to go out beyond the garden double that of men. However, there was no gender difference in the prevalence of severe mobility disability. Men tended to maintain balance better than women in this sample, although differences only reached significance for one each of the static and dynamic balance tests: semi-tandem stance ($p=0.01$) and functional reach ($p=0.01$). Muscle strength was found to be significantly better in men's than in women's handgrip ($p<0.001$).

Some previous studies have reported similar findings that older men out-perform older women in balance tests only in the more challenging tests[803-805]. There are numerous reports of stronger muscle measurements in men than women at younger old age ranges than measured in the current study[359;386;806-809], and strength tests have been found to be the most significantly different measures between men and women, for example in healthy community-dwellers with a mean age of 75 ± 5 years any differences in balance and gait were accounted for by activity level, balance confidence and height but gender accounted for up to half the differences in muscle strength[810]. Other researchers have also suggested that factors such as activity and anthropometry explained the differences found[803;808;811] but the extent to which this is so remains unclear as other studies report that gender differences persist regardless of such adjustments[359;386;809]. Anthropometric data from the current study are reported in Chapter 8 but it is interesting to note here the higher levels of activity reported by men in the current study, which are in keeping with the literature to date. The disparities between men's and women's mobility and other ADL disability are widely reported to increase with age[91;812;813] and, given the higher male mortality rates, other authors have suggested such findings raise questions about the relative importance of physiological differences and possible survivor effects[92].

Relation between reported and observed measures

Almost all the reported measures of mobility from interview questioning were strongly associated with all the mobility performance tests. The exception was that answering "Yes" to taking some "Other" form of "physical activity or exercise" showed no significant relation to performance in any of the tests. The majority of participants who reported "other … physical activity" described this as doing exercises on their own at home, sometimes ones that a physiotherapist had once advised them to do or often what they called "just exercises that I've always done". Those who gave more detail usually mentioned stretches, leg lifting and ankle rotation and none of the respondents was currently seeing a physiotherapist or attending any exercise group at the time of interview. In the absence of further detail it can only be speculated that these exercises were perhaps done somewhat irregularly, or that their intensity was too low and the type of exercise not sufficiently targeted or progressive to have any measurable effect on balance or muscle strength.

The relationships reported between the two groups of measurements are cross-sectional associations from which it would be unwise to assume causation in either direction. Two alternative approaches in interpreting the comparison of reported and observed measures would be to assess the validity of one set of measures against the other, and in these data each appears to support the other. The remarkable consistency in patterns of trend across indicators of increased disability suggest both that the functional tests appear to be valid measures in this population and that reported mobility provides a reliable estimate of function. Reported mobility was self-reported for 80% of those who had functional performance tests, an indication that those able to answer these simple questions gave accurate assessments of their mobility, a finding worth noting given the difficulties already mentioned of recording some of the functional performance tests. Positive relationships between reported physical activity and physical performance measures have previously been reported in younger age ranges of older people[634;814]. In the EPESE study self-report items answered by men and women aged 65-102 predicted performance in functional tests and the authors suggest that self-reported walking ability may be the best over-all predictor of functional mobility[815]. However, other researchers have found variation between population groups – by age, sex, income and country – in the level of objectively measured physical limitation at which functional difficulty or disability are reported[816;817].

It is interesting to note that the exception to the trend of decreasing performance across categories of reported limitation (see section 5.5.1) found for those who need another person's help to walk has been noted elsewhere as well. Older American women with disabilities in the Women's Health and Aging Study whose adaptive strategies involved the use of equipment such as walking aids but did not need anyone else's help "actually exhibited worse measured physical performance than those using human help for mobility tasks"[818].

Usefulness of functional performance testing in advanced old age

With a population as frail as these participants many standard performance tests were not feasible. Three-quarters could not complete the full set of standing balance tests, nearly two-thirds could not manage the first chair stand test and more than half could not attempt the functional reach test. This does not necessarily mean these assessments are inappropriate as, for many of the tests, inability to complete the test is regarded as a

test result in itself[92;799]. However, too high a proportion of a population all scoring zero on any test will inevitably lessen its usefulness as a predictor of any outcome.

Clearly the sensitivity of any measurement depends in part on the level set as an indicative cut-point. In the current chapter's presentation of the functional mobility test results, data were categorised on the basis of cut-points identified in other studies as indicative of increased falls risk. Functional reach over 25 cm (10 inches) was taken as the baseline category against which increased falls risks were measured in the seminal paper that first highlighted the test's falls predictive potential in older men[641]. However, this was shown not to be associated with reported mobility in the current study as only three people attained this level, raising questions as to the relevance of this cut-point for the over-90-year-old age-group. Similarly, 80% of the study sample walked slower than 0.6m/sec, a gait speed previously identified as indicating falls risk in a population of younger old age[168].

Reported mobility was self-reported for 80% of those who has functional tests, so the concordance of reported and observed measures suggests these very old people able to answer simple questions about physical activity give accurate assessments of their mobility levels - an important message given the difficulties of performance measurement.

Whether functional performance measures serve any useful purpose as risk indicators – risk of falling, recurrent falling or suffering a fall with serious consequences – will be examined in the following chapters along with other potential fall risk factors in relation to both retrospectively and prospectively collected falls data (see Chapters 6, 7 and 8).

Summary points

- The study found wide variation in mobility in this population-based sample of men and women aged over 90, but overall levels of restricted mobility were high

Reported mobility

- Higher proportions of men than women reported better levels of mobility, but there was no gender difference in the prevalence of severe mobility disability.
- Three-quarters of the participants reported they could no longer walk around their local area, a third could not walk outdoors and one in ten people said they never went out.
- Fewer than half the participants took any form of physical activity or exercise and almost two-thirds did not climb stairs regularly or could not climb stairs at all.

Observed functional performance

- Men had significantly stronger hand grip than women and maintained balance better than women in this sample.
- Many of the standard performance tests were not feasible for many of the study participants.
- Two-thirds were unable to stand up from a chair without using their arms.

Relation between reported and observed measures

- There were strong associations between reported mobility and functional performance.
- Reported mobility was self-reported for 80% of those who has functional tests, so the concordance of reported and observed measures suggests these very old people able to answer simple questions about physical activity give accurate assessments of their mobility levels - an important message given the difficulties of performance measurement.

CHAPTER 6

FALLS IN MEN AND WOMEN AGED OVER 90 YEARS OLD

PART I: FALLS REPORTED IN RETROSPECTIVE RECALL

6.1 Introduction

6.2 Methods used at interview: cross-sectional retrospective falls measures
- 6.2.1 Perceived instability
- 6.2.2 Remembered falls

6.3 Perceived instability: reported tendency to fall and unsteadiness

6.4 Remembered falls: prevalence, incidence and time since last fell
- 6.4.1 Missing data
- 6.4.2 Time since last fell
- 6.4.3 Prevalence and incidence from different periods of recall
- 6.4.4 Falling and repeated falling in the past year

6.5 Reported circumstances of and consequences of remembered falls
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6.7 Summary

6.1 Introduction

This chapter presents data collected at interview on perceptions of balance difficulties and retrospectively recalled falls. Section 6.2 below summarises the measures derived from interview questions, but the reader is referred also to Chapter 2, section 2.2.1. Results derived from interview are then presented in sections 6.3 – 6.5 in terms of participants' perceived unsteadiness and tendency to fall as well as the actual falls they remember, the circumstances of the last remembered fall described for each respondent and its consequences. Full details are given in Chapter 2.4 of the analytical approaches used to describe the falls data and examine associations between falls measures and identified potential risk factors.

The following chapter (Chapter 7) presents the methods, process measures and findings from the prospective collection of falls data conducted in this study, following-up participants for the year after interview, and explores whether factors that are reported in this chapter to be associated with remembered falls are also useful as predictors of prospectively verified falls. The reader is also referred to the next chapter for examination of the effects on falls risk estimates of potentially confounding covariates. Chapter 8 then goes on to report on the consequences of falls monitored during prospective follow-up. Note that each of these chapters ends with a summary of findings, but fuller discussion drawing together results from all three chapters is found in Chapter 9.

6.2 Methods used at interview: cross-sectional retrospective falls measures

6.2.1 Perceived instability
6.2.2 Remembered falls

Falls data collection instruments and methodology issues are discussed in Chapter 1's literature review and the selection of methods used for this study in section 2.2.1.2 of the Chapter 2 *Study methodology*. Here the measures taken from these instruments are summarised prior to presenting the findings from these cross-sectional measures.

6.2.1 Perceived instability

Before taking a detailed fall history, the interview questions on health included two items that assess the extent to which participants felt they had problems with balance. These measures – reportedly having a tendency to fall and being unsteady on one's feet – are presented in section 6.3

6.2.2 Remembered falls

Prevalence and frequency of falling
Time since last fall
Falls with or without injury
Circumstances and consequences of falls

Prevalence and frequency of falling

At interview respondents were asked "Have you fallen in the last three months?" and then "Have you fallen in the last year?". If the response to either question was "Yes" then as accurate as possible an estimate of the timing of any fall was sought with the prompting questions "How many times?", "When did the fall(s) happen?" and "Can you say roughly which month?". Information given was subsequently coded to provide summary measures of frequency of remembered falls comparable with measurement periods used earlier in the CC75C study and in other studies: the number of falls in the month before interview, and in the last 3, 6 and 12 months. Reporting more than one fall in the previous year was classified as repeat falling. The definition of a fall used throughout was that of the Kellogg International Work Group on the Prevention of Falls[132] as described in Chapter 2.

Time since last fall

Those who reported no falls in the previous year were asked "If you have ever fallen, how long ago was the last time you fell?" and replies were rounded up to the nearest month, with a maximum coding category for those whose last remembered fall was more than 5 years ago.

Falls with or without injury

If any falls were reported at any time respondents were asked "How long ago was the last time you fell and hurt yourself?" and responses were recorded as for the time since last fall.

Circumstances and consequences of falls

The question about injurious falls led into a series of questions about fall circumstances and consequences, introduced with "Thinking back to that time, when you last fell and hurt yourself…" and "Thinking back to just the last time you fell…". If the most recent fall had not led to any injury then respondents were asked about both the last fall and the last fall resulting in injury. As much detail as possible was recorded from the

respondents' and/or proxy informants' accounts of what happened in the check-box form used for questions 186a) (vi) to (xx) in the interview schedule (see Appendix C).

From this history of falling ascertained at interview, the data can describe remembered falls over different retrospective time periods in terms of both numbers and proportions of the study population who recall falling and numbers of falls recalled.

For description only section 6.4 shows comparative data on time frames from the last month to the last five years. However, for analyses of association with potential risk factors only data on falls in the past year are used.

6.3 Perceived instability: reported tendency to fall and unsteadiness

Responses to the question asking whether having a "tendency to fall" or being "unsteady on your feet" had affected the participants' day-to-day routine in the past month (see the methods description in Chapter 2.1.2.1 *Reported diagnoses and physical symptoms*) provided data on the proportions of participants who described themselves, or who were described by a proxy informant, as:

- either disabled by these conditions
- or having these conditions but not disabled by them
- or unaffected

Table 6.3.1 and 6.3.2 report these proportions for each item separately for men and women. The same data have already been shown graphically as part of Figure 4.3.5.2 along with the other potentially disabling health-related conditions in Chapter 4's description of the study sample.

There were data missing from three participants who were not asked any questions in this section of the interview and from two more whom it was not appropriate to ask about being unsteady on their feet as they were unable to stand at all.

Half the participants reported having a tendency to fall, and for the vast majority of them this was a disabling condition. All the men affected described it as disabling, as did more than three-quarters of the women affected, about 40% of each from the sample over-all.

"Unsteadiness on your feet" was even more commonly reported than having a "tendency to fall". Two-thirds of women and almost half the men described this as a disabling condition affecting day-to-day routine, and four out of five over-all admitted to some degree of unsteadiness.

Table 6.3.1 Tendency to fall by described extent to which this was disabling

	Men [n=18]		Women [n=89]		All [n=107]	
	n	(%)	n	(%)	n	(%)
Disabling tendency to fall	8	(44)	35	(39)	43	(40)
Tendency to fall, but not disabling	0		10	(11)	10	(9)
Any tendency to fall	8	(44)	45	(51)	53	(50)

Table 6.3.2 Unsteadiness on feet by described extent to which this was disabling

	Men [n=17]		Women [n=88]		All [n=105]	
	n	(%)	n	(%)	n	(%)
Disabling unsteadiness on feet	8	(47)	58	(66)	66	(63)
Unsteadiness on feet, but not disabling	4	(24)	15	(17)	19	(18)
Any unsteadiness on feet	12	(71)	73	(83)	85	(81)

6.4 Remembered falls: prevalence, incidence and time since last fell

6.4.1 Missing data
6.4.2 Time since last fell
6.4.3 Prevalence and incidence from different periods of recall
6.4.4 Falling and repeated falling in the past year

6.4.1 Missing data

Analyses use information from interviews with proxy informants as well as study participants themselves, drawing on whichever source provided more information. The minimal missing data on these variables have been excluded from all analyses of remembered past falls. Information was available about falls in the year before interview for all but one participant. She had recently been moved between residential homes and neither institution was able to provide this information, nor could any next of kin be contacted. Another participant remembered falling some time in the last year but could not be more precise, and two further participants were reported to have had no falls in the past year but it was not known when they last fell. Thus the denominators shown in the results sections vary slightly between measures.

6.4.2 Time since last fell

The first set of figures (6.4.2.1-2) show graphically the distributions of time since the participants were said to have last fallen, and also the time since they said they last hurt themselves falling. Comparison of these plots and their summary statistics reveal that the last falls resulting in injury appear to be remembered from a further time back than last falls in general, with a longer median time to the last remembered injurious fall (9 months, IQR 2-30 months) than to any last fall (5.5 months, IQR 1-23 months).

6.4.3 Prevalence and incidence from different periods of recall

Table 6.4.3.1 summarises the cross-sectional findings on retrospectively recalled falls in this over-90-year-old population as prevalence of falling at least once, falling more than once and incidence of falls per person-year, all based on falls remembered as having happened within the year before interview (see also Table 6.6.1.7 for risk estimates).

Figure 6.4.2.1 Distribution over time of most recent recalled fall

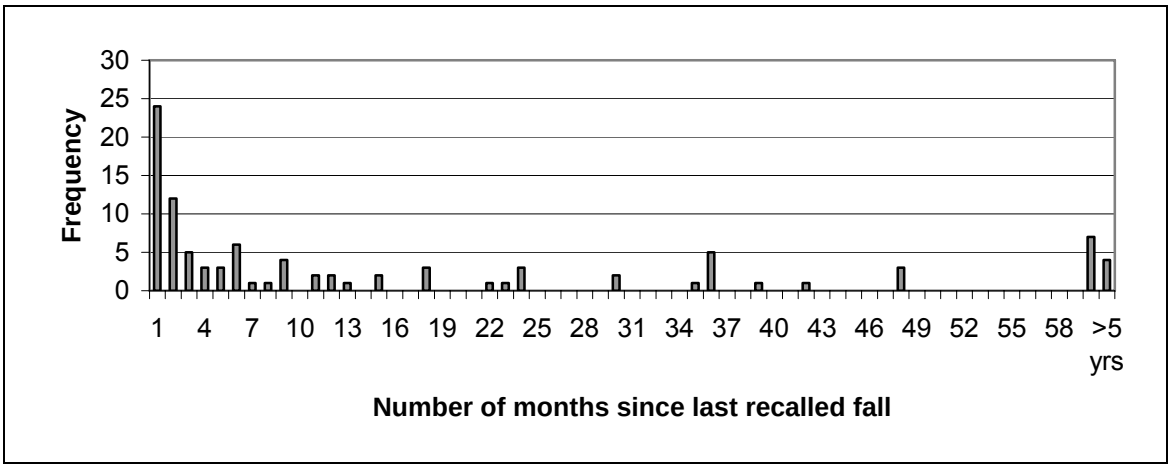


Figure 6.4.2.2 Distribution over time of most recent recalled injurious fall

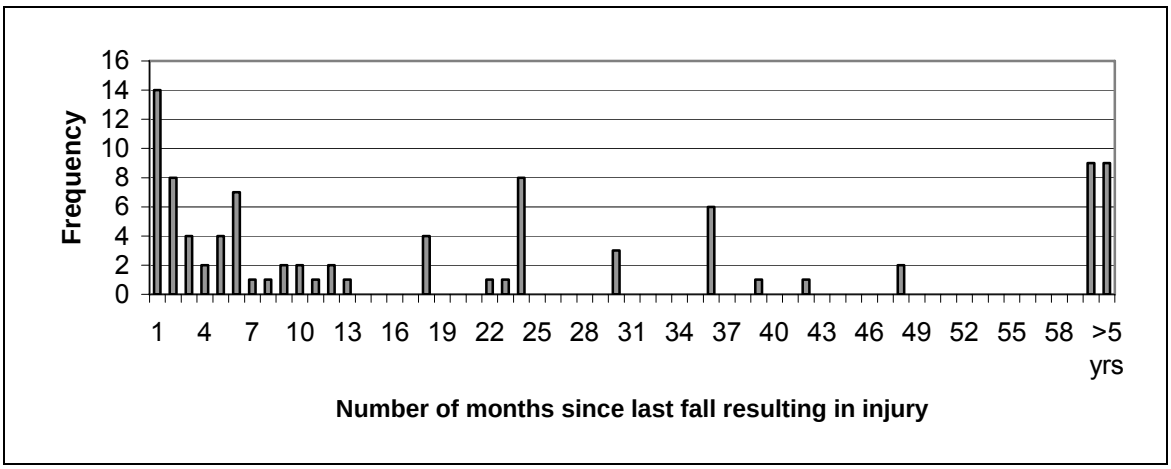


Table 6.4.3.1 Prevalence and incidence of remembered falls in the previous year

	Number with data for falls in past yr (persn-yrs)	Prevalence				Incidence	
		Recalled ≥ 1 fall		Recalled ≥ 2 falls		Number of recalled falls	Incidence of recalled falls/100 person-yrs
		n	(%)	n	(%)		
GENDER							
Men	20	11	(55)	5	(25)	23	115
Women	89	52	(58)	32	(36)	154	173
PLACE OF RESIDENCE							
Living in the community (house, flat or granny flat)	62	30	(48)	18	(29)	74	119
Living in sheltered housing (mobile/site warden or very sheltered)	19	15	(79)	9	(47)	41	216
Living in care (residential/nursing home or hospital)	28	18	(64)	10	(36)	62	221
TOTAL SAMPLE	109	63	(58)	37	(34)	177	162

The cross-sectional data on recalled falls allow calculation of the prevalence and incidence of reported falling over a range of time periods before interview (see Methods in section 2 of this chapter and Chapter 2). Figures 6.4.3.2 and 6.4.3.3 illustrate how the prevalence of falling, based on reports of remembered falls, increases with the length of time about which respondents are questioned regarding their fall history. These two figures separate the proportions for men and women, and for those living in different residential settings, all showing the same increasing levels of recalled falling with longer time frames. However, incidence rates based on of the number of falls reported as having happened within different time periods before interview decreased with longer recall times. Table 6.4.3.4 illustrates this using reports of falls in the previous year, the time frame of recall used for comparison with the one year follow-up period.

Figure 6.4.3.2 **Remembered falls reported within different time frames by men and women aged over 90 years old**

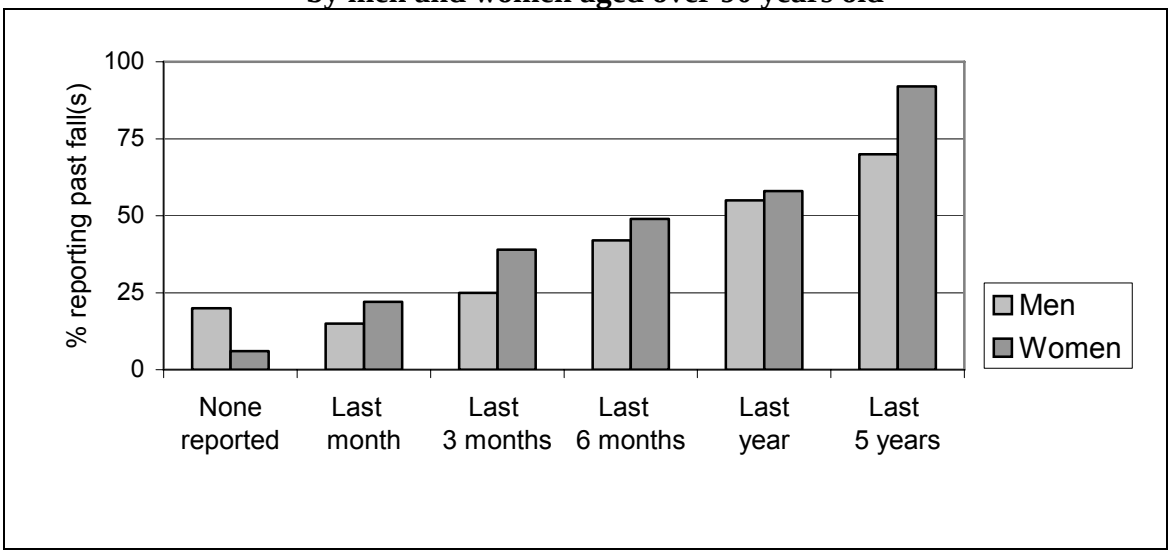


Figure 6.4.3.3 **Remembered falls reported within different time frames by over-90-year-olds living in different residential settings**

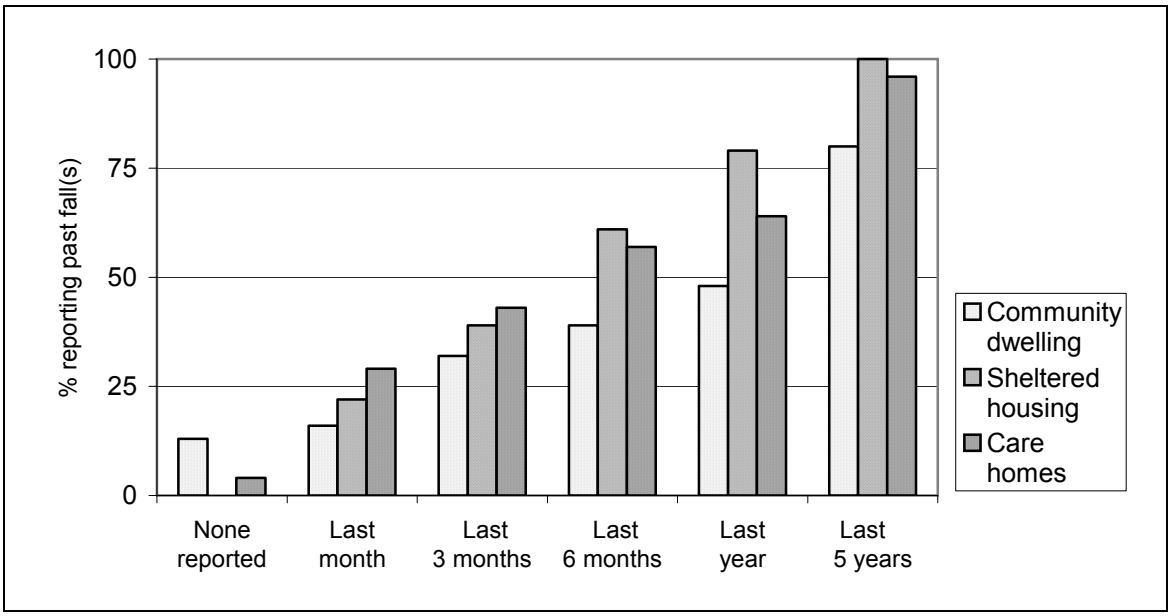


Table 6.4.3.4 **Increasing prevalence and decreasing incidence of falling with lengthening period of recall**

	Prevalence		Frequency	Incidence
	n	(%)	Number of falls	Falls/person-year
≥ 1 fall in the past month	22/108	(20)	28	3.11
≥ 1 fall in the past 3 months	39/108	(36)	66	2.44
≥ 1 fall in the past 6 months	52/108	(48)	121	2.24
≥ 1 fall in the past year	63/109	(58)	177	1.62
≥ 1 fall in the past 5 years	94/107	(88)	-	-
No falls remembered	9/107	(8)	-	-

6.4.4 Falling and repeated falling in the past year

Well over half the participants (58%) reportedly fell in the year before interview and 59% of them, or 34% of the total, reported falling more than once in the past year. A fifth recalled falling at least three times in the last year. Figure 6.4.4.1 plots the frequencies of remembered falls in the previous year, ranging from none to "too many to remember". The distribution shows a strong positive skew: 46/109 (42%) remembered no falls in the past year and 26/109 (24%) reported only falling once.

Figure 6.4.4.2 and Figure 6.4.4.3 show the prevalence of reporting falling at least once, more than once and three times or more broken down by sex and by place of residence. There were only slight differences in the prevalence of falling between men and women, but repeated falling and the number of falls reported were about 50% higher amongst women than men. Community dwelling older people reported falling less than those in any sort of supported care setting including those in sheltered housing whose residents reported falling as much as or more than those living in institutional care. Section 6.6 later in this chapter explores the associations between remembered falls and a range of covariates including these and other demographic factors.

Figure 6.4.4.1 Frequency of recalled falls in the past year reported at interview

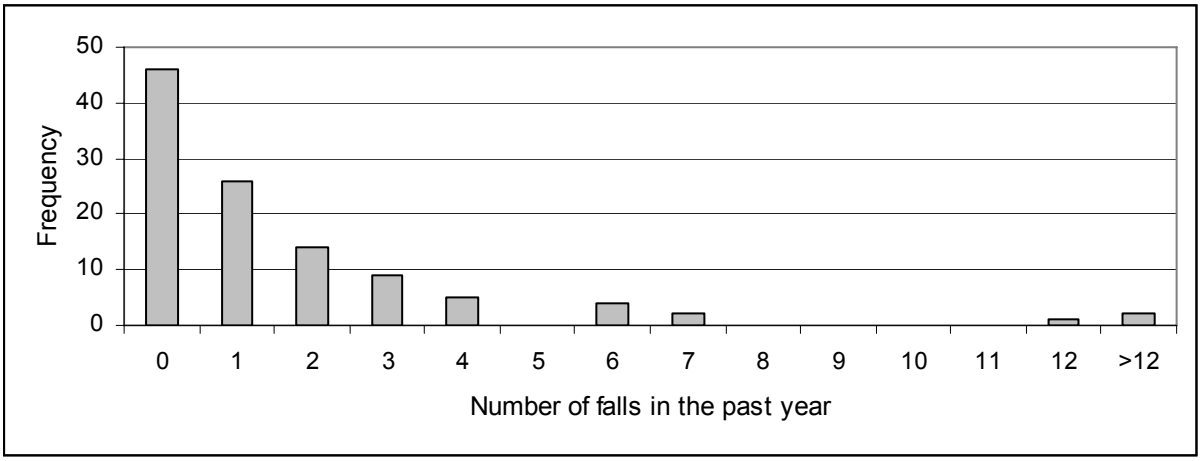


Figure 6.4.4.2 Falls and repeated falls in the past year remembered at interview by men and women aged over 90 years old

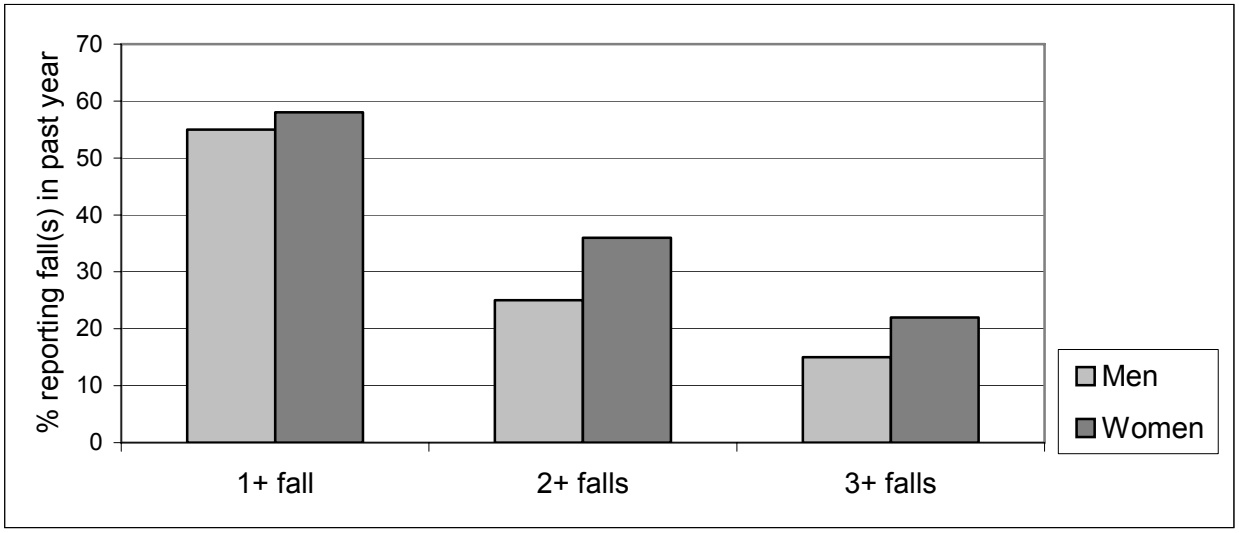
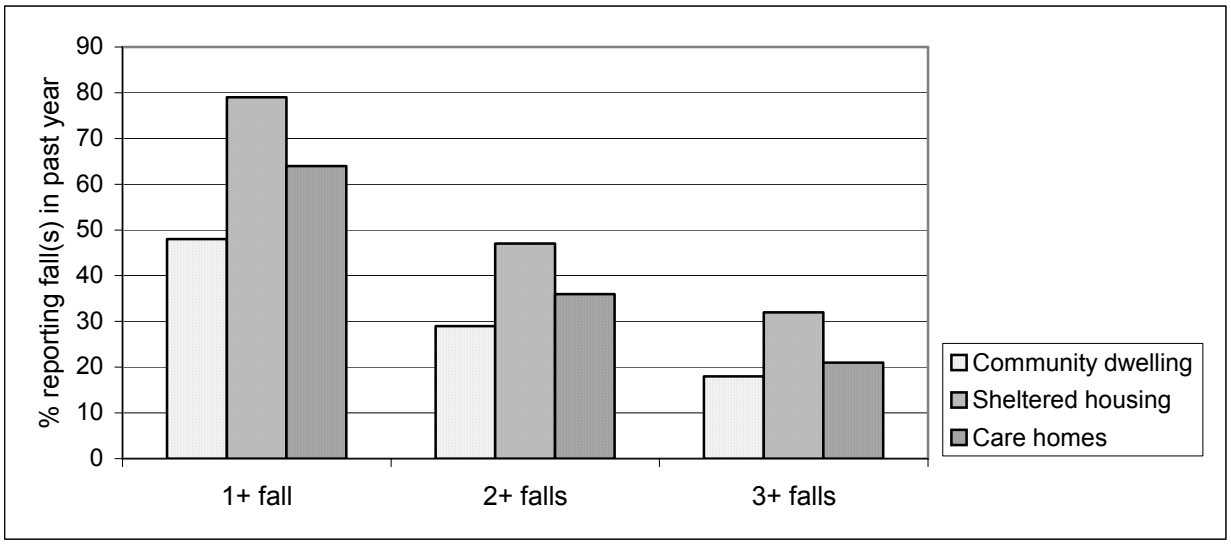


Figure 6.4.4.3 Falls and repeated falls in the past year remembered at interview by over-90-year-olds living in different residential settings



6.5 Reported circumstances of and consequences of remembered falls

6.5.1 Circumstances of last remembered falls reported at interview
6.5.2 Consequences of last remembered falls reported at interview
6.5.3 Injuries as a result of falling

6.5.1 Circumstances of last remembered falls reported at interview

Participants were asked to describe the last fall they remembered and also, if this was a different occasion, the last fall which resulted in any injury. Data on injurious falls that were not the last recalled falls are included in section 6.5.3 *Injuries as a result of falling* but not in this and the following sections (6.5.1 and 6.5.2). As Table 6.5.1.1 shows, there were virtually no differences between the recalled circumstances of injurious and non-injurious last falls, except that those who remembered hurting themselves last time they fell reported slightly higher proportions of falls occurring at night, outdoors and from higher than standing height. These features were the relatively uncommon circumstances and none of these differences were significant.

Around two-thirds of all last recalled falls happened in the daytime, indoors, from standing and were described by respondents as accidents. Only rarely was any cause other than an accident ascribed to a fall. Just 3% described their fall as the result of feeling dizzy, no-one remembered "blacking out" and nor did proxy informants report either of these causes. A quarter of those who remembered falling could not say why they had fallen.

Table 6.5.1.1 Reported circumstances of last recalled falls with / without injury

	Participants recalling their last fall caused some injury [n=63]		Participants recalling their last fall caused no injury [n=35]		Participants recalling any fall (+/-injury) [n=98]	
	n	(%)	n	(%)	n	(%)
TIME						
Daytime	44	(70)	23	(66)	67	(68)
Evening	6	(10)	4	(11)	10	(10)
Night	12	(19)	5	(14)	17	(17)
Unknown	1	(2)	3	(9)	4	(4)
LOCATION						
Indoors	41	(65)	26	(74)	67	(68)
Outdoors	21	(33)	9	(26)	30	(31)
Unknown	1	(2)			1	(1)
HEIGHT FALLEN						
From standing	45	(71)	22	(63)	67	(68)
From bed, chair or bending down	15	(24)	9	(26)	24	(25)
Unknown	3	(5)	4	(11)	7	(7)
From higher than standing height	9	(14)	1	(3)	10	(10)
From standing height or less	52	(83)	32	(91)	84	(86)
Unknown	2	(3)	2	(6)	4	(4)
CAUSE						
Accident	45	(71)	22	(63)	67	(68)
Dizziness	2	(3)	1	(3)	3	(3)
Blackout	0		0		0	
Other	2	(3)	2	(6)	4	(4)
Not known	14	(22)	10	(29)	24	(25)

6.5.2 Consequences of last remembered falls reported at interview

Sixty-four per cent (63/98) of last remembered falls resulted in some form of injury. Table 6.5.2.1 summarises some of the sequelae of the most recent fall remembered, showing separately the reports of participants who said they had hurt themselves when they last fell, those who had not and of all last recalled falls.

Only 39% of the study participants who reported any past fall had been able to get up by themselves when they last fell. More than half of those who recalled no injury from the last fall had been able to get up unaided but of those who remembered hurting themselves it was only a third had got themselves up (p=0.08). The vast majority (83%) of those who could were on the floor less than five minutes, as compared with only a third of those who needed help to get up (see Figure 6.5.2.2). Over a quarter (27%) of those who could not get up unaided when they last fell suffered a "long lie" of more than two hours (in several cases overnight) before anyone arrived to help them, another 8% waited between 1 and 2 hours, and nearly a third (31%) more were on the floor for up to an hour.

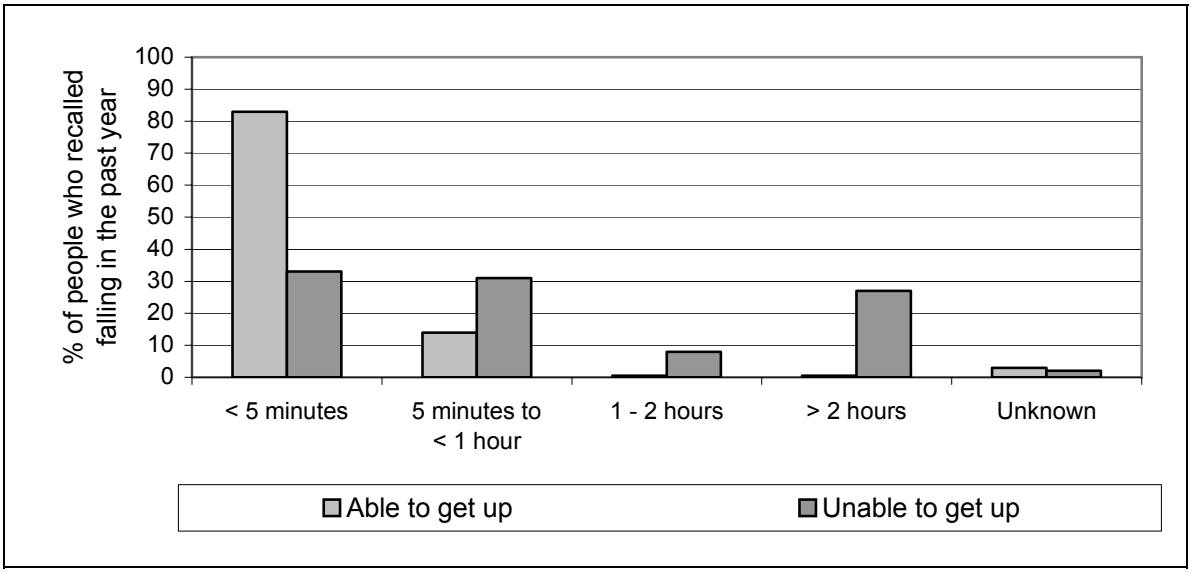
One in ten people remembered using a personal alarm system or a call bell installed in the room to call for assistance when they last fell. At the time of interview only a fifth of the participants did not have access to one or other or both these types of call alarm systems, but clearly these may not have been available at the time of the last fall.

Almost everyone who recalled an injury the last time they fell (94%) had told a relative, friend, neighbour or carer about the fall that caused the injury, and 72% of those without injury had also told someone. GPs or other healthcare staff had been told about only a tenth of the non-injurious last falls, while 59% reported that their GP knew about the last fall injury and a third had told another health professional (mainly ambulance crew and district or practice nurses). Hospital attendance following a fall resulting in injury was high: 43% of those who recalled an injury from their last fall remembered going to a casualty department and 30% said they had been admitted at least overnight. About one in five of all the most recent recalled falls led to a stay in hospital.

Table 6.5.2.1 Reported consequences of last recalled falls with / without injury

	Participants recalling their last fall led to injury [n=63]		Participants recalling their last fall caused no injury [n=35]		Participants recalling any fall (+/-injury) [n=98]	
	n	(%)	n	(%)	n	(%)
UNABLE TO GET UP UNAIDED						
Needed help to get up	35	(56)	17	(49)	52	(53)
Got up without anyone helping	21	(33)	18	(51)	39	(39)
Not known	7	(11)	0		7	(7)
LONG LIE ON THE FLOOR						
< 5 minutes	38	(60)	16	(46)	54	(55)
5 minutes to < 1 hour	14	(22)	12	(34)	26	(27)
1 – 2 hours	2	(3)	0		2	(2)
> 2 hours	7	(11)	4	(11)	11	(11)
Not known	2	(3)	3	(9)	5	(5)
TELLING OTHERS ABOUT A FALL						
Family, friend, carer or neighbour	59	(94)	25	(72)	84	(86)
Call alarm - warden or call centre	6	(10)	4	(11)	10	(10)
PRESENTING TO SERVICES						
General practitioner	37	(59)	3	(9)	40	(41)
Other healthcare professional	21	(33)	4	(11)	25	(26)
Accident and Emergency Dept.	27	(43)	0		27	(28)
Hospital admission	19	(30)	0		19	(19)
Already in hospital	0		1	(3)	1	(1)

Figure 6.5.2.2 Recalled length of time on the floor after last remembered fall for people reported able or unable to get up unaided



6.5.3 Injuries as a result of falling

Table 6.5.3.1 presents injury data from all those who remembered a previous fall in which they had hurt themselves, not necessarily their most recent fall (n=93). Proportions shown total more than 100% as many individuals reported more than one injury from a single fall. The most common sites of injury reported from the last injurious fall were "hips, legs or feet" (about half), "head or face" and "shoulders, arms, wrists or hands" (about a quarter each). Half the reported injuries were a "bruise, bump or swelling", with a fracture (27%) reported at least as commonly as a "cut or laceration" (23%).

Table 6.5.3.1 Recalled injury and treatment as a result of falling in the past year

	Participants recalling their most recent fall that led to any injury [n=93]	
	n	(%)
TYPE OF INJURY		
Bruise, bump or swelling	47	(51)
Graze, scrape or abrasion	7	(8)
Cut or laceration	21	(23)
Sprain or strain	7	(8)
Fracture	25	(27)
Head injury	0	
Back pain	1	(1)
SITE OF INJURY		
Hips, legs or feet	47	(51)
Shoulders, arms, wrists or hands	23	(25)
Trunk, back or neck	13	(14)
Head or face	24	(26)
Other	7	(8)
TREATMENT		
No treatment	38	(41)
At home	11	(12)
At GP surgery	1	(1)
In hospital	43	(46)

6.6 Factors associated with remembered falls

6.6.1 Demographics
6.6.2 Cognitive function
6.6.3 Reported balance problems and fear of falling
6.6.3.1 Perceived problems with balance
6.6.3.2 Worry about falling
6.6.4 Health and disability
6.6.4.1 Self-rated health
6.6.4.2 Medication
6.6.4.3 Activities of daily living
6.6.5 Mobility – reported measures
6.6.5.1 Limitation in walking distance
6.6.5.2 Use of walking aids
6.6.5.3 Stair climbing
6.6.5.4 Reported physical activity or exercise
6.6.6 Mobility – observed functional performance measures
6.6.6.1 Static balance tests
6.6.6.2 Dynamic balance tests
6.6.6.3 Gait speed
6.6.6.4 Hand grip strength

Analytical approach

Chapter 4 characterised the study sample population in terms of a variety of descriptors that the existing literature has highlighted as relevant to the problem of falling in old age. This section now examines how these key factors relate to the retrospectively recalled falls data collected at interview. An equivalent section of the following chapter examines to what extent these same factors predict falling in the prospective falls follow-up data. The statistical approaches to these analyses of association between potential risk factors identified a priori from the literature and the study outcomes are explained in more detail in section 2.4.3 *Analysis of association* under Chapter 2's section *Data handling and analytical approach*. For the recalled fall data in this chapter these include exploratory bi-variate analyses, logistic regression with the outcomes "faller" and "repeat faller" in the last year and negative binomial regression on the number of falls in the last year.

6.6.1 Demographics

Age
Gender
Education and social class
Place of residence

The findings described below and illustrated in Figures 6.6.1.1-6 are summarised in Tables 6.6.1.7 and 6.6.1.8 at the end of this section.

Age

Older age was associated with reported previous falls, despite the relatively narrow age-range. Figure 6.6.1.1 suggests a trend towards increasing proportions recalling falls and repeated falls across the tenth decade, though the trend in incidence rates is less clear-cut in Figure 6.6.1.2. A similar pattern was seen regardless of the time period of recall used or the measures taken: age as a continuous variable or age-band (aged 95 or older versus <95 years) were both significantly associated with prevalence of recalled falling or falling more than once, and with incidence rates using the number of reported falls in the past year (see Tables 6.6.1.7 and 6.6.1.8). However, there were data from only two centenarians giving proportions ranging from 0 to 100% and both the highest and lowest incidence rates, obviously with wide confidence intervals. To test to what extent the significance of age is driven by one individual aged 102 with 7 reported falls in the past year, analyses were repeated excluding her and the effect of age-band remained, as did the association between age (as a continuous count) and repeated falls.

Gender

Higher proportions of women than of men reported past falls (see Figure 6.6.1.3) but these gender differences were not significant. Almost identical proportions of both remembered having fallen in the past year (55% of men and 58% of women) but differences widened in the measures of repeated falling (see Tables 6.6.1.7 and 6.6.1.8). Odds ratios associated with having fallen more then once over different past time periods were in a range consistent with the rate ratio of falls incidence calculated from the number of falls reported by women compared with that of men: RR 1.5 (95% CI 0.7 – 3.1).

Figure 6.6.1.1 Prevalence of recalled falling at least once or more than once last year by age

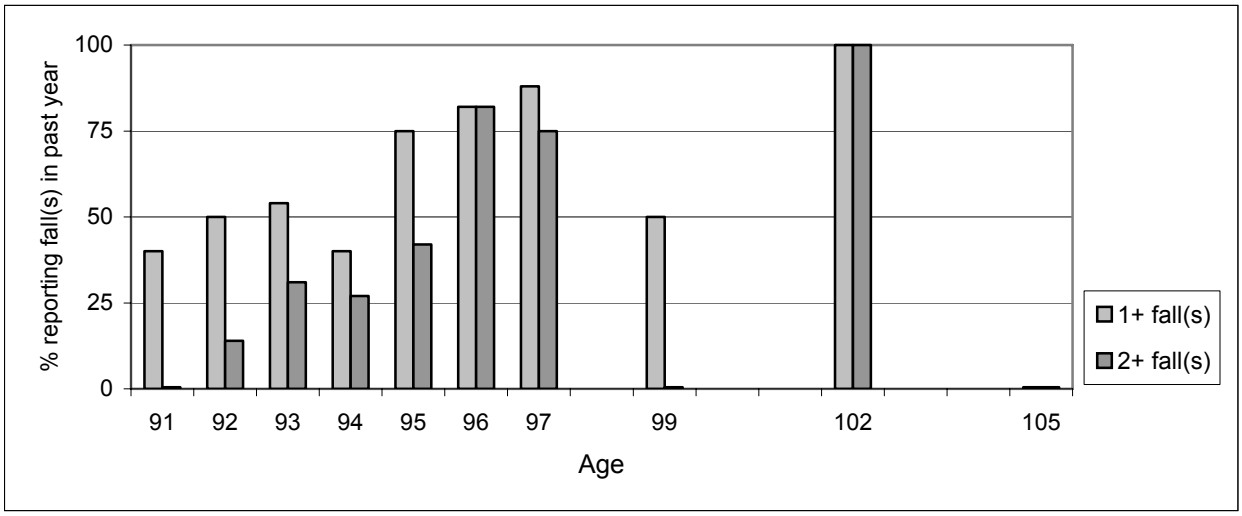


Figure 6.6.1.2 Incidence of recalled falls in the past year by age

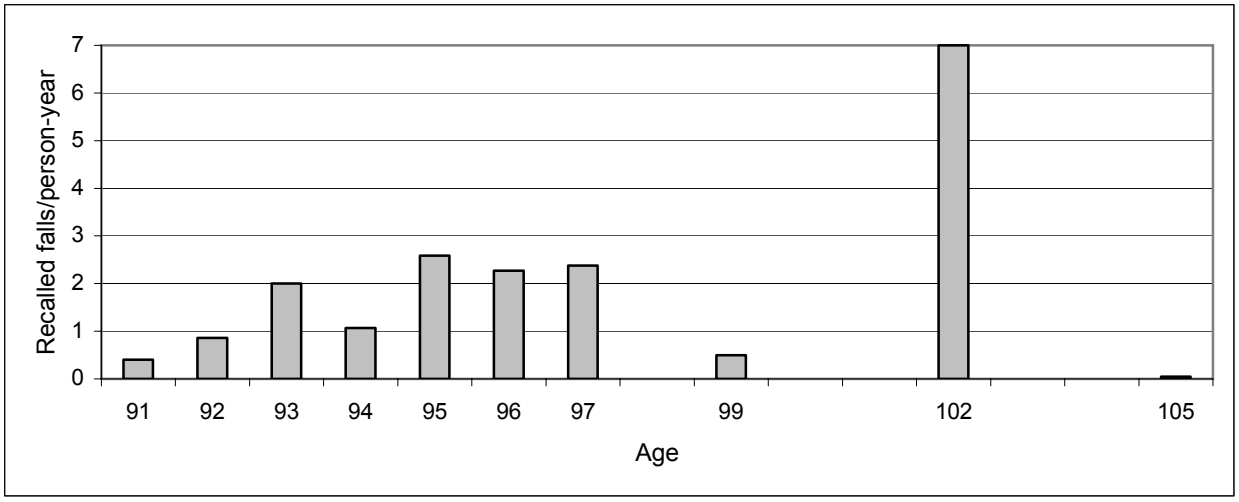
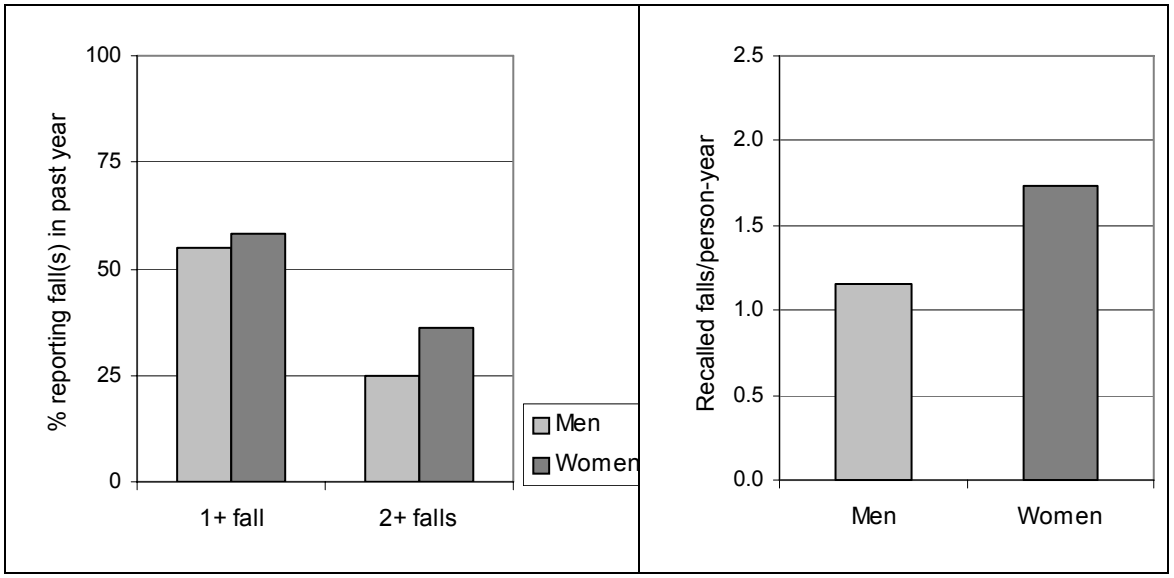


Figure 6.6.1.3 Prevalence and incidence of recalled falls in the past year by sex



Education and social class

Participants who had continued full-time education beyond school leaving age reported a higher rate of falling in the past year, and a significantly higher proportion of them recalled at least one fall compared with those who had left school by the age of 14 years old (see Figure 6.6.1.4). This association remained even when adjusted for age, sex, place of residence and level of cognition and was still bordering significance when all four covariates were added in the same model: adjusted OR 2.3 (95% CI 1.0 – 5.4) p=0.06. There were no social class differences in reporting of remembered falls (see Figure 6.6.1.5)

Place of residence

Sheltered housing residents remembered falling as frequently as was reported for those living in institutional care settings. Incidence rates based on falls recalled as occurring in the past year were identical, and prevalence of reportedly having fallen in the past year, or fallen twice, were even higher in sheltered accommodation (see Figure 6.6.1.6). Dichotomising the sample to compare those resident in any form of supported living setting – sheltered schemes, residential and nursing homes or long-stay hospital wards – with the remainder living in the community showed a 2 ½ fold odds of having fallen associated with supported residential status, and an almost 2 fold risk ratio (see Table 6.6.1.7 and 6.6.1.8)

Figure 6.6.1.4 Prevalence and incidence of recalled falls in the past year by education

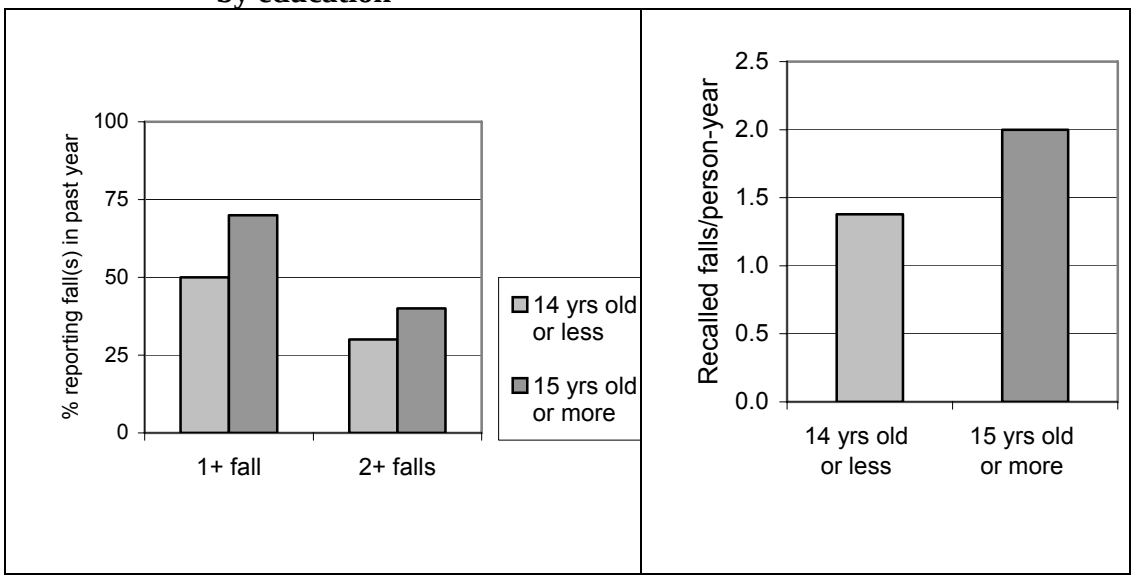


Figure 6.6.1.5 Prevalence and incidence of recalled falls in the past year by social class

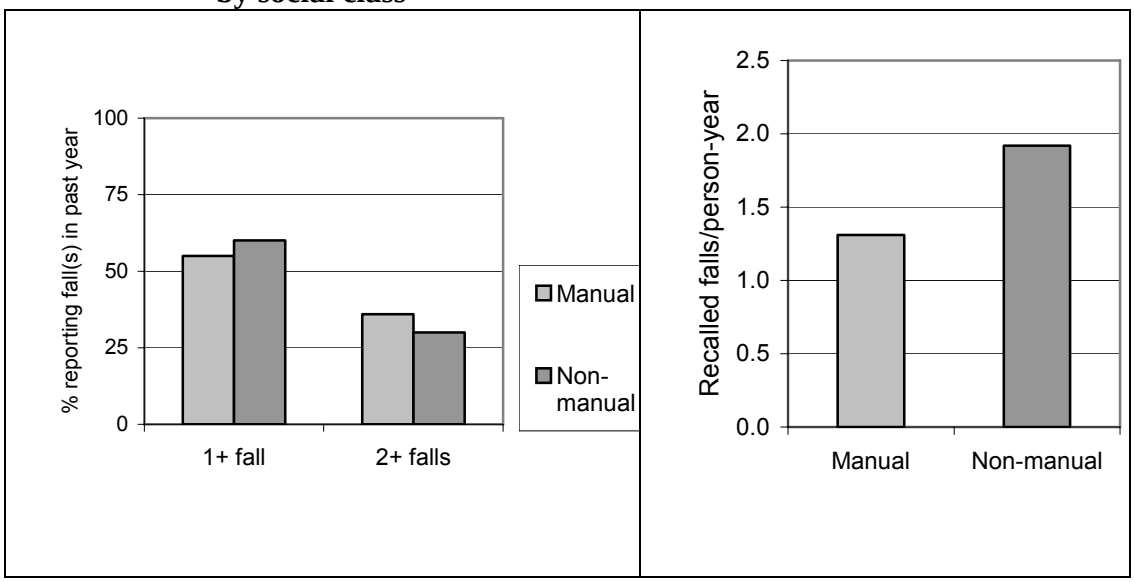
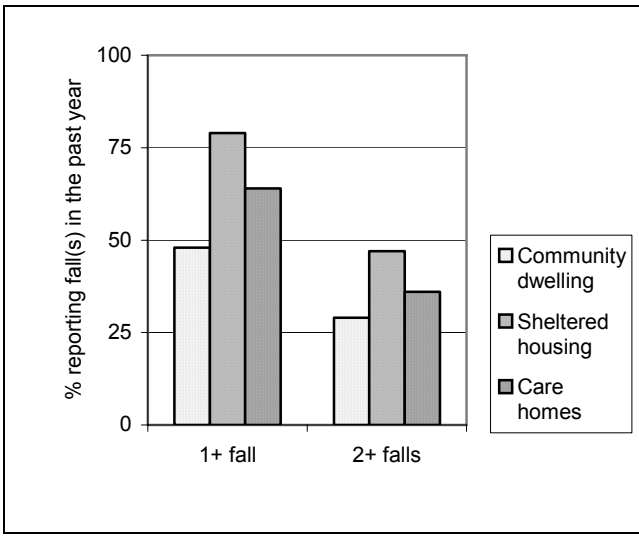


Figure 6.6.1.6 Prevalence and incidence of recalled falls in the past year by place of residence


100
75
50
25
0
% reporting fall(s) in the past year
1+ fall
2+ falls
Community dwelling
Sheltered housing
Care homes

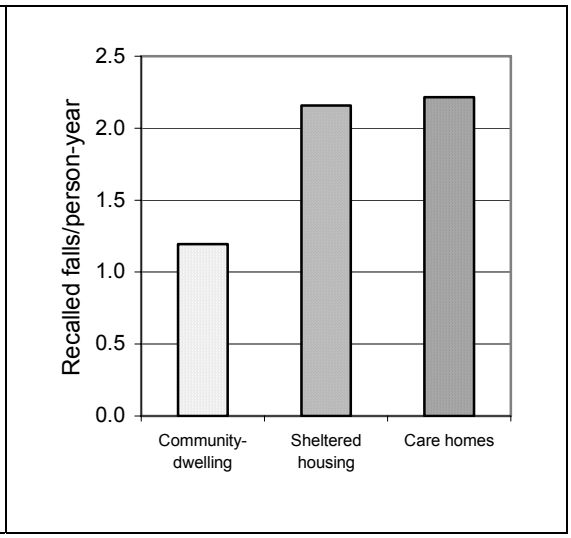

2.5
2.0
1.5
1.0
0.5
0.0
Recalled falls/person-year
Community-dwelling
Sheltered housing
Care homes

Table 6.6.1.7 Demographic associations: ORs for recalled falling and repeat falling

	Past year falls data n	Recalled ≥ 1 fall n (%)	Odds Ratio unadjusted (95% C.I.)	Recalled ≥ 2 falls n (%)	Odds Ratio unadjusted (95% C.I.)
AGE-BAND					
91-94	74	36 (48)	1.0	16 (22)	1.0
≥ 95	35	27 (77)	**3.6 (1.4-8.9)**	21 (60)	***5.4 (2.3-13.0)***
AGE					
Each additional year			**1.2 (1.0-1.4)**		**1.4 (1.1-1.7)**
GENDER					
Men	20	11 (55)	1.0	5 (25)	1.0
Women	89	52 (58)	1.2 (0.4-3.1)	32 (36)	1.7 (0.6-5.1)
EDUCATION					
Left school aged 14 yrs or less	66	33 (50)	1.0	20 (30)	1.0
Full-time education aged 15+ yrs	43	30 (70)	**2.3 (1.0-5.2)**	17 (40)	1.5 (0.7-3.7)
SOCIAL CLASS					
Manual	55	30 (55)	1.0	20 (36)	1.0
Non-manual	50	30 (60)	1.3 (0.6-2.7)	15 (30)	0.8 (0.3-1.7)
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	62	30 (48)	1.0	18 (29)	1.0
Living in any supported setting (Sheltered housing or institution)	47	33 (70)	**2.5 (1.1-5.6)**	19 (40)	1.7 (0.8-3.7)
TOTAL SAMPLE	109	63 (58)		37 (34)	

Table 6.6.1.8 Demographic associations: Relative risk for incidence of recalled falls

	Number recalled of falls	Person-years with recalled falls data	Incidence of recalled falls /100 p-years	Relative Risk - unadjusted (95% C.I.)
AGE-BAND				
91-94	94	74	127	1.0
≥ 95	83	35	237	**1.9 (1.1-3.2)**
AGE				
Each additional year				**1.2 (0.99-1.3)**
GENDER				
Men	23	20	115	1.0
Women	154	89	173	1.5 (0.7-3.1)
EDUCATION				
Left school aged 14 yrs or less	91	66	138	1.0
Full-time education aged 15+ yrs	86	43	200	1.5 (0.8-2.5)
SOCIAL CLASS				
Manual	72	55	131	1.0
Non-manual	96	50	192	1.5 (0.8-2.6)
PLACE OF RESIDENCE				
Living in the community (house, flat or granny flat)	74	62	119	1.0
Living in any supported setting (Sheltered housing or institution)	103	47	219	**1.8 (1.08-3.12)**
TOTAL SAMPLE	177	109	162	

6.6.2 Cognitive function

There was a consistent pattern that the more cognitively impaired groups tended to have more remembered falls reported, but the proportions were only slightly higher than amongst the cognitively intact (see Figure 6.6.2.1). The exception was for the longest time frame: falls over the last five years were as commonly remembered by the cognitively intact as by the severely impaired but clearly questions of recall are especially pertinent to any examination of associations with cognition. Information about past falls was provided by proxy informants for the severely cognitively impaired, but this was not always the case for those with moderate cognitive impairment. This latter group may have over-reported not having fallen for over five years and never having had a fall.

Cognitive function made little difference to the reported prevalence of having falling in the last year, but reports of more than one fall in the previous year were more common for the severely cognitively impaired (see Figure 6.6.2.2), which guided the data split shown in Tables 6.6.2.3 and 6.6.2.4 With such small numbers these differences were only significant for the differences in proportions falling three or more times: unadjusted OR 3.2 (95% C.I. 1.2-8.2). Incidence rates calculated from recalled falls give the same picture of an association between cognitive impairment and recurrent falling. Although there were no significant differences in the proportions of participants of different cognitive levels who remembered previous falls or who were reported to have fallen in the past, regardless of the time period taken, the incidence of falls recalled as occurring in the past year was higher amongst those with severe cognitive impairment both when compared any lesser degree of impairment (or when compared with just the cognitively intact (Unadjusted RRs 2.6 (95% C.I.s 1.5-4.3) and 2.5 (95% C.I.s 1.4-4.7) respectively).

Figure 6.6.2.1 Prevalence of recalled falls over different time periods by cognition

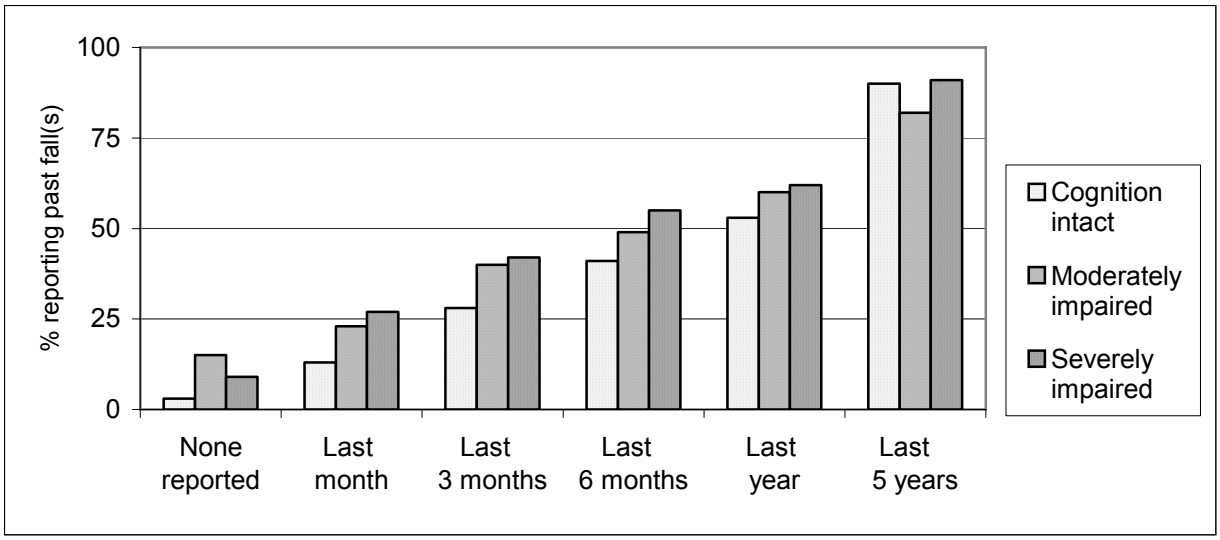


Figure 6.6.2.2 Prevalence of falling and repeated falling last year by cognition

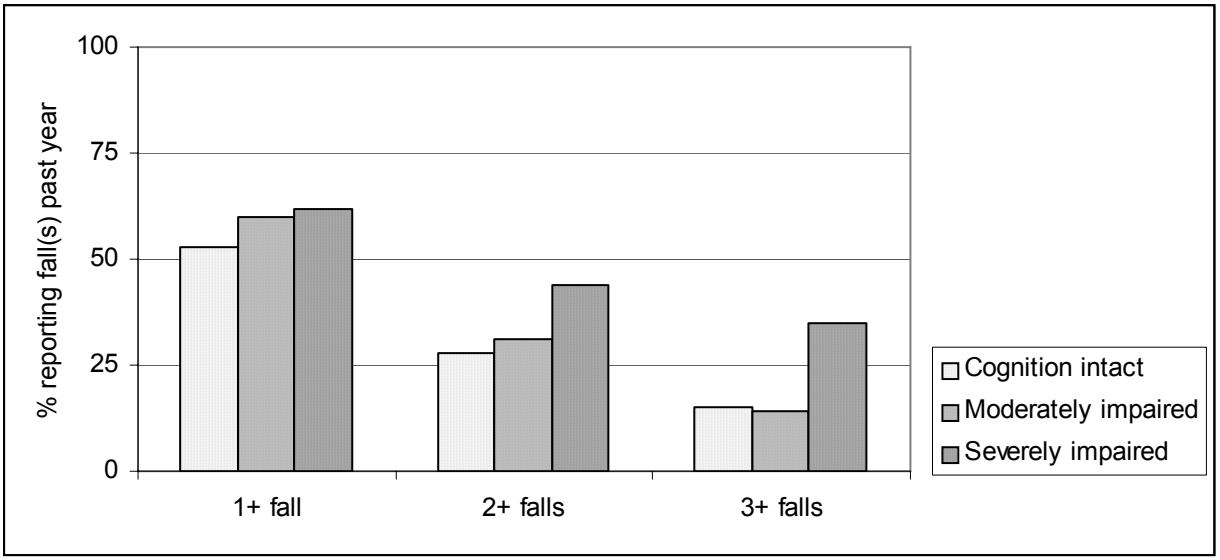


Table 6.6.2.3 Associations with cognition: ORs for recalled falling and repeat falling

	Number with data on falls in past year	Recalled at least 1 fall n (%)	Odds Ratio unadjusted (95% C.I.)	Recalled more than 1 fall n (%)	Odds Ratio unadjusted (95% C.I.)
Cognition intact / Mod. Impairment	75	42 (56)	1.0	22 (29)	1.0
Severe cognitive impairment	34	21 (62)	1.3 (0.6-2.9)	15 (44)	1.9 (0.8-4.4)

Table 6.6.2.4 Associations with cognition: Relative risk for incidence of recalled falls

	Number recalled of falls	Person-years with recalled falls data	Incidence of recalled falls /100 p-years	Relative Risk - unadjusted (95% C.I.)
Cognition intact / Mod. Impairment	82	75	1.09	1.0
Severe cognitive impairment	95	34	2.79	**2.6 (1.5-4.3)**

6.6.3 Reported balance problems and fear of falling

6.6.3.1 Perceived problems with balance
6.6.3.2 Fear of falling

6.6.3.1 Perceived problems with balance

Two of the items in the list of conditions in interview question 68 (see Appendix C) about which participants were asked provide a measure of how very old people in our sample perceive their balance. Being "unsteady on your feet" was the most commonly reported of the ten items, affecting 71% of men and 83% of women. The majority of both sexes (2/3 of men and 4/5 of women) described this problem as disabling.

For both measures there was a clear gradient across categories: falls in the past year were reported more frequently with reportedly worse balance problems (see Figure 6.6.3.1.1). The accompanying tables (6.6.3.1.2-3) confirm that the risk estimates associated with recalled falling, repeat falling and number of falls in the past year are all higher if the balance difficulty is rated disabling. Unsteadiness confers a 2- to 4-fold increase and having a tendency to fall is associated with fall risk estimates between 3 and almost 7 times higher.

Figure 6.6.3.1.1 Reported problems with balance in relation to recalled falls rates

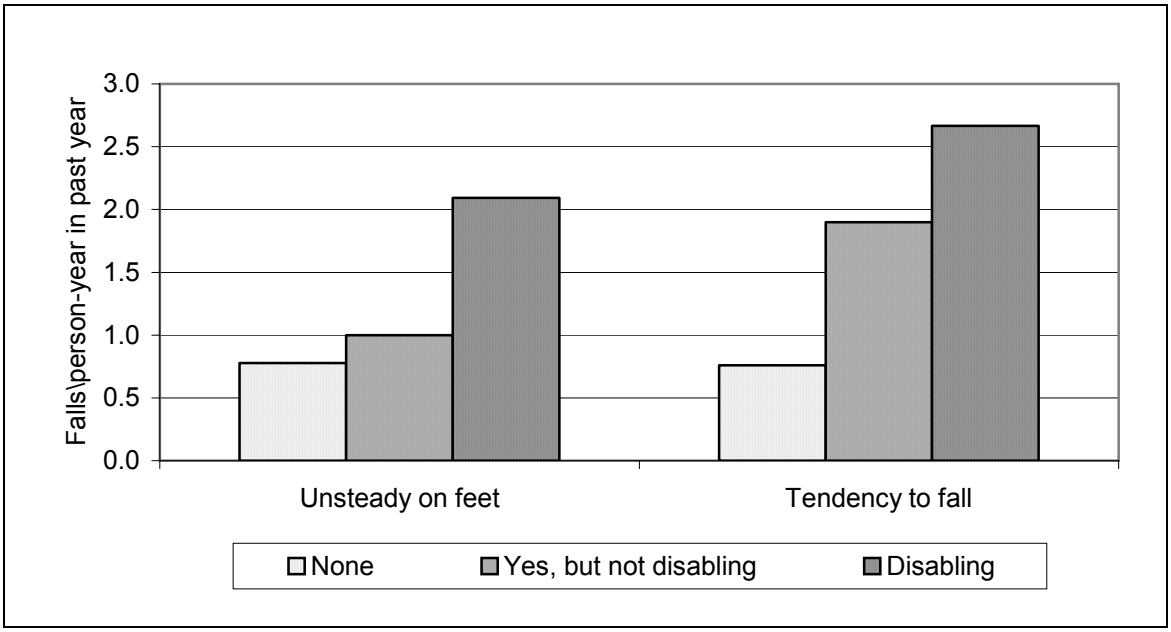


Table 6.6.3.1.2 Reported problems with balance: Odds ratios and relative risks associated with falling, repeated falling & number of falls in the past year

	CONDITION RATED AS DISABLING		CONDITION PRESENT TO ANY EXTENT, DISABLING OR NOT	
	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)
Unsteady on feet	2.1 (0.95-4.9)	**3.9 (1.4-10.6)**	2.6 (0.9-7.3)	3.3 0.9-12.1)
Tendency to fall	**3.0 (1.3-7.0)**	**5.5 (2.2-13.4)**	**3.7 (1.6-8.3)**	**6.8 (2.6-18.0)**

Table 6.6.3.1.3 Reported problems with balance: Relative risks of falls in the past year comparing effects whether respondents rated problems as disabling or not

	CONDITION RATED AS DISABLING	CONDITION PRESENT TO ANY EXTENT, DISABLING OR NOT
	Relative Risk of falls - unadjusted (95% C.I.)	Relative Risk of falls - unadjusted (95% C.I.)
Unsteady on feet	**2.5 (1.3-4.6)**	**2.6 (1.1-6.0)**
Tendency to fall	**3.0 (1.8-5.2)**	**3.7 (2.1-6.3)**

6.6.3.2 Fear of falling

Worry about falling in relation to recalled falls and falls with injury

Of the vast majority who had fallen before, more than half those asked the single question "Are you worried about falling?" [156;737] said they were not worried about falling again (36/68 or 53%). An even higher proportion of the minority who reported no past falls but who were asked whether they were worried about falling (6/8 or 75%) said they were not.

All but one of the people who said they were worried about falling had fallen before (25/26 or 96%), but almost as high a proportion of those who said they were not worried about it also recalled past falls (36/43 or 84%).

61 (78%) of the 78 people asked whether they were worried about falling had hurt themselves in a past fall. 41% of them were worried about falling again, as compared with only (1/11) 9% of those who reported no previous fall injuries.

Figures 6.6.3.2.1 illustrates the prevalence of single and repeated falls and fall incidence in the past year were all higher amongst those worried about falling, than those who could not give a clear response and lowest amongst those who said they were not worried. The relative risk of falls in the past year and odds of having fallen more than once in the past year was increased three-fold amongst those who reported being worried about falling (see Table 6.6.3.2.3).

Falls Efficacy

A similar pattern of increasing likelihood of multiple recalled falls was found in relation to falls efficacy scale scores. As Figure 6.6.3.2.2 shows, the lowest score tertile – those least confident about not falling during daily activities – recalled more multiple falls and higher falls rates in the past year. However, recall of at least one fall was even more common amongst the most confident top tertile so the risk estimates in Table 6.6.3.2.3 show contradictory effects, though all with wide confidence intervals.

Figure 6.6.3.2.1 Prevalence and incidence of falls in the past year in relation to worry about falling

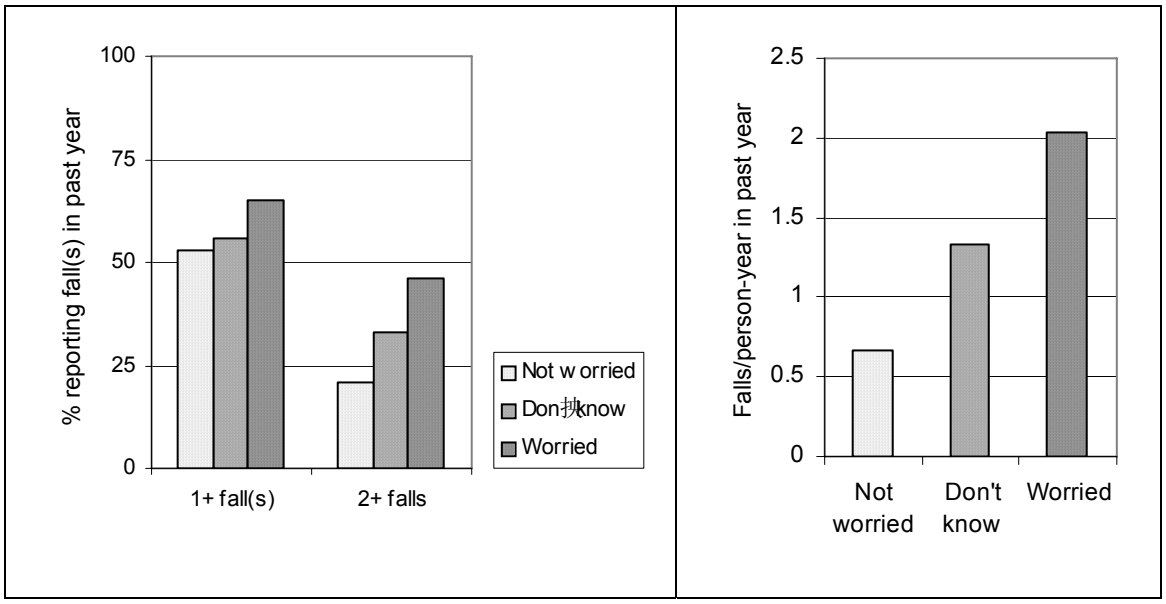


Figure 6.6.3.2.2 Prevalence and incidence of falls in the past year in relation to falls efficacy

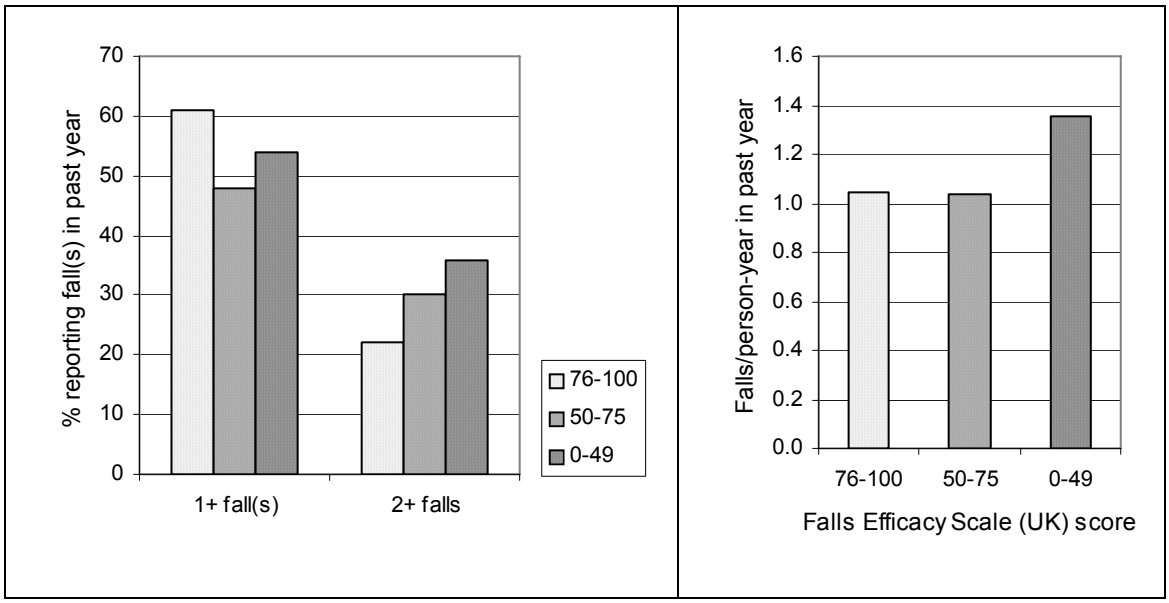


Table 6.6.3.2.3 Fear of falling in relation to recalled falling, repeated falling and falls in the past year

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Not worried about falls n=43	23 (53)	1.0	9 (21)	1.0	1.0
Worried about falls n=26	17 (65)	1.6 (0.6-4.5)	12 (46)	**3.2 (1.1-9.4)**	**3.0 (1.6-5.8)**
FES-UK score 76 -100 n=23	14 (61)	1.0	5 (22)	1.0	1.0
FES-UK score 50 - 75 n=27	13 (48)	0.6 (0.2-1.8)	8 (30)	1.5 (0.4-5.5)	1.0 (0.4-2.4)
FES-UK score 0 - 49 n=28	15 (54)	0.7 (0.2-2.3)	10 (36)	2.0 (0.6-7.0)	1.3 (0.5-3.1)

6.6.4 Health and disability

6.6.4.1 Visual impairment
6.6.4.2 Hearing impairment
6.6.4.3 Weakness
6.6.4.4 Arthritis
6.6.4.5 Incontinence
6.6.4.6 Depression
6.6.4.7 Co-morbidity
6.6.4.8 Self-rated health
6.6.4.9 Activities of daily living
6.6.4.10 Medication

The effects of health and disability on falling have been investigated by many previous researchers, and sections 1.2.4 and 1.2.5 of the introductory chapter reviewed their findings. This section now examines the associations between the recalled falls of CC75C's "old old" sample and some of the health-related conditions identified in the research literature as predictive of falls for older people, often from studies of much younger old people. Data in the present study do not permit exploration of all the key factors highlighted in Chapter 1, for example the CC75C interview schedule has no question about Parkinson's disease and the number who reported a past stroke was too low for meaningful analysis. The sub-section titles above list which aspects of health it is possible to examine in this study.

As already explained fully in Chapter 2, section 2.1.2 *Measures used to date in CC75C*, health status was assessed in a number of ways – interview questions about reported diagnoses, health-related conditions that may affect life day-to-day, self-rated general health and activities of daily living, review of prescribed medications and two short interviewer assessments of hearing and eyesight.

6.6.4.1 Visual impairment

Although visual impairment, as assessed by the reading vision test, appeared to double the relative risk of falls as recalled in the previous year, all other associations between recalled falls measures and either reported or observed impairments were inconclusive. Self-reported "poor vision" showed only slight positive, negative or null effects (see Figure 6.6.4.1 and Table 6.6.4.2).

6.6.4.2 Hearing impairment

Figure 6.6.4.1 and Table 6.6.4.2 present the associations found between measures of recalled falling in the previous year and two measures of hearing: any reported hearing loss and assessed hearing impairment (inability to hear and accurately repeat at normal speech volume). As reported in Chapter 4, there was marked discrepancy between estimates of hearing disability derived from the reported and observed measures of hearing and this may contribute to the conflicting picture presented by the results in this table. Reported hearing loss appears to be associated with increased recalled fall measures, but objectively assessed hearing impairment shows no clear pattern of association.

Figure 6.6.4.1 Incidence of recalled falls in the past year by reported and assessed visual impairment and hearing loss

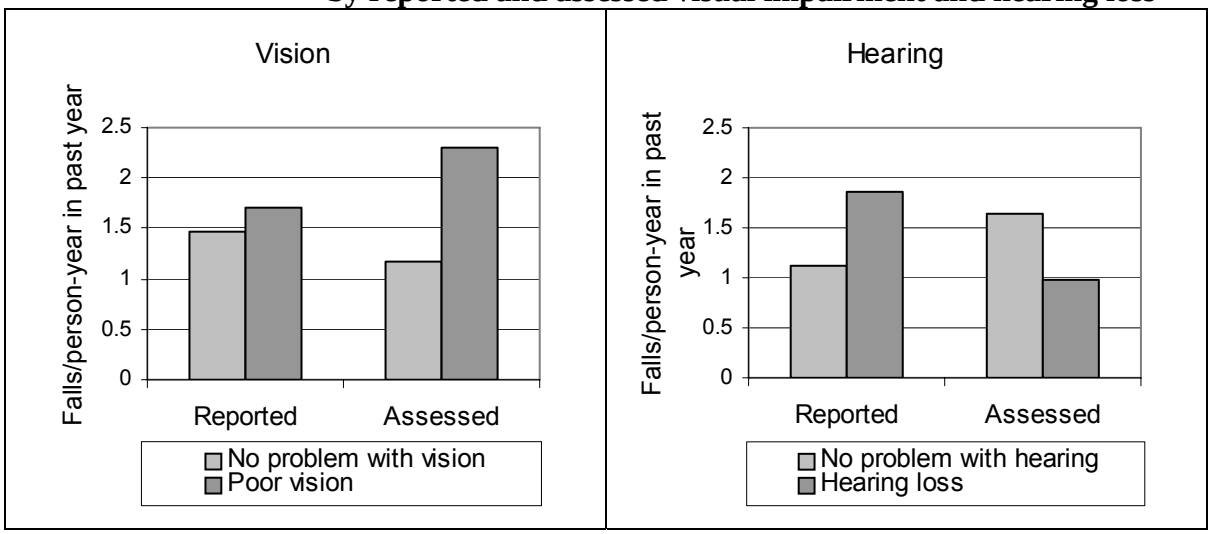


Table 6.6.4.2 Poor vision and hearing loss – reported and tested – in relation to falling, repeated falling and falls in the past year

		At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Reported poor vision *						
No problem reported	n=45	28 (62)	1.0	15 (33)	1.0	1.0
Any - disabling or not	n=61	34 (56)	0.8 (0.4-1.7)	22 (36)	1.1 (0.5-2.5)	1.2 (0.7-2.1)
Visual impairment †						
Able to read 3mm print	n=68	41 (60)	1.0	24 (35)	1.0	1.0
Unable to read 3mm print	n=27	15 (56)	0.8 (0.3-2.0)	8 (30)	0.8 (0.3-2.0)	**2.0 (1.03-3.7)**
Reported hearing loss ‡						
No problem reported	n=37	16 (43)	1.0	9 (24)	1.0	1.0
Any - disabling or not	n=68	45 (66)	**2.6 (1.1-5.8)**	27 (40)	2.0 (0.8-5.0)	1.7 (0.9-3.1)
Hearing loss §						
Can hear normal speech	n=44	25 (57)	1.0	12 (27)	1.0	1.0
Cannot hear accurately…	n=46	27 (59)	1.1 (0.5-2.5)	16 (35)	1.4 (0.6-3.5)	0.6 (0.3-1.1)

* Missing data on "poor vision" (n=3) and number of falls in the past year (n=1)
† n=96 took reading print size assessment, less n=1 whose falls in the past year were unknown
‡ Missing data on "hearing loss" (n=4) and number of falls in the past year (n=1)
§ n=91 had hearing assessed with whisper test, less n=1 whose falls in the past year were unknown

A number of other health-related conditions that previous research has identified as linked with falling could be examined in the current study data; these are described below and presented in Figure 6.6.4.3 and Table 6.6.4.4

6.6.4.3 Weakness

The effects on recalled fall measures of reporting any "Marked weakness in arms or legs" were examined on the assumption that this question provided a surrogate measure of muscle strength. Odds ratios for falling and repeated falling in the past year are negligibly increased; the 50% relative risk increase carries wide confidence intervals.

6.6.4.4 Arthritis

People reported to have "arthritis/rheumatism" were no more likely to recall having fallen in the previous year than those who had none, but were three times as likely to remember recurrent falls. The relative risk of recalled falls was also raised, but less so.

6.6.4.5 Incontinence

Only arthritis gave any associations as strong as those found between incontinence and the repeated falling measures. People who had "accidents more than once a week" had two- to three-fold increased falls risk compared with those who rarely or never suffered episodes of incontinence.

6.6.4.6 Depression

People who recalled having fallen at least twice in the past year scored significantly higher on the Depressive Symptoms Scale (DSS). The risk estimates for falling during follow-up, falling more than once and for the number of falls were increased two- to three-fold amongst those with DSS scores higher than the median.

6.6.4.7 Co-morbidity

Risk estimates associated with remembered recurrent falling in the past year – the relative risk of falls and the odds for having fallen more than once – were doubled and quadrupled if more than five diagnoses or symptoms were reported.

Figure 6.6.4.3 Incidence of falls in the past year by health-related conditions

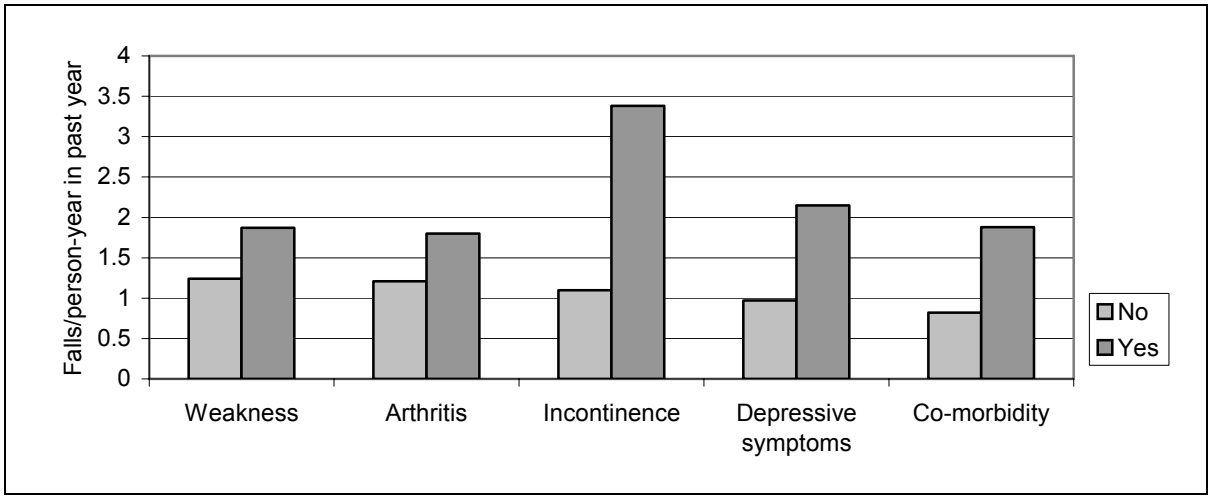


Table 6.6.4.4 Health-related conditions in relation to falling, repeated falling and falls in the past year

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Reported limb weakness *					
No problem reported n=45	26 (58)	1.0	15 (33)	1.0	1.0
Any - disabling or not n=61	36 (59)	1.1 (0.5-2.3)	22 (36)	1.1 (0.5-2.5)	1.5 (0.8-2.7)
Reported arthritis †					
No problem reported n=38	23 (61)	1.0	7 (18)	1.0	1.0
Any - disabling or not n=69	39 (57)	0.8 (0.4-1.9)	30 (44)	**3.4 (1.3-8.8)**	1.5 (0.8-2.7)
Getting to the toilet on time ‡					
No problem/rare accidents n=78	42 (54)	1.0	22 (28)	1.0	1.0
Accidents > once/week n=26	19 (73)	2.3 (0.9-6.2)	14 (54)	**3.0 (1.2-7.4)**	**3.1 (1.8-5.3)**
Depressive symptoms score§					
DSS 0-4 n=58	30 (52)	1.0	15 (26)	1.0	1.0
DSS 5-11 n=27	19 (70)	2.2 (0.8-5.9)	13 (48)	**2.7 (1.02-6.9)**	**2.2 (1.2-4.2)**
Co-morbid conditions ¶					
0-5 reported/diagnosed n=22	14 (64)	1.0	3 (14)	1.0	1.0
> 5 reported/diagnosed n=84	48 (57)	0.8 (0.3-2.0)	34 (40)	**4.3 (1.2-15.7)**	**2.3 (1.1-4.8)**

* Data were missing on "marked weakness in arms or legs" for n=3 and falls in the past year for n=1
† Data were missing on "arthritis/rheumatism" for n=3 and on number of falls in the past year for n=1
‡ Data were missing on "getting to the toilet on time" for n=5 and on number of falls in past year for n=1
§ Data on depressive symptoms were missing on n=24 (DSS questions not asked if proxy interview only) and the number of falls in the past year was unknown for n=1
¶ Data on reported physical symptoms or diagnosed conditions were missing on n=3 and the number of falls in the past year was unknown for n=1

6.6.4.8 Self-rated health

Both measures of self-assessed general health – comparing with others the same age and comparing one's own health with how it was a year ago – showed clear gradients or increasing falls risk with decreasing self-rated health (see Figure 6.6.4.8.1). Discounting the sizeable minority who were unable to answer the peer-comparison question ("I don't know anyone as old as me"), the valid replies showed a three-fold increase in the multiple fall risk estimates associated with rating one's health as fair, poor or very poor compared with people who rated their health a good or very good. Only a handful of people rated their health as better than a year ago so, taking them as the comparison group, the association or worse self-rated current health with recalled falls in the past year appeared stronger but did not reach significance (see Table 6.6.4.8.2).

Figure 6.6.4.8.1 Incidence of recalled falls in the past year by self-rated health compared with peers or with a year ago

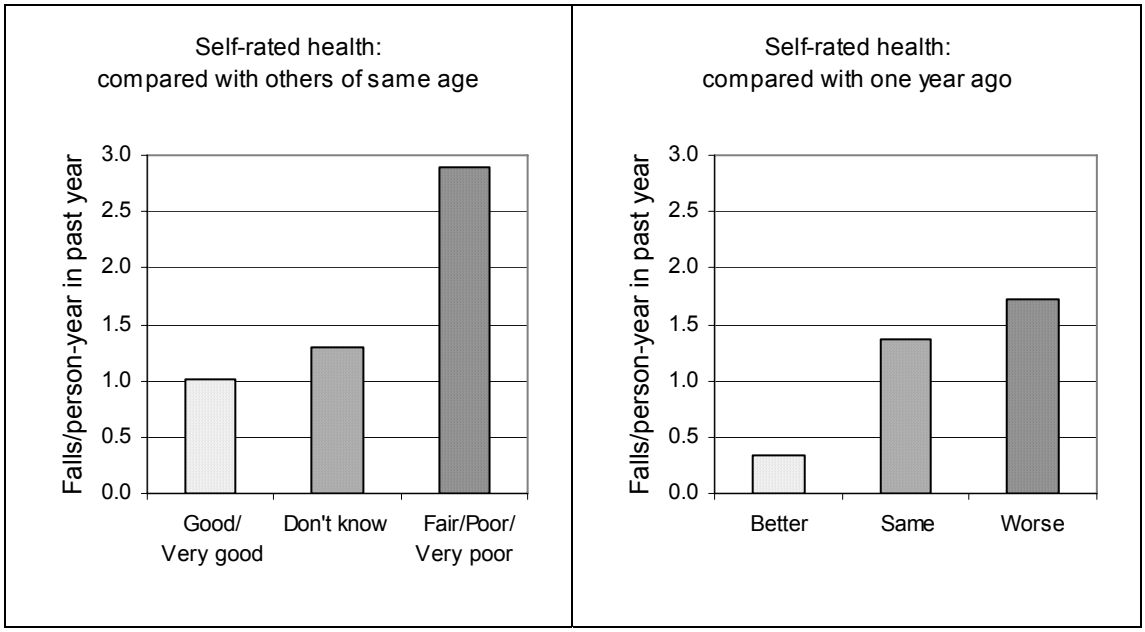


Table 6.6.4.8.2 Self-rated health compared with peers or with own health a year ago in relation to falling, repeated falling and falls in the past year

		At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Good/very good	n=59	29 (49)	1.0	14 (24)	1.0	1.0
Fair/poor/very poor	n=18	11 (61)	1.6 (0.6-4.8)	9 (50)	**3.2 (1.1-9.7)**	**2.8 (1.3-6.4)**
Better than 1 yr ago	n= 6	2 (33)	1.0	0	*No O.R. obtainable with zero reference category cell*	1.0
Same as 1 yr ago	n=42	23 (55)	2.4 (0.4-14.7)	13 (31)		4.1 (0.7-24.0)
Worse than 1 yr ago	n=41	27 (66)	3.9 (0.6-23.7)	17 (41)		5.2 (0.9-30.5)

6.6.4.9 Activities of daily living

Chapter 4 describes the extent of difficulties reported in different domains of daily functioning and the categorisation of activities of daily living (ADL) question responses used to facilitate dichotomous comparisons. Individuals who were limited in more than two activities within each group of ADLs – basic, mobility and instrumental ADLs – are compared with those reporting difficulty with none or only one activity in each group in the following figures and table. Any recalled fall in the past year was not found to be associated with any of these three measures, but repeated falls and the falls incidence rate recalled for the last year were both associated with more limited mobility and especially with disability in basic ADLs (see Figure 6.6.4.9.1 and Table 6.6.4.9.2).

Figure 6.6.4.9.1 Prevalence and incidence of recalled falls in the past year by difficulty with activities of daily living

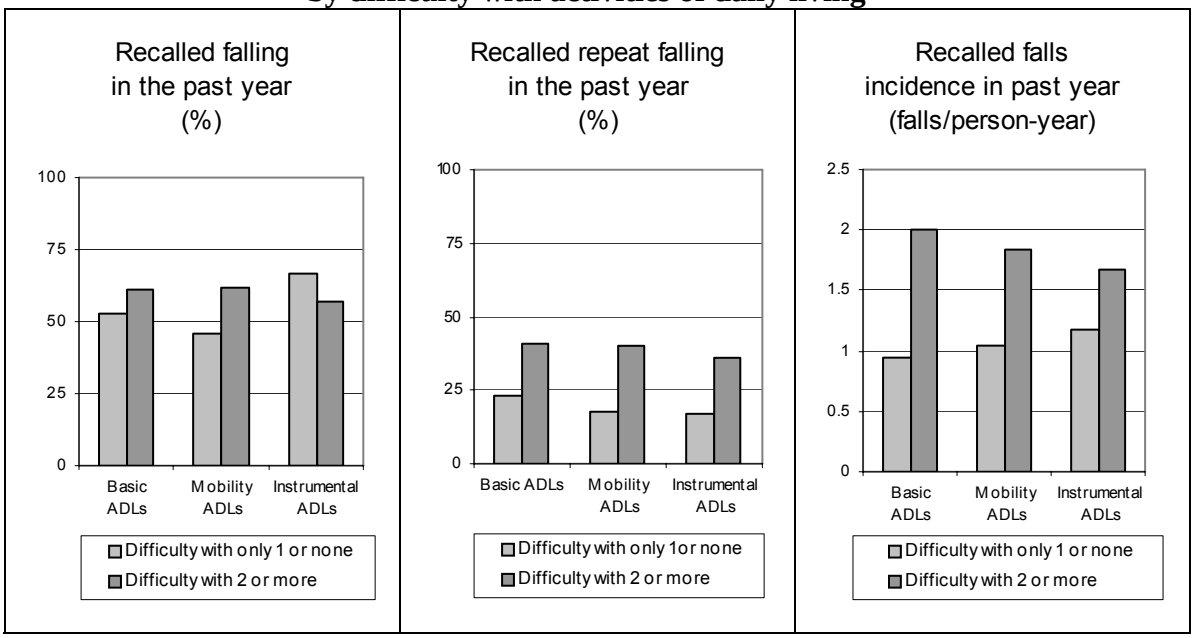


Table 6.6.4.9.2 Difficulty with activities of daily living in relation to falling, repeated falling and falls in the past year

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 / more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Difficulty with					
<2 basic ADLs n=40	21 (53)	1.0	9 (23)	1.0	1.0
≥2 basic ADLs n=69	42 (61)	1.4 (0.6-3.1)	28 (41)	**2.4 (0.97-5.7)**	**2.1 (1.2-3.8)**
Difficulty with					
<2 mobility ADLs n=28	13 (46)	1.0	5 (18)	1.0	1.0
≥2 mobility ADLs n=81	50 (62)	1.9 (0.8-4.4)	32 (40)	**3.0 (1.04-8.7)**	1.8 (0.9-3.4)
Difficulty with					
<2 instrumental ADLs n=12	8 (67)	1.0	2 (17)	1.0	1.0
≥2 instrumental ADLs n=97	55 (57)	0.7 (0.2-2.3)	35 (36)	2.8 (0.6-13.6)	1.4 (0.6-3.6)

6.6.4.10 Medication

Table 6.6.4.10.1 details the risk estimates associated with various categories of medication use as described below. Comparing those taking or not taking the different types of medications identified as potentially increasing falls risk, no differences were found in recall of having fallen at least once in the past year. The proportions who remembered falling and falling more than once in the last year are displayed graphically for each of these categories of drug (Figures 6.6.4.10.2 and 6.6.5.10.3).

The sample size is too small to expect to detect any significant differences for the separate categories of medication risk factors, so the data were simplified. Those taking any type of medication that the literature review identified as potentially increasing fall risk were compared with those taking none of these medicines. Figure 6.6.3.10.4 shows reports of falls in the past year by this broader categorisation of medication use. Identical proportions of both groups (58% of each) remembered having had at least one fall in the last year. However, the proportion of those taking any of these "falls risk" drugs who remembered falling within just the last month was about double that amongst those not taking these medications (33% and 16% respectively, OR 2.6, 95% C.I. 0.97 – 6.8, p=0.06). Recall of more than one fall in the last year was also markedly higher: 48% of those taking at least one medicine suspected of increasing falls risk versus 28% of those not taking any of these (OR 2.4, 95% C.I. 1.01-5.6, p=0.05).

The other commonly reported indicator of falls risk from medications is poly-pharmacy. Figure 6.6.3.10.5 shows that dividing individuals in the study sample into a group taking four or more prescribed medications and those taking three, fewer or no medications produced identical proportions reporting falling in the past year (58%) and almost no difference in the proportions (36% v. 31%) who remembered falling more than once.

Table 6.6.4.10.1 Medication use previously identified as increasing falls risk in relation to falling, repeated falling and falls in the past year

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Any "falls risk" medication					
No n=78	45 (58)	1.0	22 (28)	1.0	1.0
Yes n=31	18 (58)	1.0 (0.4-2.4)	15 (48)	**2.4 (1.01-5.6)**	1.4 (0.8-2.6)
Four or more medications					
No n=48	28 (58)	1.0	15 (31)	1.0	1.0
Yes n=61	35 (57)	1.0 (0.5-2.1)	22 (36)	1.2 (0.6-2.8)	0.9 (0.5-1.5)

Figure 6.6.4.10.2 Falling in the past year by medication risk factors

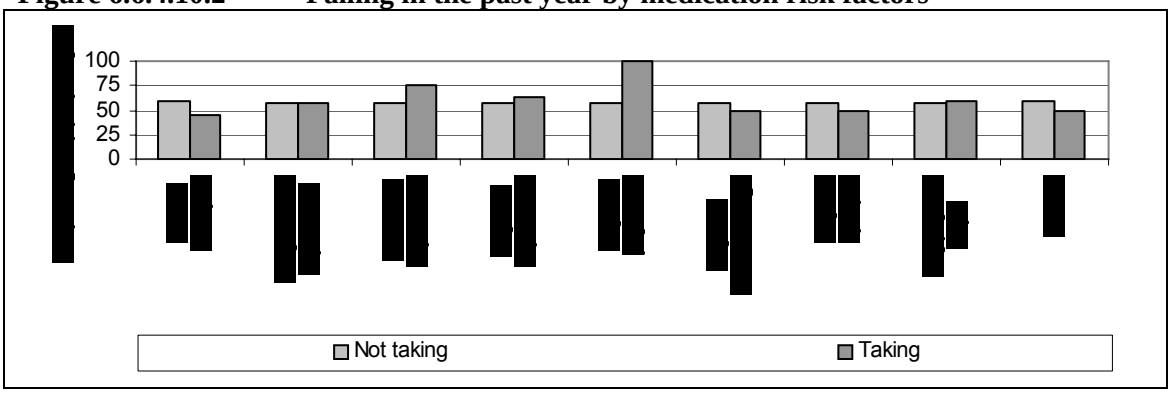


Figure 6.6.4.10.3 Repeated falling last year by medication risk factors

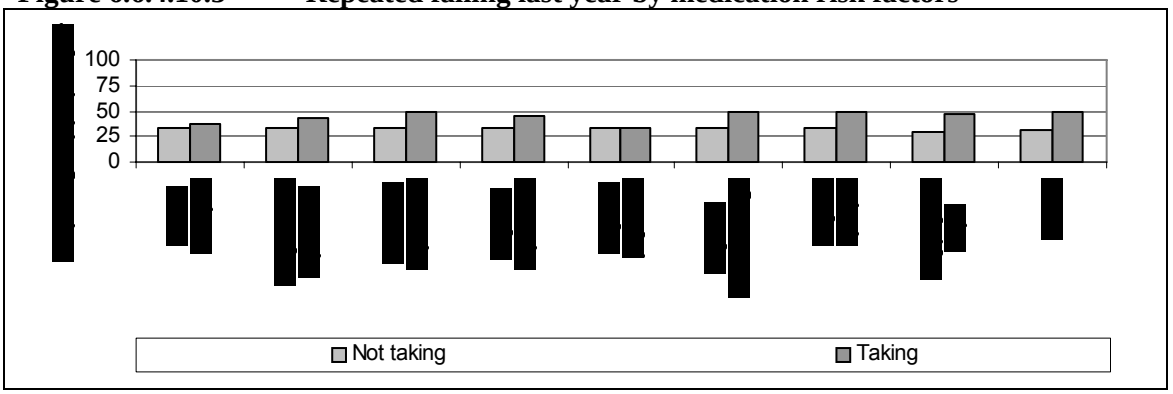


Figure 6.6.3.10.4 Prevalence and incidence of falls in the past year in relation to taking any of the above drugs previously associated with falling

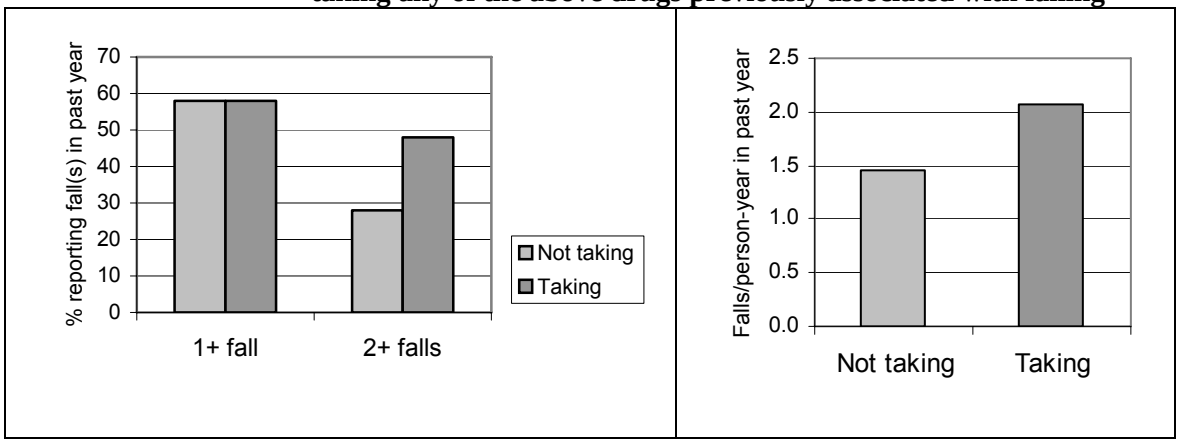
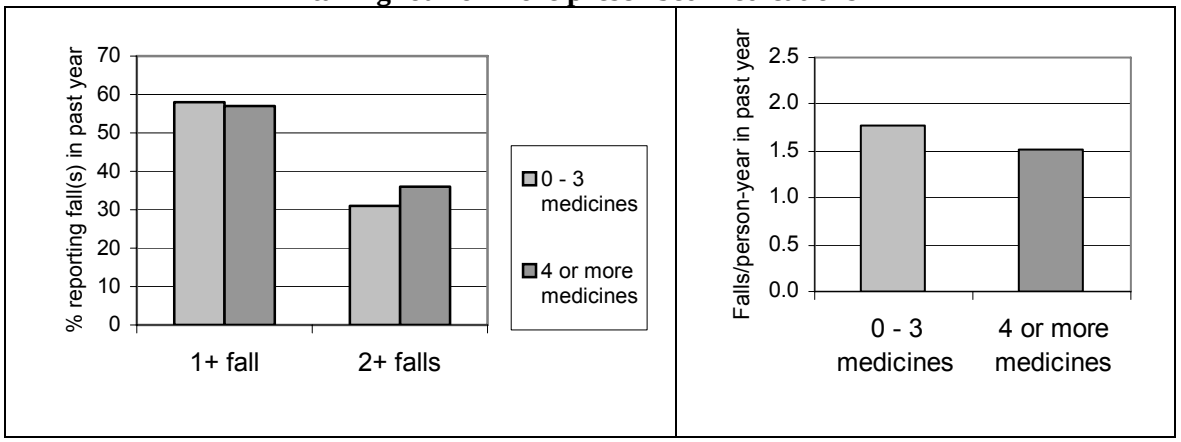


Figure 6.6.3.10.5 Prevalence and incidence of falls in the past year in relation to taking four or more prescribed medications



6.6.5 Mobility – reported measures

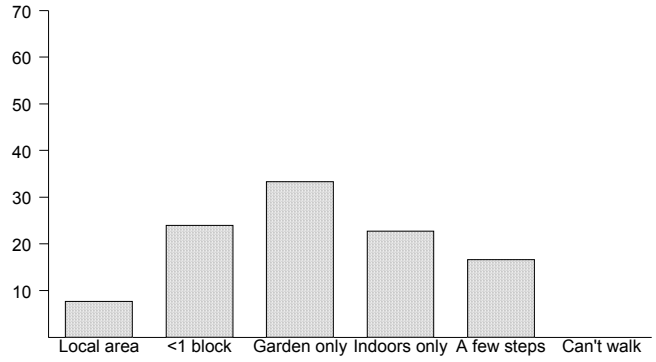
6.6.5.1 Limitation in walking distance
6.6.5.2 Use of walking aids
6.6.5.3 Stair climbing
6.6.5.4 Reported physical activity or exercise

6.6.5.1 Limitation in walking distance

The following three figures with accompanying risk estimates illustrate the prevalence of falling retrospectively remembered as having happened within different time frames of the last year before interview (Figure 6.6.5.1.1), the prevalence of varying fall frequency (Figure 6.6.5.1.2) and the incidence of falls (Figure 6.6.5.1.3), each shown by category of reported maximum walking distance. Examining the data from these different approaches all confirm an underlying pattern in the relationship between reported walking ability and falls. Those who could not walk at all were reported to have had fewer falls than those in any other category of maximum walking distance. Confidence intervals are wide but support the direction of effect associated with limited walking which is consistently in the direction of increased odds of reporting falls, except for the most disabled group.

Excluding those who couldn't walk at all, the apparent trend of increasing reports of remembered falls across categories of worsening walking disability is only clearly significant for the repeated falls analysis (two or more falls: test for trend p=0.03). It may be more instructive to view the relationship not so much as a rising trend but as falls risk rising to a broad peak across intermediate categories of walking disability then dropping with maximum disability. This pattern, is most clearly shown in the measure of most recent falls – falls within the past month – with falling lower in both the more and less mobile groups.

Figure 6.6.5.1.1 Remembered falls reported at interview as occurring over different times
- prevalence by reported distance able to walk
- odds ratios compared with walking around the local area

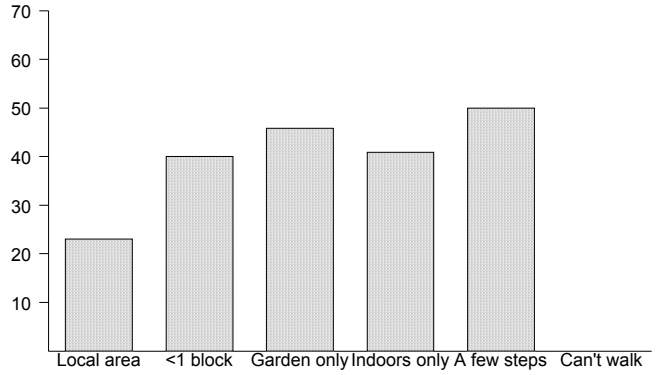


Recalled falling in the previous month

Crude Odds Ratios (95% C.I.s)
for recalled fall(s) in the last month
if maximum walking distance:

Local area	1.0	
<1 block	3.8	(0.6 – 22.3)
Garden only	6.0	(1.0 – 35.7)
Indoors only	3.5	(0.6 – 21.6)
A few steps	2.4	(0.2 – 33.9)
Cannot walk	-	

Score test for trend p=0.6
Excluding if unable to walk:
Score test for trend p=0.2

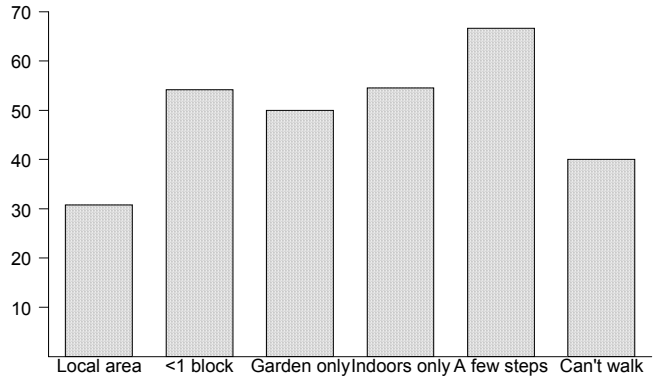


Recalled falling in the previous 3 months

Crude Odds Ratios (95% C.I.s)
for recalled fall(s) in last 3 months
if maximum walking distance:

Local area	1.0	
<1 block	2.2	(0.7 – 7.5)
Garden only	2.8	(0.8 – 9.5)
Indoors only	2.3	(0.7 – 8.0)
A few steps	3.3	(0.5 – 21.0)
Cannot walk	-	

Score test for trend p=0.7
Excluding if unable to walk:
Score test for trend p=0.1

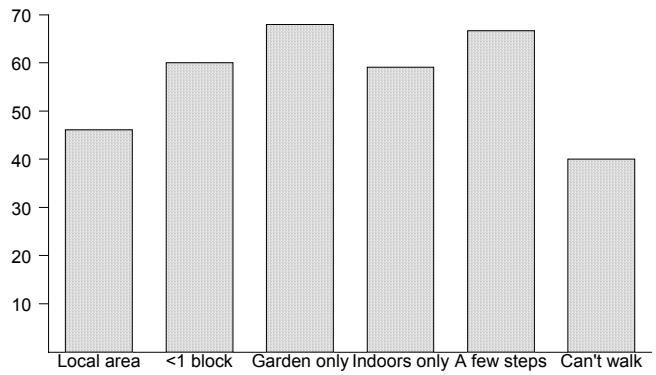


Recalled falling in the previous 6 months

Crude Odds Ratios (95% C.I.s)
for recalled fall(s) in last 6 months
if maximum walking distance:

Local area	1.0	
<1 block	2.7	(0.8 – 8.5)
Garden only	2.3	(0.7 – 7.1)
Indoors only	2.7	(0.8 – 8.8)
A few steps	4.5	(0.7 – 29.8)
Cannot walk	1.5	(0.2 – 10.8)

Score test for trend p=0.2
Excluding if unable to walk:
Score test for trend p=0.08



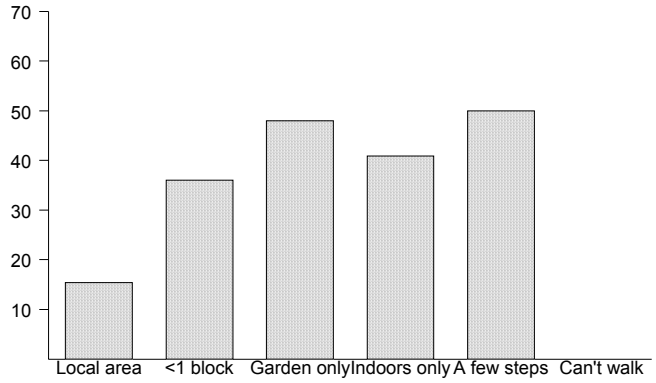
Recalled falling in the previous year

Crude Odds Ratios (95% C.I.s)
for recalled fall(s) in the last year
if maximum walking distance:

Local area	1.0	
<1 block	1.8	(0.6 – 5.3)
Garden only	2.5	(0.8 – 7.8)
Indoors only	1.7	(0.5 – 5.3)
A few steps	2.3	(0.4 – 15.1)
Cannot walk	0.8	(0.1 – 5.5)

Score test for trend p=0.6
Excluding if unable to walk:
Score test for trend p=0.2

Figure 6.6.5.1.2 Remembered falling at least once, twice or more in the past year by reported distance able to walk

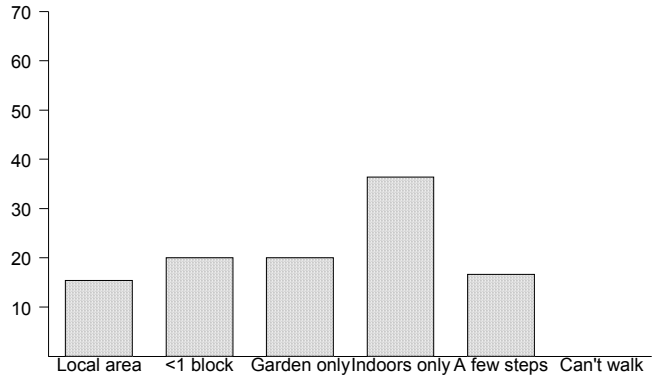


Recalled falling at least twice in the previous year

Crude Odds Ratios (95% C.I.s)
for ≥2 recalled falls in the last year
if maximum walking distance:

Local area	1.0	
<1 block	3.1	(0.8 – 11.8)
Garden only	5.1	(1.4 – 19.1)
Indoors only	3.8	(1.0 – 14.9)
A few steps	5.5	(0.8 – 37.6)
Cannot walk	-	

Score test for trend p=0.3
Excluding if unable to walk:
Score test for trend p=0.03



Recalled falling three times or more in the previous year

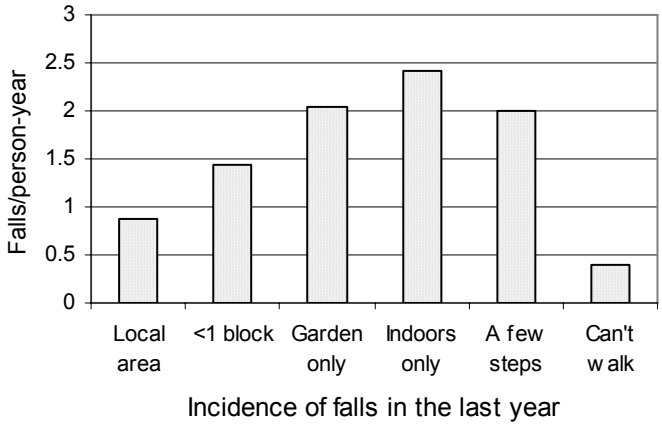
Crude Odds Ratios (95% C.I.s)
for ≥3 recalled falls in the last year
if maximum walking distance:

Local area	1.0	
<1 block	1.4	(0.3 – 5.8)
Garden only	1.4	(0.3 – 5.8)
Indoors only	3.1	(0.8 – 12.4)
A few steps	1.1	(0.1 – 12.1)
Cannot walk	-	

Score test for trend p=0.6
Excluding if unable to walk:
Score test for trend p=0.2

Crude Odd Ratios for each level of walking distance limitation are in comparison with the baseline level of being able to walk around the local area.

Figure 6.6.5.1.3 Incidence of falls reported as having occurred in the past year by reported distance able to walk



Incidence of falls in the last year

Relative Risk (95% C.I.s)
of falls reported in the past year
if maximum walking distance:

Local area	1.0
<1 block	1.6 (0.7-3.6)
Garden only	2.3 (1.05-5.1)
Indoors only	2.7 (1.2-6.1)
A few steps	2.3 (0.7-7.6)
Cannot walk	0.5 (0.08-2.7)

Relative Risks for each level of walking distance limitation are in comparison with the baseline level of being able to walk around the local area.

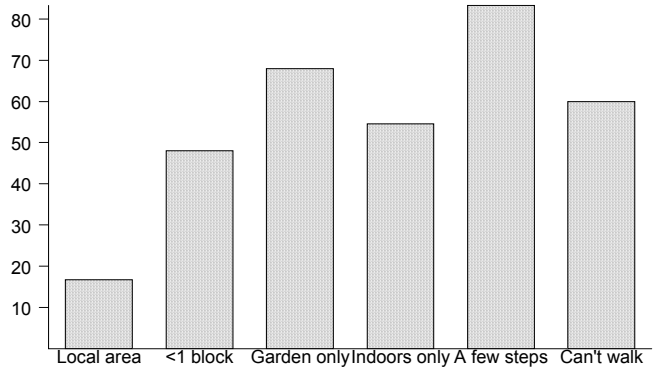
This same distribution was also visible in the proportions of people reported as having a "tendency to fall", regardless of whether analysis included any reported tendency to fall or only those describing this as a "disabling" problem (see Figure 6.6.5.1.4 and section 6.6.3.1 earlier in this chapter). There was also a clear trend in the association between reported "tendency to fall" and categories of decreasing maximum walking distance (score test for trend $p=0.002$ if present to any extent or $p<0.001$ if rated disabling), more marked than the associations found with actual falls remembered.

Table 6.6.5.1.5 presents risk estimates associated with falls outcomes taking different dichotomous cut-points of the walking distance measure. This confirms the visual impression from the preceding graphs (Figures 6.6.5.1.1-3) that the most informative distinction is between those who are able to walk around their local neighbourhood and the rest: those with any lesser degree of mobility are at 2-fold increased risk of falls (RR 2.1 95% C.I. 1.07-4.1) and have an even higher odds of reported repeat falls (OR 3.6, 95% C.I. 1.1-11.5). However, maintaining sufficient mobility to still be able to go out, even if maximum walking distance was less than one block, appears to lessen falls risk to some extent: those who were unable to walk further than the garden gate had almost double the risk of recalled falls in the past year (RR 1.8, 95% C.I. 1.03-3.0) compared with those who could at least walk down the street or further.

6.6.5.2 Use of walking aids

Only 12% of the old people in this study were able to walk outdoors independently of any walking device and unaccompanied, so it is not surprising that the associations seen between falling and needing a mobility aid or assistance to walk outdoors did not reach significance. Just over a third of those surveyed needed no walking aid indoors and, amongst the more disabled group who did, the associations with falls were significant and slightly stronger for all fall outcome measures: falls risk doubled and the odds of repeated falling in the past year was triple (see Figure 6.6.5.2.1 and Table 6.6.5.2.2).

Figure 6.6.5.1.4 Proportions of respondents reporting a tendency to fall -disabling or any tendency- by reported distance able to walk

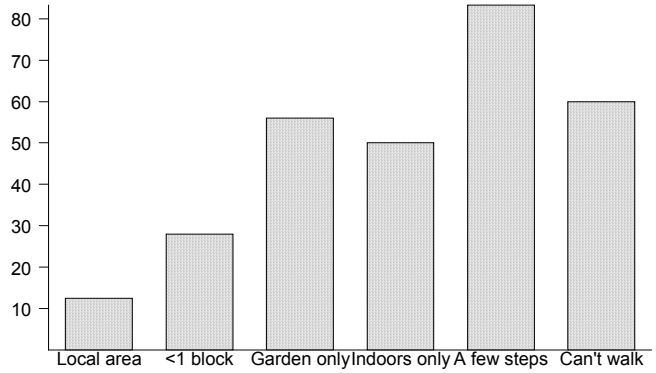


Any tendency to fall

Crude Odds Ratios (95% C.I.s)
for reporting any tendency to fall if maximum walking distance:

Local area	1.0
<1 block	4.6 (1.2 – 17.4)
Garden only	10.6 (2.7 – 41.5)
Indoors only	6.0 (1.5 – 23.4)
A few steps	25.0 (2.3 –275.7)
Cannot walk	7.5 (0.9 – 60.4)

Score test for trend p=0.002
Excluding if unable to walk:
Score test for trend p<0.001



Tendency to fall described as disabling

Crude Odds Ratios (95% C.I.s)
for reporting a disabling tendency to fall if maximum walking distance:

Local area	1.0
<1 block	2.7 (0.6 – 12.1)
Garden only	8.9 (2.1 – 37.8)
Indoors only	7.0 (1.6 – 30.5)
A few steps	35 (3.0 –411.5)
Cannot walk	10.5 (1.2 – 91.0)

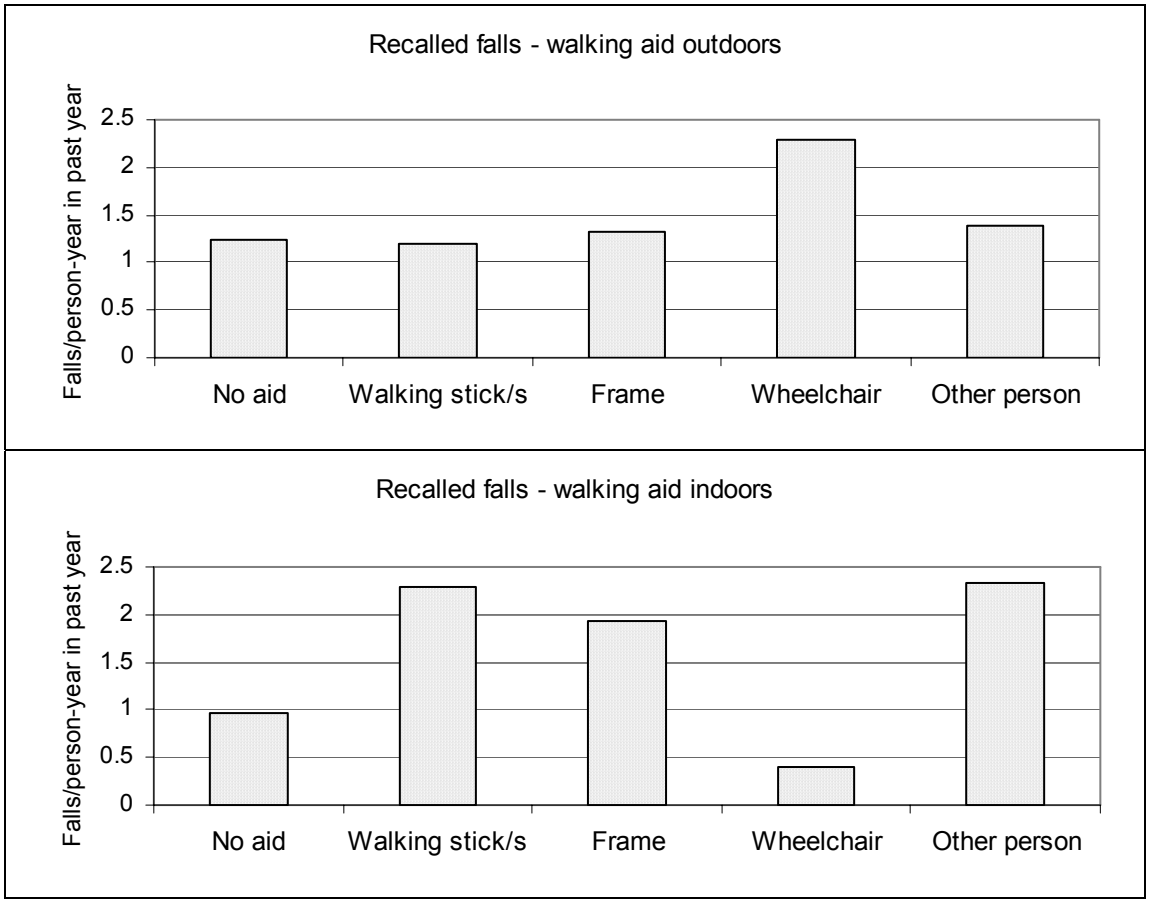
Score test for trend p<0.001
Excluding if unable to walk:
Score test for trend p<0.001

Table 6.6.5.1.5 Walking ability or disability in relation to falling, repeated falling and falls in the past year

	Odds Ratio for 1 fall or more in past year (95% C.I.)	Odds Ratio for 2 falls or more in past year (95% C.I.)	Relative Risk of falls in past year (95% C.I.)
WALKING DISTANCE *			
- UNABLE TO WALK			
Around local area (town/suburb/village)			
Able to walk around locality n=26	1.0	1.0	1.0
Unable to walk so far / at all n=83	1.9 (0.8-4.5)	**3.6 (1.1-11.5)**	**2.1 (1.07-4.1)**
Down street or around local area			
Walks at least down street n=51	1.0	1.0	1.0
Walks only garden/home/not n=58	1.5 (0.7-3.1)	2.1 (0.9-4.7)	**1.8 (1.03-3.0)**
Outdoors (garden, street or local area)			
Walks outdoors n=76	1.0	1.0	1.0
Walks only indoors/not at all n=33	1.0 (0.4-2.2)	1.2 (0.5-2.7)	1.4 (0.8-2.5)
Unable to walk more than a few steps			
Can walk, at least indoors n=98	1.0	1.0	1.0
Walks only a few steps/not n=11	0.9 (0.2-3.0)	0.7 (0.2-2.8)	0.8 (0.3-1.9)
Unable to walk at all, even a few steps			
Can walk at least a few steps n=104	1.0		1.0
Unable to walk at all n= 5	0.5 (0.1-2.9)	-	0.2 (0.04-1.4)

* Excluding n=1 with no data on falls in the past year

Figure 6.6.5.2.1 Incidence of falls in the past year by use of walking aids



Excluding cases not applicable or missing as below

Table 6.6.5.2.2 Use of walking aids in relation to falling, repeated falling and falls in the past year

		Odds Ratio for at least 1 fall in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
WALKING AIDS - OUTDOORS *				
No walking aid	n=13	1.0	1.0	1.0
Walking stick(s)	n=31	1.4 (0.4-5.3)	2.6 (0.5-14.8)	1.0 (0.4-2.5)
Walking frame	n=15	2.3 (0.5-11.5)	2.8 (0.4-18.9)	1.1 (0.4-3.2)
Wheelchair	n=32	1.5 (0.4-5.6)	3.3 (0.6-18.6)	1.9 (0.7-4.7)
Assistance of another person	n= 8	1.9 (0.3-12.6)	3.3 (0.4-29.8)	1.1 (0.3-4.0)
No walking aid	n=13	1.0	1.0	1.0
Any aid outdoors	n=86	1.6 (0.5-5.2)	2.9 (0.6-14.2)	1.3 (0.5-3.3)
WALKING AIDS - INDOORS †				
No walking aid	n=38	1.0	1.0	1.0
Walking stick(s)	n=27	**2.9 (1.0-8.7)**	**4.8 (1.4-15.8)**	**2.4 (1.2-4.7)**
Walking frame	n=35	1.9 (0.7-4.8)	**3.0 (1.0-8.9)**	**2.0 (1.04-3.8)**
Wheelchair	n= 5	0.8 (0.1-5.6)	0.0	0.4 (0.1-2.4)
Assistance of another person	n= 3	-	8.9 (0.6-131.2)	2.4 (0.5-11.1)
No walking aid	n=38	1.0	1.0	1.0
Any aid indoors	n=70	**2.2 (1.0-5.0)**	**3.3 (1.3-8.6)**	**2.0 (1.1-3.7)**

* Excluding n=11 who no longer go outdoors at all and n=1 with no data on falls in the past year

† Excluding n=1 who no longer gets out of bed at all n=1 with no data on falls in the past year

6.6.5.3 Stair climbing

Climbing stairs regularly was associated with reduced rates of recalled falls. As with the other reported mobility measures, numbers were small in the more active categories, but the odds ratios and incidence rate ratios showed a consistent pattern of lower prevalence and incidence amongst those who climbed stairs daily, lower still amongst those who climbed stairs more than five times a day (see Figure 6.6.5.3.1 and Table 6.6.5.3.2).

Figure 6.6.5.3.1 Incidence of falls during follow-up by reported stair climbing

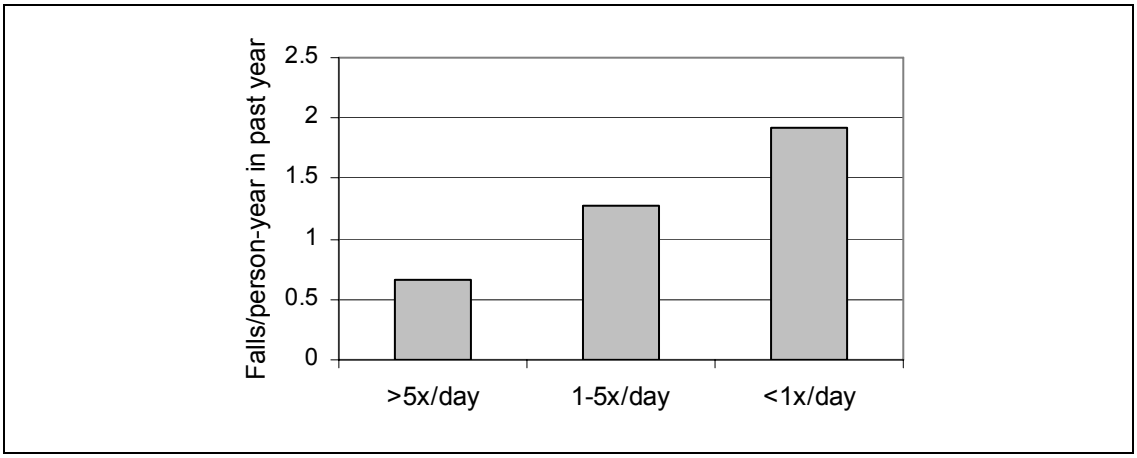


Table 6.6.5.3.2 Stair climbing in relation to falling, repeated falling and falls in the past year

		Odds Ratio for at least 1 fall in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
STAIR CLIMBING *				
Climbs a flight of stairs				
< once/day or can't	n=71	1.0	1.0	1.0
1 – 5 times/day	n=26	0.8 (0.3-1.9)	0.4 (0.1-1.2)	0.7 (0.4-1.3)
> 5 times/day	n=12	**0.2 (0.05-0.8)**	0.1 (0.01-1.1)	**0.3 (0.1-0.95)**
Can't climb stairs or < once/day	n=71	1.0	1.0	1.0
At least one flight of stairs/day	n=38	0.5 (0.2-1.1)	**0.3 (0.1-0.8)**	**0.6 (0.3-1.0)**

* Excluding n=1 with no data on falls in the past year

6.6.5.4 Reported physical activity or exercise

In answer to the question "What physical activity or exercise do you manage?" the majority replied none. Amongst those who said they managed the most frequently reported examples – walking and gardening – falling and repeated falling were both less common. Gardening was associated with the greatest reductions, with odds ratios indicating 60% lower prevalence of both and incidence reduced to the same extent (RR 0.4, 95% C.I. 0.2-0.9). Reporting some form of "other physical activity" had only mild non-significant effects in both directions: slightly decreased odds associated with both falls prevalence measures, though incidence rates were slightly increased (see Figure 6.6.5.4.1 and Table 6.6.5.4.2).

Figure 6.6.5.4.1 Incidence of falls during follow-up by reported physical activity

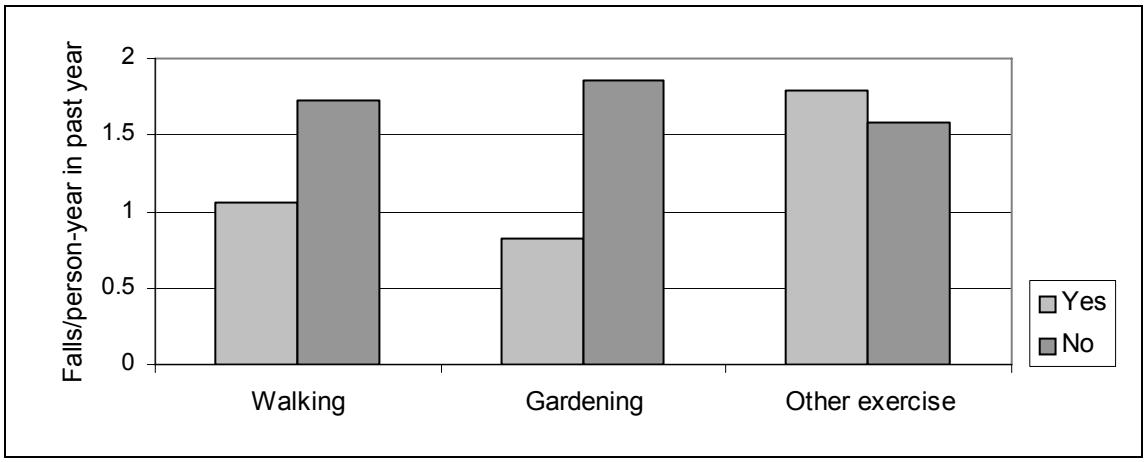


Table 6.6.5.4.2 Reported physical activity in relation to falling, repeated falling and falls in the past year

			Odds Ratio for at least 1 fall in the last year - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more in the last year - unadjusted (95% C.I.)	Relative Risk of falls in the last year - unadjusted (95% C.I.)
REPORTED PHYSICAL ACTIVITY					
Walking *	No	n=93	1.0	1.0	1.0
	Yes	n=16	0.9 (0.3-2.7)	0.4 (0.1-1.5)	0.6 (0.3-1.4)
Gardening †	No	n=84	1.0	1.0	1.0
	Yes	n=24	0.4 (0.2-1.2)	0.4 (0.1-1.3)	**0.4 (0.2-0.9)**
Other exercise †	No	n=84	1.0	1.0	1.0
	Yes	n=24	0.8 (0.3-2.1)	0.7 (0.3-2.0)	1.1 (0.6-2.2)

* Excluding n=1 with no data on falls in the past year
† Excluding n=1 not asked about gardening or other exercise and n=1 with no data on falls in past year

6.6.6 Mobility – observed functional performance measures

Static balance
Dynamic balance
Gait speed
Hand grip strength

The majority of the performance measures used to assess functional mobility were not strongly or significantly associated with recalled falls but, as Tables 6.6.6.1-4 suggest, there were consistent patterns in the effect size and direction of risk estimates for the different fall outcome measures.

Static balance

Static balance was in general less able to distinguish between fallers, repeat-fallers and non-fallers than dynamic balance. There appears to be a suggestion that those whose stand test scores reached only a moderate level might be at slightly increased falls risk. The odds ratios for falls over all periods of recall – one month to one year – were increased for those who could stand for 60 seconds unsupported compared with those who could not, whilst associations between success in the more demanding stand tests gave slightly decreased odds ratios for falls within time frames less than a year (see Figure 6.6.6.1.1 and Table 6.6.6.1.2). However, all the standing balance tests showed very weak positive associations with falling and repeated falling in the past year, and weak negative associations with the number of falls in the past year.

Figure 6.6.6.1.1 Incidence of recalled falls in the past year by ability or inability to perform static balance tests

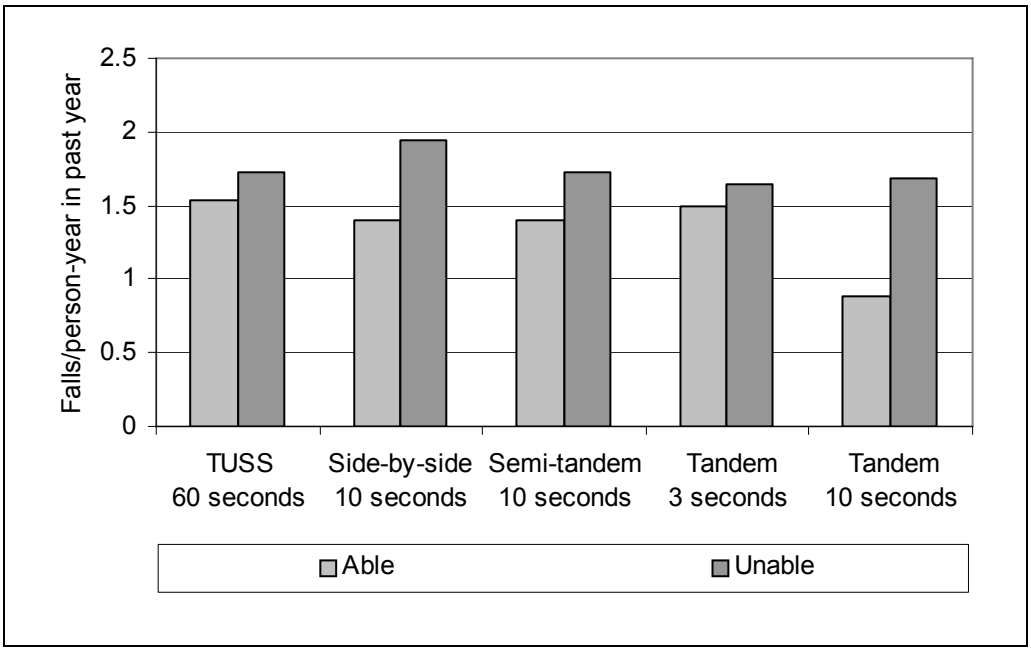


Table 6.6.6.1.2 Static balance tests: Odds ratios and relative risks associated with falling, repeated falling and number of falls in previous year

	Odds Ratio for 1 fall or more in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
STATIC BALANCE			
Timed Unsupported Stand 60 seconds			
Unable n=37	1.0	1.0	1.0
Able n=53	1.3 (0.5-3.0)	1.3 (0.5-3.1)	0.9 (0.5-1.6)
Side-by-side stand 10 seconds			
Unable n=35	1.0	1.0	1.0
Able n=55	1.0 (0.4-2.4)	1.1 (0.5-2.7)	0.7 (0.4-1.3)
Semi-tandem stand 10 seconds			
Unable n=60	1.0	1.0	1.0
Able n=30	1.0 (0.4-2.4)	1.1 (0.4-2.7)	0.8 (0.4-1.5)
Tandem stand 3 seconds			
Unable n=72	1.0	1.0	1.0
Able n=18	1.4 (0.5-4.2)	1.2 (0.4-3.5)	0.9 (0.4-1.9)
Tandem stand 10 seconds			
Unable n=82			
Able n= 8	1.1 (0.3-5.0)	0.2 (0.03-2.0)	0.5 (0.2-1.6)

Dynamic balance

The dynamic balance tests generally showed a consistent relationship between better balance and fewer falls, except for the most demanding performance levels which only a minority achieved and in which associations were variable (see Figure 6.6.6.2.1 and Table 6.6.6.2.2). For example, with fewer than one in eight able to maintain their balance beyond 20 cm in the functional reach test, these higher benchmarks commonly quoted were not useful in age-range in this study. However, a functional reach of 15 cm or more was associated with effect sizes similar to those found with successfully rising from a chair without using arms once or five times, all three tests showing significant falls risk reductions of 40% to 50%. The 180˚ turn measures showed no significant associations with any recalled fall outcomes, although the effect was consistently towards reduced falling if no support was needed.

Figure 6.6.6.2.1 Incidence of recalled falls during the past year by ability or inability to perform dynamic balance tests

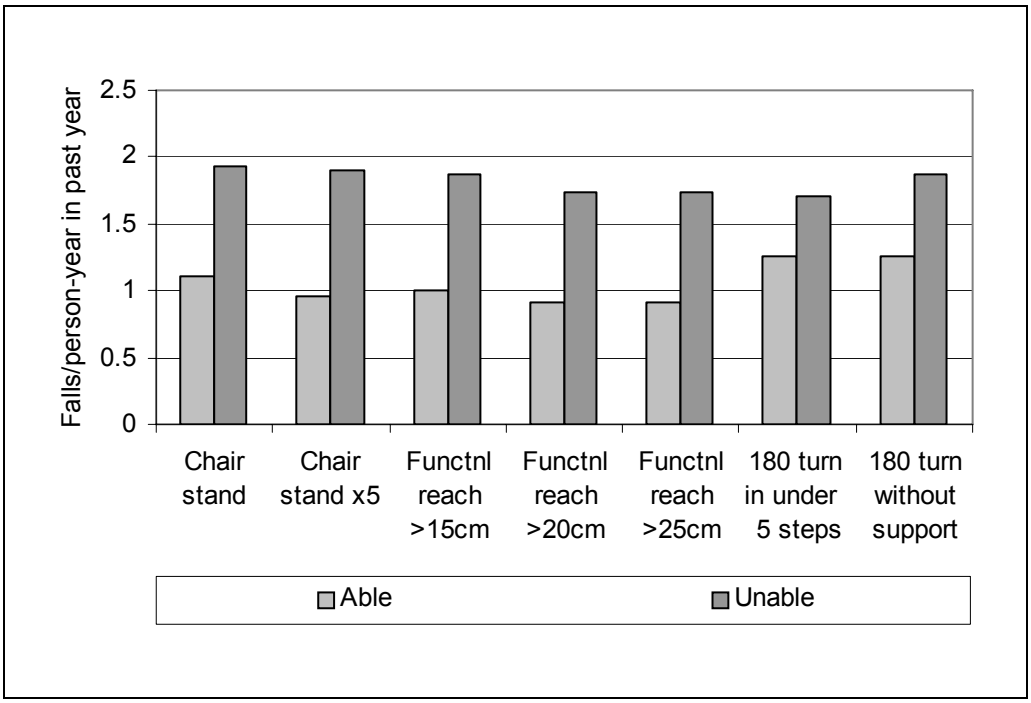


Table 6.6.6.2.2 Dynamicic balance tests: Odds ratios and relative risks associated with falling, repeated falling and number of falls in previous year

	Odds Ratio for 1 fall or more in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
DYNAMIC BALANCE			
Chair stand – single			
Unable n=55	1.0	1.0	1.0
Able n=35	0.6 (0.2-1.3)	0.5 (0.2-1.2)	**0.6 (0.3-1.04)**
Chair stand – 5 repeats			
Unable n=62	1.0	1.0	1.0
Able n=28	0.4 (0.2-1.1)	0.5 (0.2-1.3)	**0.5 (0.3-0.95)**
Functional reach>15cm			
Unable n=62	1.0	1.0	1.0
Able n=24	0.9 (0.3-2.3)	**0.3 (0.1-0.9)**	**0.5 (0.3-1.04)**
Functional reach>20cm			
Unable n=74	1.0	1.0	1.0
Able n=12	1.4 (0.4-4.9)	0.3 (0.1-1.6)	0.5 (0.2-1.3)
Functional reach>25cm			
Unable n=83	1.0		1.0
Able n= 3	1.3 (0.1-15.1)	-	0.4 (0.1-2.7)
180˚ turn – without support			
Unable n=52	1.0	1.0	1.0
Able n=38	0.7 (0.3-1.7)	0.7 (0.3-1.8)	0.7 (0.4-1.2)
180˚ turn – under 5 steps			
Unable n=71	1.0	1.0	1.0
Able n=19	1.2 (0.4-3.4)	0.6 (0.2-1.8)	0.7 (0.4-1.5)

- none of the 3 people with functional reach over 25cm recalled more than 1 fall in the past year

Gait speed

Slow gait speed was significantly associated with most measures of recalled falling. Walking at 0.6m/second or faster lowered the risk of falls by 60% and the odds of being a faller or repeat faller in the past year by 70% and 80% respectively (see Figure 6.6.6.3-4.1 and Table 6.6.6.3.2).

Hand grip strength

Grip strength was analysed separately for men and women, due to large gender differences, but for both sexes there was a pattern of lower falls amongst those with stronger grip strength (see Figure 6.6.6.3-4.1 and Table 6.6.6.4.2). These associations reached significance for men in the risk of falls in the past year (RR 0.25, 95% C.I. 0.07-0.86) and for women in the odds of recalling any fall in the past month (0.27, 95% C.I. 0.08-0.96).

Figure 6.6.6.3 -4.1 Incidence of recalled falls during the past year by gait speed and hand grip strength

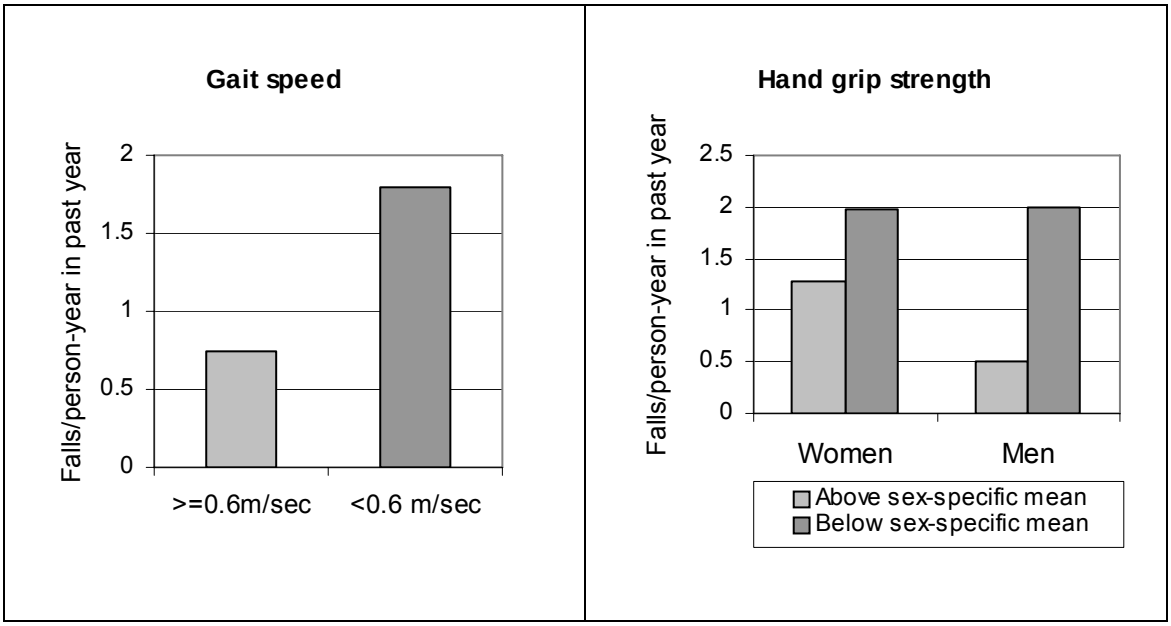


Table 6.6.6.3.2 Gait speed: Odds ratios and relative risks associated with falling, repeated falling and number of falls in previous year

	Odds Ratio for 1 fall or more in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
TIMED WALK			
Gait speed – 0.6m/sec or faster			
Unable n=74	1.0	1.0	1.0
Able n=16	**0.3 (0.1-1.0)**	**0.2 (0.04-1.0)**	**0.4 (0.2-0.95)**

Table 6.6.6.4.2 Hand grip strength: Odds ratios and relative risks associated with falling, repeated falling and number of falls in previous year

	Odds Ratio for 1 fall or more in the last year (95% C.I.)	Odds Ratio for 2 falls or more in the last year (95% C.I.)	Relative Risk of falls in the last year (95% C.I.)
MUSCLE STRENGTH			
Grip strength – mean for men			
Below n= 9	1.0	1.0	1.0
Above n= 8	0.2 (0.02-1.4)	0.2 (0.02-2.1)	**0.25 (0.07-0.9)**
Grip strength – mean for women			
Below n=35	1.0	1.0	1.0
Above n=32	0.6 (0.2-1.6)	0.6 (0.2-1.7)	0.6 (0.3-1.3)

6.7 Summary

Summary points

Issues in falls research methodology

- Cross-sectional surveys of falling are inevitably subject to possible recall bias
- Falls resulting in injury are remembered from a further time back than falls in general
- The prevalence of falling appears lower but incidence appears higher for shorter periods of retrospective recall

Summary measures

- 177 falls were remembered as having occurred in the past year, from reports for 109 individuals, a retrospective incidence rate of 162/100 person-years
- 58% reportedly fell in the year before interview and 59% of them, or 34% of the total, reported falling more than once in the past year
- Half the study participants were affected by a tendency to fall, and two-thirds were unsteady on their feet – at least ¾ rated these problems as disabling

Circumstances of recalled falls

- Around two-thirds of all recalled falls happened in the daytime, indoors, from standing and were described by respondents as accidents
- Circumstances did not differentiate falls that resulted in injury from non-injurious falls
- 1 in 4 of those who remembered falling could not say why they had fallen.

Consequences of falls

- 2/3 reported hurting themselves when they last fell
- 6 out 10 people had been unable to get up when they last fell, and over a third of them were on the floor more than an hour before help came, most of them for 2 hours or considerably longer
- One fifth of the last remembered falls led to hospital admission, or a third if any injury
- 90% of non-injurious falls had not been reported to any health care professional

Risk factors associated with recalled falls

- Interpretation of the significance or non-significance of the relationships examined between potential risk factors and falling requires caution given the sample size

Socio-demographic factors

- Women recalled falling more than men but not significantly more
- Older age and more years in full-time education were associated with higher prevalence of recalled falls
- Living in any supported setting was associated with higher prevalence of falling and incidence of falls recalled in the past year, as high or higher in sheltered housing as in care homes

Health-related factors

- Incidence of recalled falls in the previous year was 2½ times higher for those with severe cognitive impairment compared with the cognitively intact and moderately impaired, but their prevalence of falling was almost the same
- Lower self-reported health, perceived problems with balance, worry about falling, incontinence, depressive symptoms and reporting >5 physical symptoms or chronic conditions were all found to be associated with both repeated falling and the number of falls recalled for the past year
- Arthritis was associated with recalled falling more than once in the last year
- Evidence to link visual and hearing impairment – reported or tested – or use of medication with falls was inconsistent and inconclusive

Function and mobility factors

- Many measures illustrated an overall pattern of lower falls amongst both the most mobile and the most disabled
- Basic activities of daily living were associated with higher rates of recalled falls but the relation between instrumental ADLs and falling was not clear cut
- Recalled falls rates were lowest amongst those unable to walk at all and people who could walk the furthest distance or who did not need any aid to walk
- Other reported mobility measures that showed inverse associations with falls risk were gardening or climbing stairs regularly
- Dynamic balance measures, gait speed and (for men only) grip strength were significantly associated with reduced recalled falls rates, but all functional tests showed consistent patterns in effect size and direction of falls risk estimates

CHAPTER 7

FALLS IN MEN AND WOMEN AGED OVER 90 YEARS OLD

PART II: FALLING REPORTED IN PROSPECTIVE FOLLOW-UP

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7.7 Summary

7.1 Introduction

This chapter is the second presenting data on falls amongst the very old people in the study sample, here reporting the prospectively collected reports of falls during the year following interview. Chapter 2, section 2.2.3 discusses the selection of methods for this part of the study, which are described more fully in this chapter's methods section 7.2 below. Full details are given in Chapter 2, section 2.4 of the analytical approaches used to describe the falls data and examine associations between falls measures and identified potential risk factors. The process measures from this follow-up exercise, provided in section 7.3, summarise how these methods worked in practice. Sections 7.4 and 7.5 present descriptive data reporting measures of falling and fall circumstances, before section 7.6 examines whether factors previously shown to be associated with retrospectively reported falls are also predictive of these falls during follow-up. The findings are summarised in section 7.7 and discussed further, along with results from Chapters 6 and 8, in Chapter 9.

7.2 Methods of prospective falls data collection

7.2.1 Fall calendars
7.2.2 Telephone follow-up
7.2.3 Visits in person
7.2.4 Fall definition

Data on falls during the year after interview were collected prospectively for everyone who took part in the latest survey. Follow-up was for twelve months or until death if sooner and involved a combination of methods.

Respondents were asked whether they would "be happy to let us know if [they] were unfortunate enough to fall at all any time over the next year". No-one interviewed refused, but one respondent's next-of-kin did not want her father or herself bothered. However, after his death the study was subsequently informed of his death and the falls prompting the hospital admission that preceded it. For all other study participants, follow-up involved a combination of weekly fall calendars, telephone follow-up and visits.

7.2.1 Fall calendars

Participants and/or their carers were shown the fall calendar (see Appendix F) at the end of the interview and it was explained that letting the study know about a fall was more important than filling in written details, as the project nurse would be getting in touch after a fall in any case. If they were willing and able to provide even minimal information by completing a tear off page and returning it weekly they were given a calendar and six months' supply of pre-paid envelopes. After six months those still returning their calendar pages regularly were asked if they would be willing to continue to the end of the year before providing them with a second calendar and batch of envelopes.

7.2.2 Telephone follow-up

Regular follow-up phone-calls were the alternative method for those participants or proxy informants who were unable or reluctant to complete the calendars, or if no calendar had been received for over a fortnight. If resident in a care home, participant and/or proxy consent was asked to follow up falls using the institutions' records and care homes were contacted every four weeks.

7.2.3 Visits in person

On occasions when repeated attempts to contact by telephone were unsuccessful visits were made in person. Participants were also contacted after reporting a fall, as far as possible in person but also by telephone when this was necessary to avoid delayed contact. Contact was made within a month of a reported fall; the target was to make contact within a week of receipt of any report of a fall, given that there was usually already some delay between a fall occurring and being reported (see section 6.2.4 below). These fall follow-up visits or phone-calls were to gather the same data on fall circumstances and consequences as collected about remembered falls, using a follow-up fall version of the same check-box as in interview question 186a (see Appendix C).

7.2.4 Fall definition

Chapter 2, section 2.2.3.3 explains the rationale behind the study's practice of encouraging participants and proxy informants to report anything that could be construed as falling, even "nearly" falling, in order to avoid the under-reporting of falls that a respondent might feel "didn't really count as a fall". All reports were then coded as either a "fall" or a "near fall", following the commonly used definition of a fall – "unintentionally coming to the ground or some lower level other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or seizure" (see Chapters 1 and 2)[132]. It was impossible to achieve blinding in the coding of fall reports but each report underwent two separate reviews for classification as an actual fall or near fall, initially for the study falls log (a hard-copy paper system for daily use) and again at the later data-entry stage. This repeat process resulted in only one of the 297 reports being re-classified and in almost all cases there was little doubt over whether the incident described met the definition.

7.3 Process measures of prospective fall data collection in practice

7.3.1 Combination of data collection methods
7.3.2 Time between falls and receipt of fall reports
7.3.3 Length of follow-up
7.3.4 Falls, "near falls" and "non follow-up falls"

7.3.1 Combination of data collection methods

The methodological problems that beset falls data collection are discussed in *Chapter 1.2.3 Researching falls: methodological issues* so the difficulties encountered were not unexpected. It was anticipated from the outset that more than one method would be necessary for this very old population, many of whom would not manage to use fall calendars for reasons of physical and mental frailty.

In practice it was not only amongst the sample as a whole that different methods were needed, but also methods used for a given individual often changed. Although nearly half the sample accepted a fall calendar, only about a quarter used them until the end of follow-up, the change of methods often brought on by changes in circumstances such as illness or a hospital admission. Table 7.3.1.1 summarises the extent to which different methods provided the data, and Table 7.3.1.3 details who reported the falls. Both tables show separately the situation at the beginning and end of follow-up, reflecting the changes over this period. Whereas the tables provide data on the distribution of methods and information sources amongst the participants, Figure 7.3.1.2 and 7.3.1.4 show the distribution of methods and sources in the actual reports received.

Follow-up methods in relation to socio-demographic factors

Slightly higher proportions of men than women were prepared to accept calendars initially (55% vs 43%), and the gender difference persisted to the study end, although use of calendars dropped in both sexes (35% vs 24%). Higher proportions of men than of women reported falls themselves (45% vs 32%).

All people in institutional care, except two whose daughters provided fall reports, were followed-up through phone-calls to the care home staff. Only three people whose MMSE score classified them as severely cognitively impaired were initially the sole

informants at the start of follow-up but proxy informants were found to supplement their reports.

Similar proportions accepted calendars at outset and used them throughout, regardless of whether full-time education had finished by 14 or continued until older (45% and 47% initially, 25% and 28% by the end of the study). Both initially and at end of follow-up it was more likely to be the study participant themselves, rather than proxy informants, who provided fall reports if they had stayed in full-time education beyond the school leaving age of 14 years old (43% vs 58% initially and 28% vs 44% at study end, leaving school by 14 vs older respectively).

Fall calendars were initially accepted by a slightly higher proportion of people classified as from non-manual social classes than manual (53% vs 40%). The differences were marked by the end of follow-up when the proportion still completing fall calendars in non-manual classes was double that in manual classes (37% vs 18%). There were virtually no class differences in the proportions of study participants who provided fall reports themselves, rather than via a proxy, about half when follow-up began, dropping to just over a third by the end.

Table 7.3.1.1 Number and proportion of participants using different methods of prospective falls data collection during follow-up (n=110 participants)

	Methods when follow-up began	n	(%)	Methods by the end of follow-up	n	(%)
Fall calendars	Initially accepted	50	(45)	Used throughout follow-up	29	(26)
Phone flw-up	From the outset	59	(54)	Used throughout follow-up	68	(62)
Combination		-	-	Both calendars & phone	12	(11)
Other	Initially no falls follow-up	1	(<1)	Notification of death/admn	1	(<1)

Figure 7.3.1.2 Proportion of falls notified by different methods (n=287 reports)

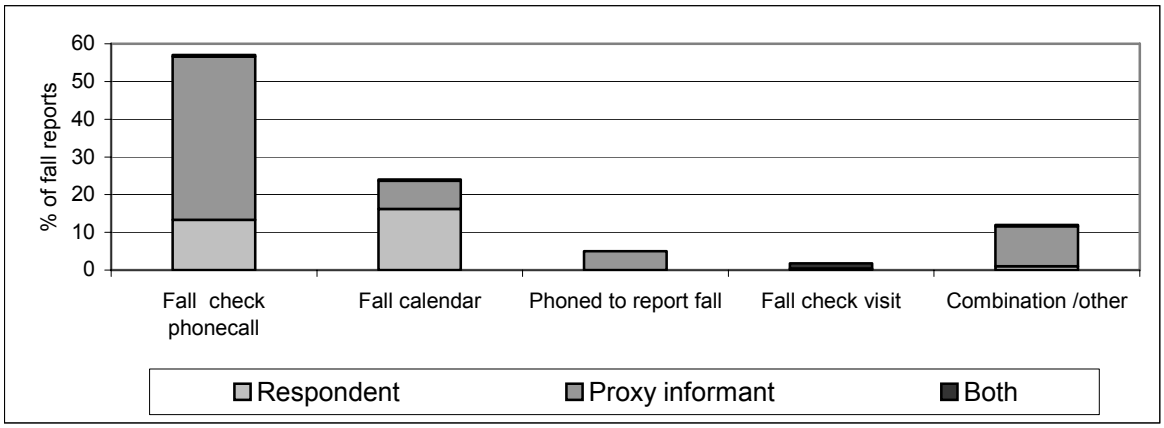
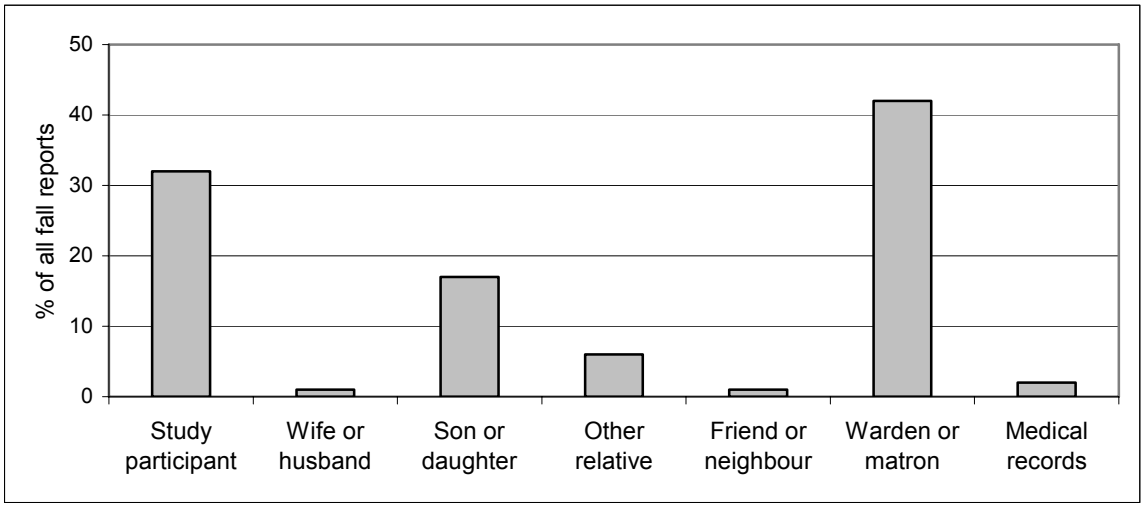


Table 7.3.1.3 Who gave fall follow-up information for each participant (n=110)

	When follow-up began (%)	n	(%)	n	By end of follow-up (%)	n	(%)	n
Study participant			54	(49)			38	(35)
Spouse	1	(<1)			1	(<1)		
Son/daughter	14	(13)			17	(16)		
Other relative	6	(5)			8	(7)		
Friend	1	(<1)			0			
Warden/Matron/Care assistant	33	(30)			45	(41)		
Proxy informant			55	(50)			71	(64)
No informant → death notified			1	(<1)			1	(<1)

Figure 7.3.1.4 Proportion of falls reported by different informant sources (n=287)



7.3.2 Time between falls and receipt of fall reports

The time for notification of a fall to reach the study co-ordinator was less than a month for about three-quarters of the falls, less than three weeks for two-thirds of them and less than a fortnight for half the fall reports. Figure 7.3.2.1 illustrates this distribution.

Tables 7.3.2.2 and 7.3.2.3 give breakdowns by methods and informant sources of summary statistics for the number of days that had lapsed since a fall occurred by the time the study co-ordinator knew about the fall, either from receiving a fall calendar, or through her contacting the respondent or proxy informant.

The time lapses could be expected to be longer for reports on those living in care as the agreement with the care homes was that checks would be made monthly: the mean interval between a fall and notification of that fall by a warden, care home matron or care assistant was 30 days, with a median of 18 days. The following tables report medians and inter-quartile ranges as the distribution is clearly skewed.

Not surprisingly the longest delays occurred when details of falls were only obtained from following up those from whom regular information was missing, for instance if contact was lost temporarily due to a hospital admission and ward documentation needed to be checked or GPs were asked for information from their medical records, thereby identifying falls that had not been previously notified.

Occasionally (<5% of fall reports) a relative contacted the study by telephone to report that a participant had had a fall rather than posting in a calendar page, and these reports tended to reach the study most quickly, but for routine reporting there was no difference in the time lags for fall notification via study participants themselves compared with via a relative or friend.

Figure 7.3.2.1 Days lapsed between fall and receipt of report

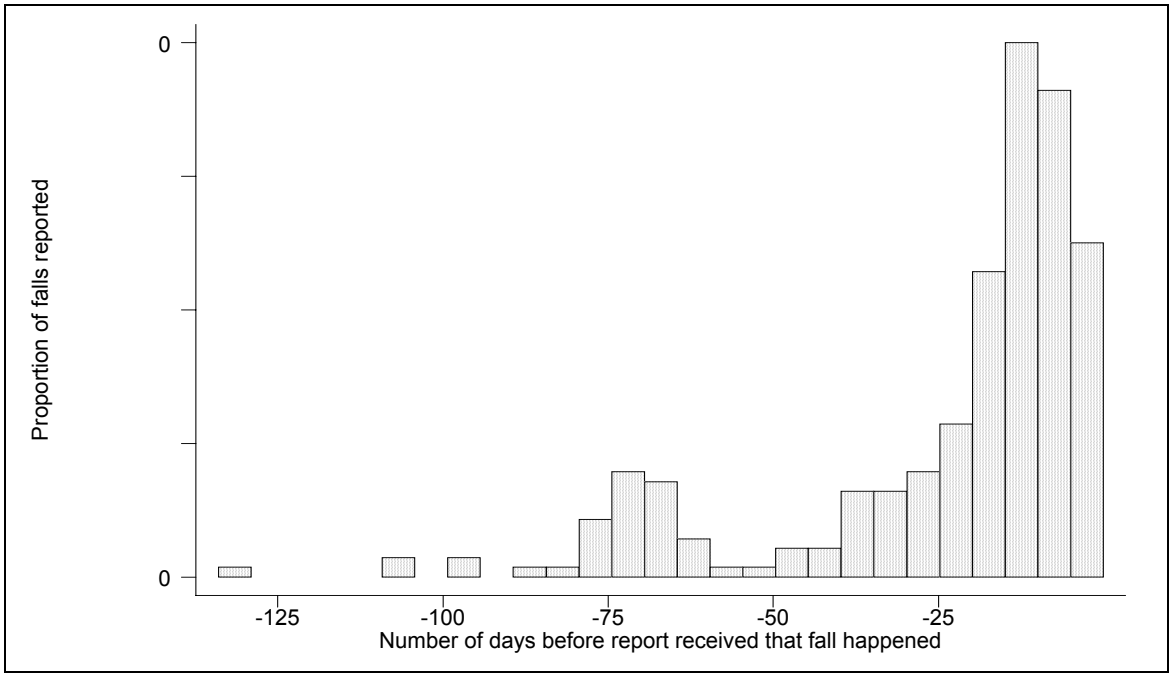


Table 7.3.2.2 Median (IQR) number of days lapsed between fall occurrence and receipt of report, by method of reporting

	Median	(IQR)
Fall calendar	11	(9 - 15)
Phoned to report fall	5	(2 –5)
Fall check visit	21	(13 – 25)
Fall check phone call	14	(7 – 41)
Combination of methods / other	21	(7 – 30)

Table 7.3.2.3 Median (IQR) number of days lapsed between fall occurrence and receipt of report, by informant source of fall report

	Median	(IQR)
Study participant	10	(6 – 15)
Relative or friend	11	(5 – 21)
Care assistant, warden or matron	18	(11 – 63)
Other sources – medical records etc	91	(56 – 98)

7.3.3 Length of follow-up

Study participants were followed-up for a year after interview or until death if sooner. It was possible to complete the full 12 months' follow-up for 75% of participants (n=82) but 28 died within a year of being interviewed, 30% of the men (n=6) and 24% of the women (n=22).

The total follow-up period was 95.7 person-years. The individual length of follow-up ranged from 2 to 52 weeks and the mean (SD) was 45 (14) weeks.

There were four participants who died within 8 weeks of interview for whom no falls were reported before death. Although together they contributed only 0.3 person-years of follow-up in total they have not been excluded from the analyses.

7.3.4 Falls, "near falls" and "non follow-up falls"

In all 290 reports were made of incidents that might be counted as falls during follow-up. Three of these had to be discounted, in two cases because they occurred outside the follow-up period - one year from interview - and in a third case because a neighbour's report of participant's broken leg turned out to be due to a pathological fracture without any fall. Of the remaining 287 valid reports within follow-up, only 22 were classified as "near falls" for failure to meet the Kellogg definition[132] as described in the methods, leaving 265 valid fall reports within follow-up.

7.4 Descriptive epidemiology of falls reported during follow-up: prevalence, incidence, repeated falling and time to first fall

7.4.1 Prevalence and incidence
7.4.2 Repeated falling
7.4.3 Time to first fall

7.4.1 Prevalence and incidence

There were 265 reported falls during follow-up by 66 individuals (10 men and 56 women), a prevalence rate of 60%. Falling more than once was also very common: 7 men and 42 women fell at least twice. Thus three-quarters of the "fallers", or 45% of the full sample, were "repeat fallers". Half of those who fell reported three or more falls.

These 265 falls occurring over 95.7 person-years of follow-up give an incidence rate of 277 falls per 100 person-years. Excluding the 40% for whom no falls were reported, the number of falls per person ranged from 1 to 32 (median 2.5, IQR 1 – 5). Figure 7.4.1.1 plots the decreasing counts for increasing numbers of falls recorded for each individual.

7.4.2 Repeated falling

Many of the repeated falls occurred within a short time frame of each other, and it could be argued that episodes involving a series of falls, perhaps attributable to a common factor, might unduly affect interpretation of the data. Figure 7.4.2.1 shows the proportions of participants who fell that reported multiple falls in close time proximity. These amount to 61% of the 60% who fell at all, or 40% of the full sample, so such reports clearly cannot be discounted without grossly underestimating both prevalence and incidence rates. However, there is also the possibility that outlying fall frequency counts might contribute disproportionately to some analyses, so the effects of excluding multiple falls by several different definitions were examined.

Figure 7.4.1.1 Frequency of falls/person reported during follow-up

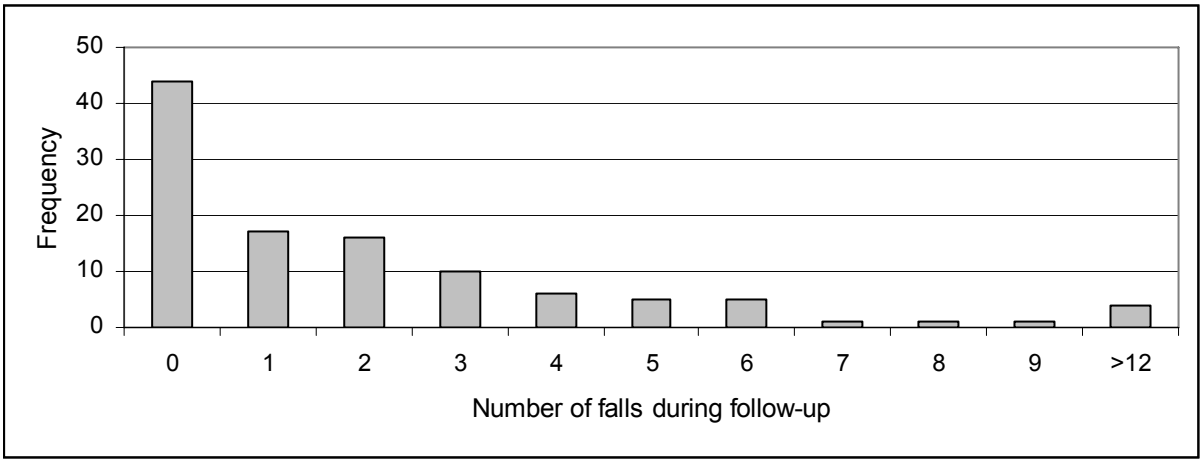
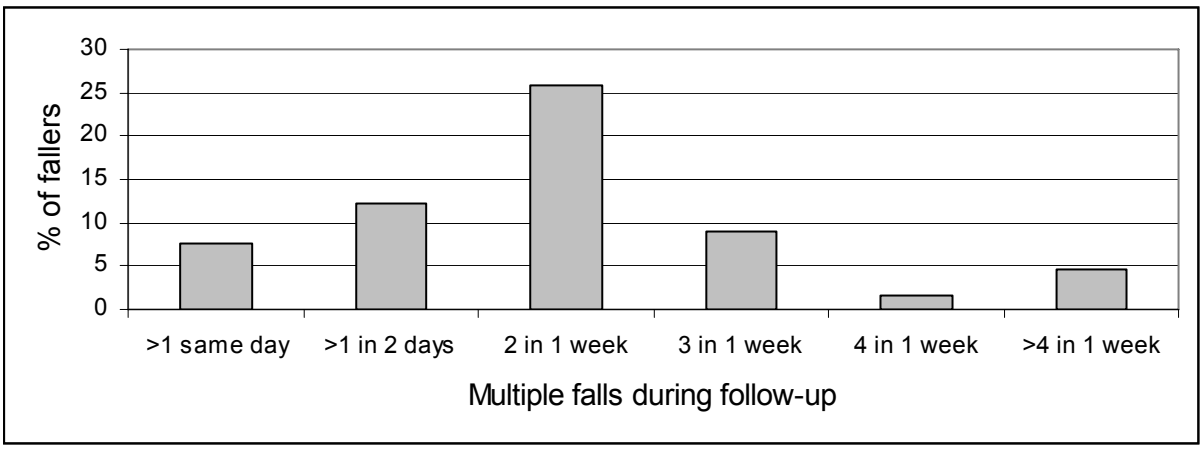


Figure 7.4.2.1 Multiple falls reported during follow-up: proportions of fallers with >1 fall within short time episodes



Analyses were run including and excluding n=3 participants who fell more than four times within a week at any stage during follow-up. For all three these multiple falling periods imminently preceded either death (n=2) or an acute hospital admission. Each had reported other falls before these episodes of multiple reports, so excluding these multiple falls did not affect the prevalence rates for falling or repeated falling shown in Table 7.4.2.2. However, incidence rates naturally dropped when 41 multiple falls by these three individuals were excluded, from 277 to 234 falls/100 person-years. Over-all incidence rates are given in Table 7.2.3, with a breakdown by two key demographic indicators – gender and place of residence – and Table 7.2.4 shows the rates excluding these multiple falls for comparison.

It could be argued that only the multiple falls preceding death should be excluded, and this would give an incidence rate of 260 falls/100 person-years. Conversely, it is also arguable that such end-of-life falls are not untypical in this advanced age-group and should be included. If then only the one participant whose reported 32 falls were extremely outlying from the distribution were excluded the incidence rate of 246 falls/100 person-years would again be slightly lowered. In most sub-group analyses only slight differences in rates were found. The exception is the drop in incidence rates for sheltered housing residents when this multiple faller is excluded, but this has little effect on the dichotomised variable taken for later analyses using place of residence.

Since any decision on criteria by which to exclude some falls would be arbitrary and arguable, for simplicity and completeness, all subsequent results present only the analyses using all falls reported.

Table 7.4.2.2 Prevalence of falling during follow-up

		Reported falling at least once n	(%)	Reported falling more than once n	(%)
GENDER					
Men	n=20	10	(50)	7	(35)
Women	n=90	56	(62)	42	(47)
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	n=62	35	(56)	25	(40)
Living in sheltered housing (mobile/site warden or very sheltered)	n=19	13	(68)	10	(53)
Living in care (residential/nursing home or hospital)	n=29	18	(62)	14	(48)
TOTAL SAMPLE	n=110	66	(60)	49	(45)

Table 7.4.2.3 Incidence of falls during follow-up

		Number of falls	Person-years follow-up	Incidence:falls /100 person-yrs
GENDER				
Men	n=20	54	17.2	314
Women	n=90	211	78.5	269
PLACE OF RESIDENCE				
Living in the community (house, flat or granny flat)	n=62	138	56.1	246
Living in sheltered housing (mobile/site warden or very sheltered)	n=19	65	17.5	372
Living in care (residential/nursing home or hospital)	n=29	62	22.1	280
TOTAL SAMPLE	n=110	265	95.7	277

Table 7.4.2.4 Multiple falls during follow-up and their effect on incidence rates

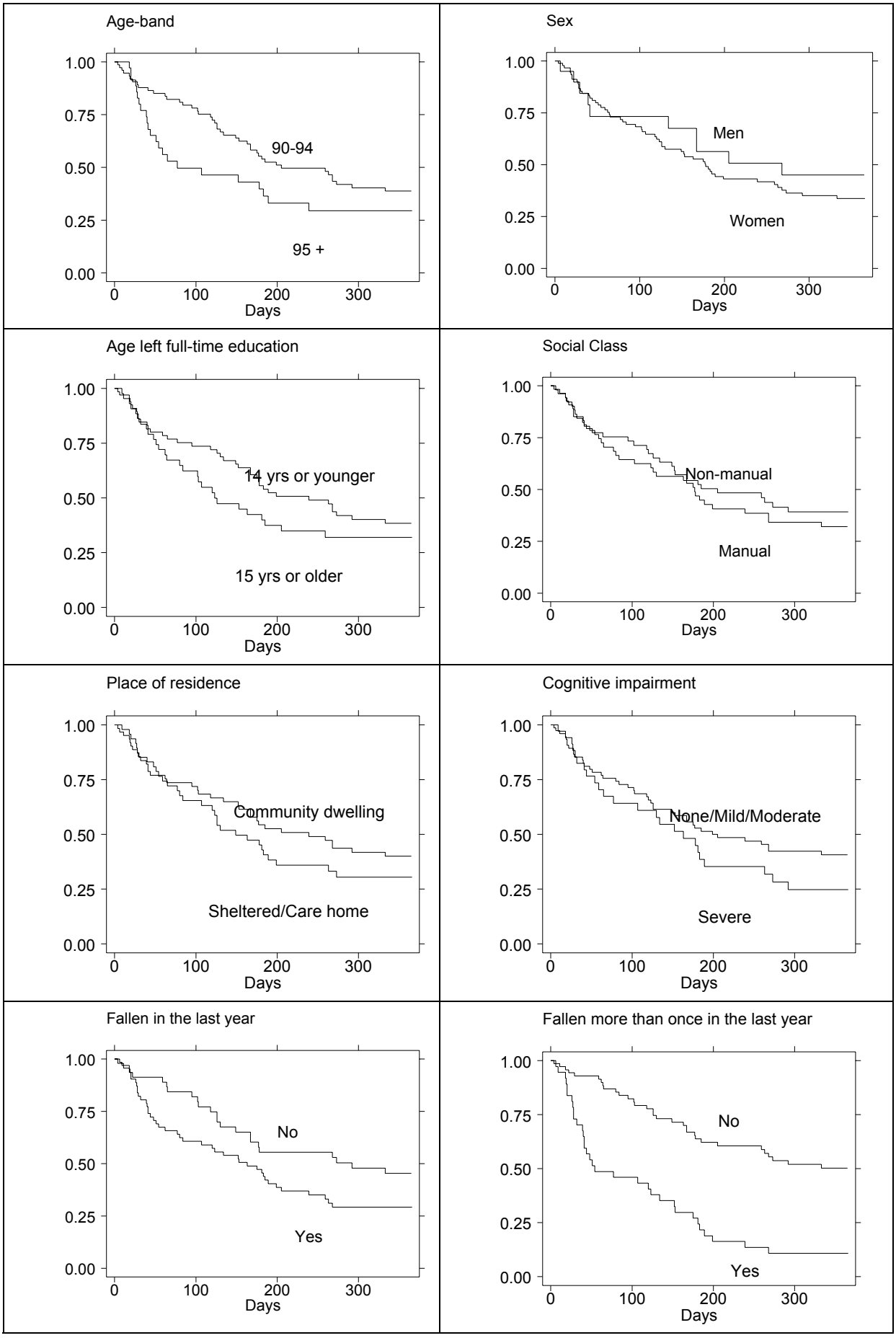
		Multiple falls *(≥5 within 1 week)*	Falls excluding multiple falls	Incidence rate excluding multiple falls
GENDER				
Men	n=20	7	47	273
Women	n=90	34	177	225
PLACE OF RESIDENCE				
Living in the community (house, flat or granny flat)	n=62	7	131	234
Living in sheltered housing (mobile/site warden or very sheltered)	n=19	29	36	206
Living in care (residential/nursing home or hospital)	n=29	5	57	257
TOTAL SAMPLE	n=110	41	224	234

7.4.3 Time to first fall

Further comparisons of falls rates are shown graphically in Figure 7.4.3's Kaplan-Meier survival plots of the time from interview until the first fall reported during follow-up. The series of graphs separate the participants' reported falls over the year's follow-up by socio-demographic factors, cognitive function and history of previous falls to give a visual representation of which factors may be associated with differences in falling.

The strengths of association with these factors and others are examined later in this chapter in section 7.6 in terms of odds ratios associated with prevalence of falling and repeated falling, relative risk for falls incidence and hazard ratios for survival time to first fall. This analysis follows after further descriptive data on the circumstances of the falls reported during follow-up in section 7.5. The consequences of these falls and analyses of associations with potential risk factors are presented in the following chapter (Chapter 8).

Figure 7.4.3 Time to first fall: by demographics, cognitive status and past falls



7.5 Circumstances of falls reported during follow-up

7.5.1 Time and place
7.5.2 Reasons for falling ascribed by the respondents
7.5.3 Falls when alone
7.5.4 Falls or people who fell

Table 7.5 summarises descriptions given of the circumstances of all the falls reported, giving a fuller picture than the data presented under similar headings in the previous chapter for last remembered falls (see Table 6.5.1.1).

7.5.1 Time and place

As already found in the cross-sectional data on remembered falls, the most common time, location and position for falls during follow-up were again day-time, indoors and from standing height. Fewer than one in four falls happened at night and only 15% were in the evening. Nine out of ten falls happened indoors, most commonly in the areas where most people spent most time – about a quarter each in the bedroom and the living area (described variously as the lounge, sitting-room or – in communal settings – the day room). Only three falls (less than 1%) occurred on stairs, and these were the only falls from higher than standing height.

7.5.2 Reasons for falling ascribed by the respondents

The four response options offered respondents to the interview question on the cause of falls in earlier CC75C surveys ("accident", "blackout", "dizziness" or "other") had been found to be largely uninformative in describing recalled falls due to the description of almost all falls as accidental. In this survey's prospective follow-up the respondents' own descriptions of how they fell and what they were doing at the time were recorded and coded into categories as shown in Table 7.5 Any given fall may fit more than one category, for example "turning while carrying…", "lost balance bending down to…" or "hurrying to get up from the chair". The 60% of falls that respondents said were an "Accident" included many such examples as well as the classic "slips and trips"

Table 7.5 Reported circumstances of falls reported during follow-up [n=265]

	Descriptors of fall circumstances	Falls reported during follow-up	
		n	(%)
TIME	Daytime	159	(60)
	Evening	39	(15)
	Night	60	(23)
	Unknown	7	(3)
LOCATION	Indoors	240	(91)
	Lounge	62	(23)
	Kitchen	17	(6)
	Bedroom	65	(25)
	Bathroom	18	(7)
	Hall	15	(6)
	Stairs	3	(1)
	Outdoors	25	(9)
	Garden	19	(7)
	Street	6	(2)
	Setting		
	In hospital	17	(6)
	In care home	66	(25)
	In sheltered housing	61	(23)
	Visiting a friend or relative	7	(3)
	Own home	114	(43)
HEIGHT FALLEN	From standing	143	(54)
	From bed, chair or bending down	85	(32)
	Unknown	37	(14)
	From higher than standing height	3	(1)
	From standing height or less	249	(94)
	Unknown	13	(5)
CAUSE	Accident	151	(57)
	Dizziness	5	(2)
	Blackout	2	(1)
	Other	57	(22)
	Not known	52	(20)
ACTIVITY AT THE TIME OF FALLING	Bending down	23	(9)
	Reaching up or out	10	(4)
	Turning	10	(4)
	Carrying something	6	(2)
	Hurrying	7	(3)
	Walking	70	(26)
	Transferring	45	(17)
	Getting up from a chair	18	(7)
	Getting up from bed	20	(8)
	Getting into bed	3	(1)
	Being transferred with a hoist	2	(<1)
	Getting out of a car	2	(<1)
DESCRIPTION OF HOW FALL HAPPENED	Tripped	19	(7)
	Slipped	10	(4)
	Just went down	12	(5)
	Legs gave way	6	(2)
	Lost balance	27	(10)
	Fell out of chair	9	(3)
	Fell out of bed	22	(8)
ALONE	Alone when fell	217	(82)
	Found on the floor	144	(54)

used in a number of other studies, and falls labelled by participants as due to "Other" reasons (22%) were often described in terms such as "I just went down", "My legs gave way" or "Somehow lost my balance". The distribution of fall circumstances do not map directly to the ascribed cause categories, but the actual words used on the fall calendar or transcribed from a follow-up visit or phone-call fill in more details than the structured interview responses could ascertain. For one in five falls the cause of the fall was said to be unknown.

7.5.3 Falls when alone

The vast majority of falls (82%) occurred when no-one else was present. Living in a supported setting did not protect against the possibility of having a fall when no-one else was there. 82% of the falls in institutional care and 94% of the falls in sheltered accommodation were un-witnessed. Likewise amongst those living in the community, 62% of falls by people who lived with relatives happened whilst no-one else was there, although the proportion of falls alone was higher (80%) amongst those who lived alone.

More than half of the fall reports described the study participant as being found on the floor. As might be expected, these falls made up a higher proportion of falls in care homes (82%) than in sheltered housing (63%), such incidents in any supported living setting being almost twice as prevalent as in the community (38%).

7.5.4 Falls or people who fell

Clearly circumstances differ for each separate fall suffered by the individuals who fell, so a slightly different overview of fall circumstances is gained from reporting circumstances in terms of the people who fell rather than the falls they reported. Considering fallers rather than falls tends to give higher proportions. Fall location is a case in point: whilst only 9% of falls occurred outside, almost a quarter of fallers fell outdoors at least once during follow-up and more men than women reported outdoor falls (50% versus 18% of those who fell at all). Similarly, just under a third of falls occurred in institutions but 42% of the fallers were in some form of institutional care when they fell on at least one occasion. A quarter of these fell whilst in hospital.

7.6 Factors predictive of falls during follow-up

7.6.1 Demographics
7.6.2 Cognitive function
7.6.3 Reported balance problems, fear of falling and recent falls
- 7.6.3.1 Perceived problems with balance
- 7.6.3.2 Worry about falling
- 7.6.3.3 Recalled falls in the past year

7.6.4 Health and disability
- 7.6.4.1 Visual impairment
- 7.6.4.2 Hearing impairment
- 7.6.4.3 Arthritis
- 7.6.4.4 Weakness
- 7.6.4.5 Incontinence
- 7.6.4.6 Depression
- 7.6.4.7 Co-morbidity
- 7.6.4.8 Self-rated health
- 7.6.4.9 Activities of daily living
- 7.6.4.10 Medication

7.6.5 Mobility – reported measures
- 7.6.5.1 Limitation in walking distance
- 7.6.5.2 Use of walking aids
- 7.6.5.3 Stair climbing
- 7.6.5.4 Reported physical activity or exercise

7.6.6 Mobility – observed functional performance measures
- 7.6.6.1 Static balance tests
- 7.6.6.2 Dynamic balance tests
- 7.6.6.3 Gait speed
- 7.6.6.4 Hand grip strength

7.6.7 Adjusting risk estimates for the effects of covariates

Analytical approach

The same group of factors that were examined in relation to retrospectively recalled falls in the previous chapter (section 6.6) were re-considered in relation to the prospective data collected on falls during the year after interview. A similar analytical approach was used but extended to account for the prospective data. An additional covariate included in this set of analyses was the history of previous falling reported at interview, another key characteristic that reviewing the literature had highlighted as important to consider along with the other potential risk factors identified a priori for analysis. As with the remembered falls, having two or more falls during follow-up was hypothesised to be a more readily identified risk group than those with just a single follow-up fall. The sample population was dichotomised on this basis in initial examination of univariate associations and subsequent logistic regression modelling. The distribution of the number of falls per person was too over-dispersed for standard Poisson regression modelling so, as described in Chapter 2, section 2.4 on analytical methods, negative binomial regression was used to calculate relative risks. Hazard ratios for differences in time to the first fall after interview were obtained by Cox regression.

In each of the following sections the graphic illustrations of different risk factor effects are followed by tables giving full details of numbers in each analysis group, risk estimates and confidence intervals.

Two or three types of risk estimate are shown for the different risk factors:

- the odds ratios for a) falling and b) falling more than once during follow-up
- the relative risk for falls, reflecting fall count data

and, for key descriptive factors, also

- the hazard ratios for survival time to first fall during follow-up.

7.6.1 Demographics

Summary tables (Tables 7.6.1.7 - 9) for all the demographic variables described and illustrated over the next few pages are at the end of this section. For the basic demographic descriptors an additional analysis was performed to demonstrate the effect on falls rates and consequently on risk ratios of the small minority of individuals who suffered repeated falls within a short time frame, as described in section 7.4 Excluding these multiple falls (5 or more within one week) had the effect of decreasing risk ratios associated with most demographic variables, but slightly increased the effect of age.

Age

The effect of age on falls prevalence and incidence during follow-up was minimal, approaching significance in the measures that reflected fall frequency but not actually reaching significance in any. As Figures 7.6.1.1 and 7.6.1.2 show, there was no difference in reported falls amongst those in their nineties but rates were higher amongst the very few centenarians. As would be expected, the confidence intervals of the effect sizes associated with the "95 plus" age-band are wider than those for the effect of each additional year of age, the latter all just approaching significance (see Tables 7.6.1.7-9).

Gender

Proportionately more women than men fell during follow-up – proportions were a third higher for repeated falling and a quarter more for falling at least once. Figure 7.6.1.3 illustrates how, conversely, the falls rate was slightly higher amongst men than women (2.7 vs 2.3 falls/person-year). None of these minor gender differences in the prospective falls data were significant (see Tables 7.6.1.7-9 for risk estimates).

As with all other risk factors subsequently described, age and sex effects on falls risk estimates were entered into multi-variable models to examine the effects of potentially confounding co-variates. Each of the demographic factors were adjusted for the basic descriptors of this population – here the remaining demographics and cognitive status (see section 7.6.2). Only educational level and severe cognitive impairment had any significant effect on risks estimated by age or sex, reducing the effect of each: very slightly for age: education and cognition adjusted RR predicted by age 1.02 (0.90 – 1.17) and more markedly for adjusted RR predicted by sex: 0.56 (0.27-1.17) (see 7.6.7).

Figure 7.6.1.1 Prevalence of falling at least once/more than once during follow-up by age

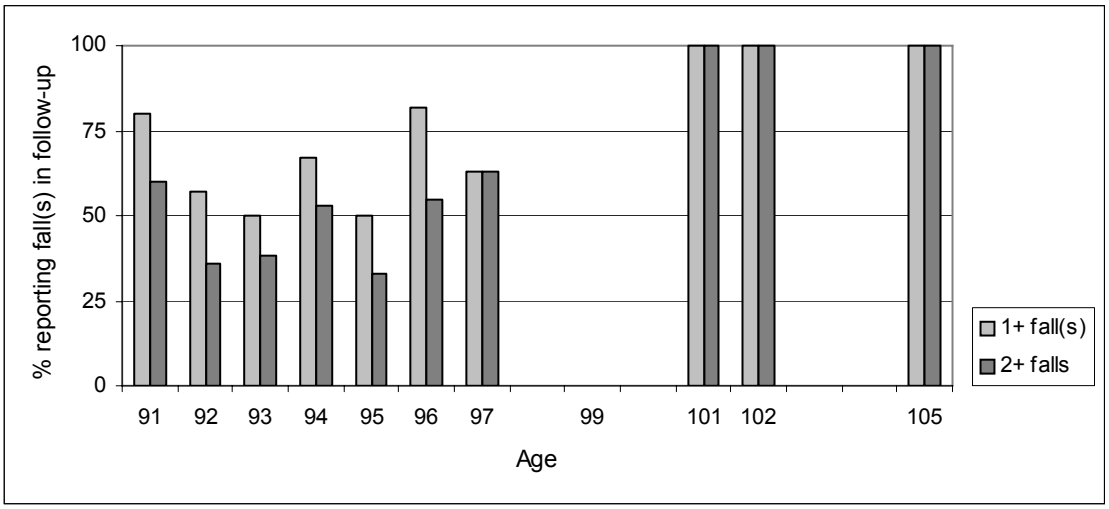


Figure 7.6.1.2 Incidence of falls reported during follow-up by age

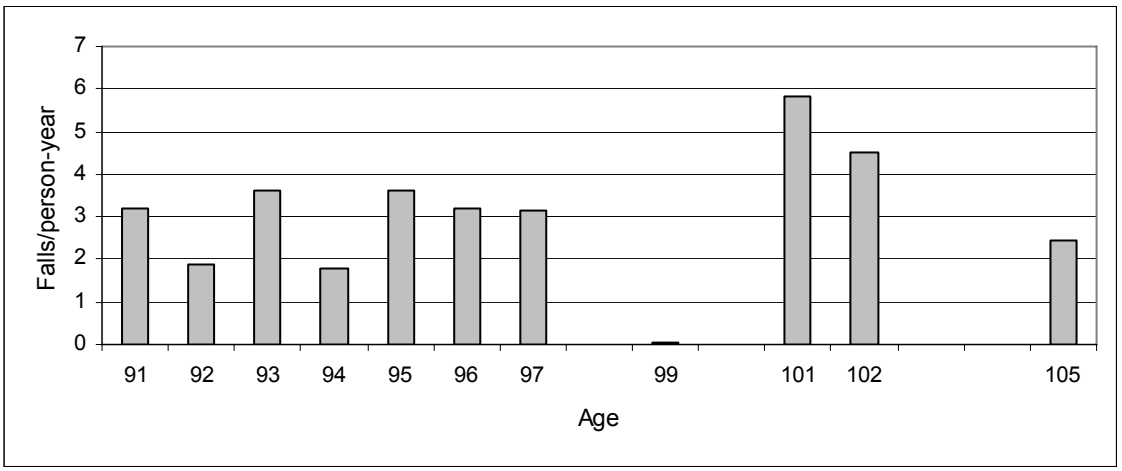
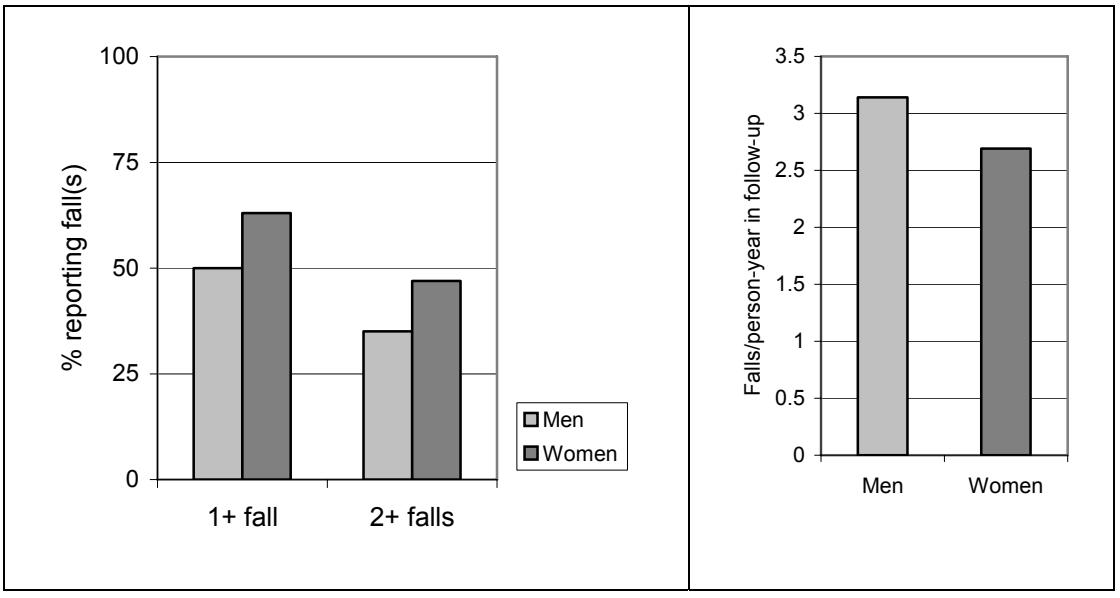


Figure 7.6.1.3 Prevalence and incidence of falls during follow-up by sex



Education

During follow-up again higher proportions of those with longer education reported falling and repeated falling than those who left school by the minimum school leaving age but differences were not significant. Incidence rates were also higher and, although significance was borderline, adjusting for potentially confounding covariates and cognitive function separately and in combination did not reduce the significance: RR 1.91 (1.09-3.36) p=0.02, adjusted for age, sex, place of residence and cognitive function (see Figure 7.6.1.4 and Tables 7.6.1.7-9).

Social class

Prospective follow-up data showed no class differences in the proportions known to have fallen at least once in the year after interview, as might be expected from the lack of class difference found in remembered falls in the year before interview. However, higher proportions of those from non-manual backgrounds (53%) were reported as suffering repeated falls than from manual social classes (38%), with an associated odds ratio of 1.8 (95% CI 0.8 – 3.9). The unadjusted risk ratio, taking account of the number of falls during follow-up, was of the same order: RR 1.9 (95% CI 1.1 – 3.4). Adjusting for age, sex and place of residence separately did not affect the significance, but a combined model including severe cognitive impairment rendered the risk ratio insignificant: RR 1.6 (0.9-3.0) p=0.1 (see Figure 7.6.1.5 and Tables 7.6.1.7-9).

Place of residence

During follow-up there were proportionately more fallers and repeat fallers, and higher incidence rates of falls, amongst those in sheltered housing (see Figure 7.6.1.6). Those living in the community fell less than those in either the sheltered schemes or in care homes. This pattern echoes that seen in the interview data on remembered falls but, unlike the retrospective findings, in the prospective data none of the differences were significant (see Tables 7.6.1.7-9).

Figure 7.6.1.4 Prevalence and incidence of falls during follow-up by education

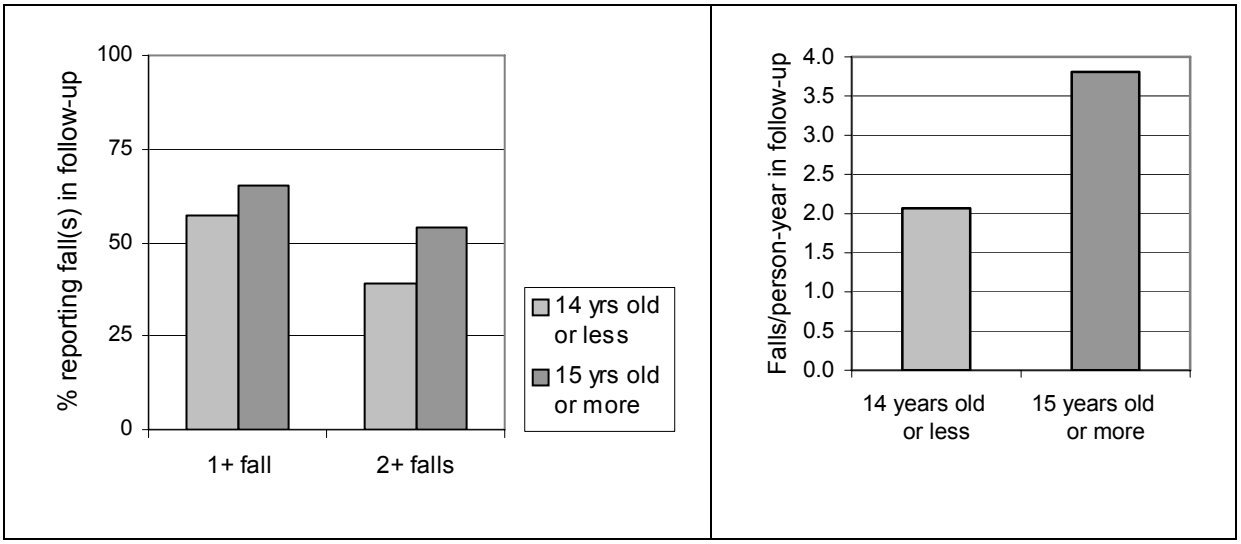


Figure 7.6.1.5 Prevalence and incidence of falls during follow-up by social class

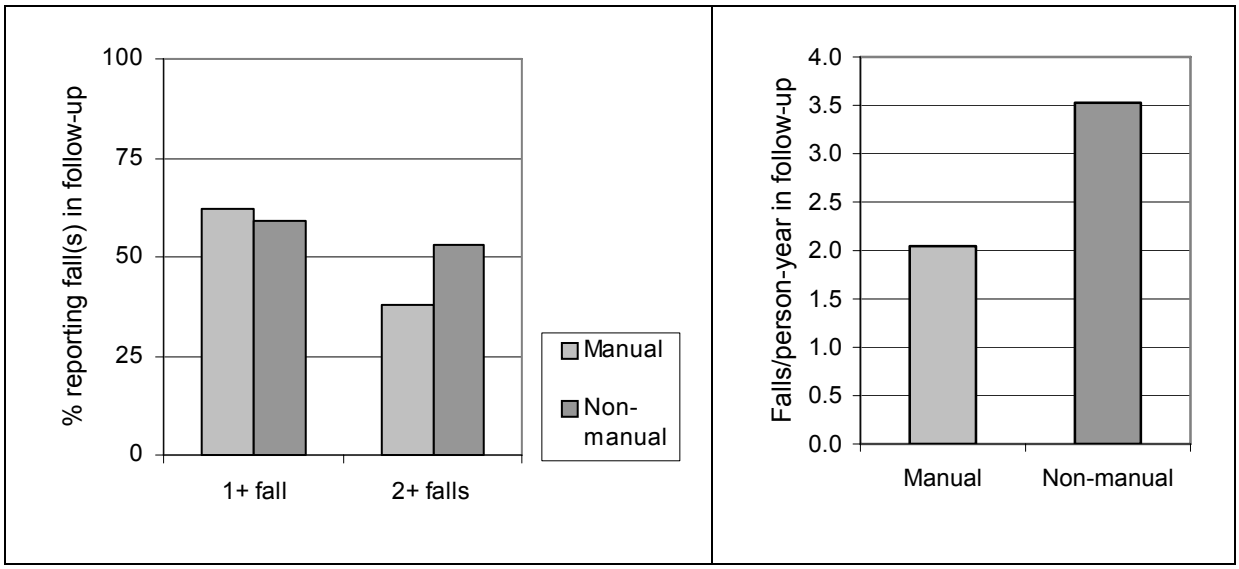


Figure 7.6.1.6 Prevalence and incidence of falls during follow-up by place of residence

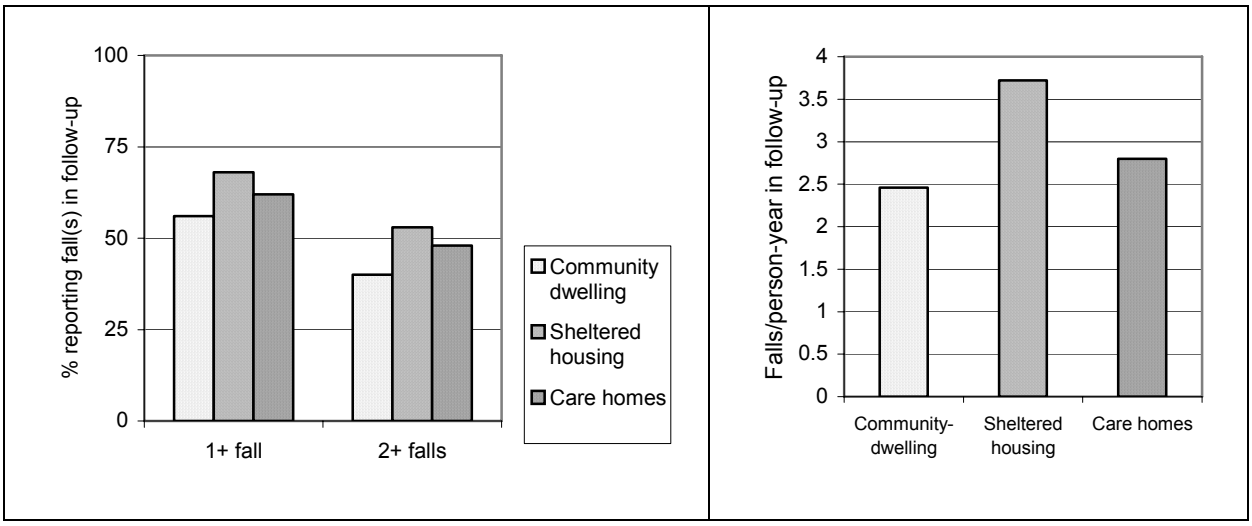


Table 7.6.1.7 Demographic associations: Odds ratios for follow-up falling / repeat falling

		Reported ≥ 1 fall n (%)	Odds Ratio unadjusted (95% C.I.)	Reported ≥ 2 falls n (%)	Odds Ratio unadjusted (95% C.I.)
AGE-BAND					
91-94	n=74	43 (58)	1.0	31 (42)	1.0
≥ 95	n=36	23 (64)	1.3 (0.6-2.9)	18 (50)	1.4 (0.6-3.1)
AGE					
Each additional year			1.07 (0.9-1.3)		**1.1 (0.96-1.4)**
GENDER					
Men	n=20	10 (50)	1.0	7 (35)	1.0
Women	n=90	56 (62)	1.7 (0.67-4.4)	42 (47)	1.6 (0.6-4.5)
EDUCATION					
Left school aged 14 yrs or less	n=67	38 (57)	1.0	26 (39)	1.0
Full-time education aged 15+ yrs	n=43	28 (65)	1.4 (0.7-3.1)	23 (54)	1.8 (0.8-3.9)
SOCIAL CLASS					
Manual	n=55	34 (62)	1.0	21 (38)	1.0
Non-manual	n=51	30 (59)	0.9 (0.49-1.9)	27 (53)	1.8 (0.8-4.0)
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	n=62	35 (57)	1.0	25 (40)	1.0
Living in any supported setting (Sheltered housing or institution)	n=48	31 (65)	1.4 (0.7-3.0)	24 (50)	1.5 (0.7-3.2)
TOTAL SAMPLE	n=110	66 (60)		49 (45)	

Table 7.6.1.8 Demographic associations: Relative risk of falls during follow-up

		Number of falls	Person-yrs follow-up	Incidence /100 p-yrs	Relative Risk (95% C.I.)
AGE-BAND					
91-94	n=74	174	68.2	255	1.0
≥ 95	n=36	91	27.5	331	1.5 (0.8-2.7)
AGE					
Each additional year					1.04 (0.9-1.2)
GENDER					
Men	n=20	54	17.2	314	1.0
Women	n=90	211	78.5	269	0.8 (0.4-1.8)
EDUCATION					
Left school aged 14 yrs or less	n=67	118	57.1	207	1.0
Full-time education aged 15+ yrs	n=43	147	38.6	381	**1.8 (1.02-3.2)**
SOCIAL CLASS					
Manual	n=55	95	46.5	204	1.0
Non-manual	n=51	163	46.2	353	**1.9 (1.07-3.4)**
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	n=62	138	56.1	246	1.0
Living in any supported setting (Sheltered housing or institution)	n=48	127	39.7	321	1.4 (0.8-2.4)
TOTAL SAMPLE	n=110	265	95.7	277	

Table 7.6.1.9 Multiple falls during follow-up: effect on incidence rates and rate ratios

		Multiple falls: ≥5 in 1 wk	Falls excl. mult. falls	Incidence /100 p-yrs excl. mult. falls	Relative Risk - unadjusted (95% C.I.)
AGE-BAND					
91-94	n=74	36	138	202	1.0
≥ 95	n=36	5	86	312	1.7 (0.96-2.9)
AGE					
Each additional year					**1.07 (0.96-1.2)**
GENDER					
Men	n=20	7	47	273	1.0
Women	n=90	34	177	225	0.8 (0.4-1.6)
EDUCATION					
Left school aged 14 yrs or less	n=67	7	111	194	1.0
Full-time education aged 15+ yrs	n=43	34	113	293	1.5 (0.9-2.5)
SOCIAL CLASS					
Manual	n=55	0	95	204	1.0
Non-manual	n=51	41	122	264	1.4 (0.8-2.4)
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	n=62	7	131	234	1.0
Living in any supported setting (Sheltered housing or institution)	n=48	34	93	234	1.06 (0.6-1.8)
TOTAL SAMPLE	n=110	41	224	234	

Time to first fall during follow-up

In describing the epidemiology of falls amongst the "oldest old" as reported in this study, the previous section illustrated the length of time from interview until a fall occurred with comparisons of different sub-groups of the sample (see Figure 7.4.3). These Kaplan-Meier plots of time to first fall showed divergence between all demographic groupings except social class, but divergence was not marked. Testing the strength of any apparent association between these factors and fall-free survival found none of the associated hazard ratios were significant (see Table 7.6.1.10).

Table 7.6.1.10 Demographic associations: Hazard ratios for time to first fall in follow-up

		Survival time			Hazard Ratio unadjusted (95% C.I.)
		25% (days)	50% (days)	75% (days)	
AGE-BAND					
91-94	n=74	118	205	-	1.0
≥ 95	n=36	39	77	-	1.6 (0.9-2.6)
GENDER					
Men	n=20	41	268	-	1.0
Women	n=90	64	178	-	1.3 (0.7-2.6)
EDUCATION					
Left school aged 14 yrs or less	n=67	95	239	-	1.0
Full-time education aged 15+ yrs	n=43	51	123	-	1.4 (0.8-2.2)
SOCIAL CLASS					
Manual	n=55	95	177	-	1.0
Non-manual	n=51	59	205	-	0.9 (0.5-1.5)
PLACE OF RESIDENCE					
Living in the community (house, flat or granny flat)	n=62	64	239	-	1.0
Living in any supported setting (Sheltered housing or institution)	n=48	59	149	-	1.3 (0.8-2.1)
TOTAL SAMPLE	n=110	62	181	-	

7.6.2 Cognitive function

Both the prevalence and incidence of falling during follow-up were raised amongst those with severe cognitive impairment, but this was not so for the moderately impaired who reportedly fell slightly less or the same as the cognitively intact (see Figure 7.6.2.1).

Table 7.6.2.2 and 7.6.2.3 show how the risk ratio for the higher falls incidence amongst the severely cognitively impaired was nearly double compared with the rest of the population, RR 1.93 (95% C.I. 1.05-3.51), on a similar scale to the odds ratio associated with having fallen at least twice during follow-up, OR 2.1 (95% C.I. 0.9-4.8). Education is the only demographic co-variate that had a significant effect on the relative risk of falls predicted by having severe cognitive impairment. Adjusting for educational level modified the RR from 1.93 (1.05 – 3.51) unadjusted to 1.89 (1.05 – 3.41).

Fall-free survival time to first fall was shown in Figure 7.4.3's Kaplan-Meier curves (see Chapter 7). Although there was increasing divergence over time between survival plots by cognitive function the separation was not clear-cut, and this is reflected in the hazard ratio proving a weaker measure of association (see Table 7.6.2.4).

Figure 7.6.2.1 Prevalence and incidence of falls during follow-up by cognitive function

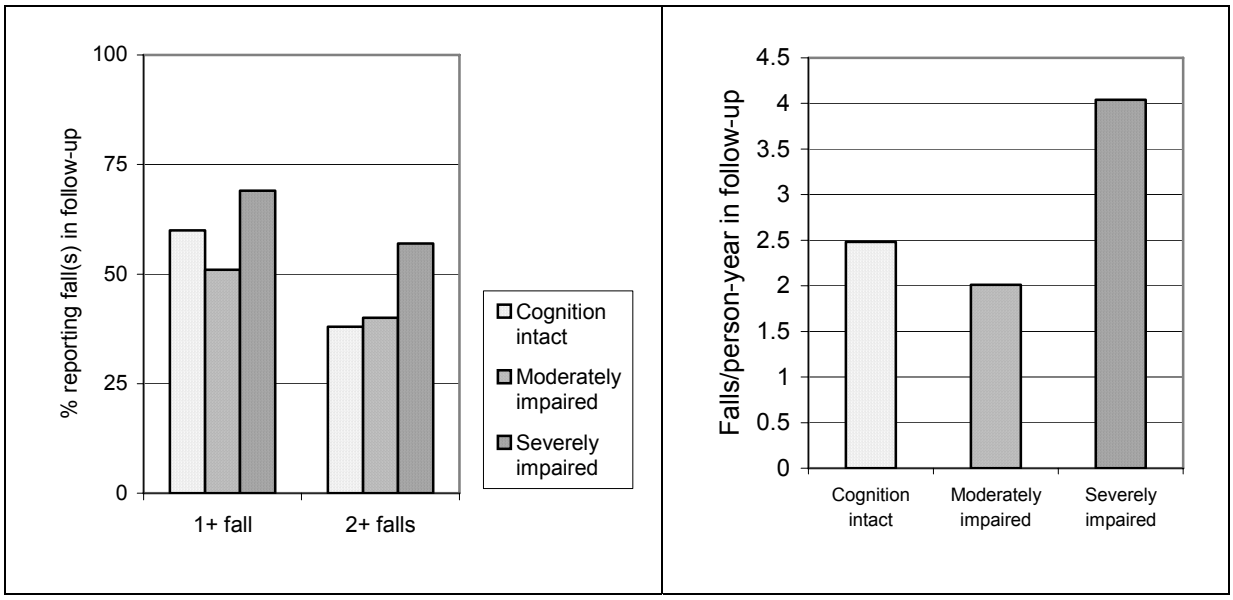


Table 7.6.2.2 Cognitive function: Odds ratios for follow-up falling / repeat falling

	Reported at least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	Reported 2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)
Cognition intact / Mod. impairment n=75	42 (56)	1.0	29 (39)	1.0
Severe cognitive impairment n=35	24 (69)	1.7 (0.7-4.0)	20 (57)	2.1 (0.9-4.8)

Table 7.6.2.3 Cognitive function: Relative risk of falls during follow-up

	Number of falls	Person-yrs follow-up	Incidence of falls / 100 person-years	Relative Risk - unadjusted (95% C.I.)
Cognition intact / Mod. impairment n=75	155	68.5	226	1.0
Severe cognitive impairment n=35	110	27.2	404	**1.9 (1.0-3.5)**

Table 7.6.2.4 Cognitive function: Hazard ratios for time to first fall during follow-up

	Survival time			Hazard Ratio unadjusted
	25% (days)	50% (days)	75% (days)	(95% C.I.)
Cognition intact / Moderate cogn. impairment n=75	80	199	-	1.0
Severe cognitive impairment n=35	54	163	-	1.4 (0.9-2.3)

7.6.3 Reported balance problems, fear of falling and recent falls

7.6.3.1 Perceived problems with balance
7.6.3.2 Worry about falling
7.6.3.3 Recalled falls in the past year

7.6.3.1 Perceived problems with balance

Chapter 3 reported the prevalence of two conditions that participants were asked whether they suffered from that can be interpreted as assessments of perception of balance: being "unsteady on your feet" and having a "tendency to fall". In examining how these relate to recalled falling Chapter 6 also gave more details.

Prospective falls data showed a trend of increasing falling across three categories of each measure – reporting no problems, reporting a problem but not finding it serious, and describing the problem as "disabling" (see Figure 7.6.3.1.1).

The odds ratios for suffering at least one fall and for being a recurrent faller are increased with both measures but having a tendency to fall showed a clearer association (see Table 7.6.3.1.2).

Relative risks of falls were more than double amongst those reporting unsteadiness and increased approximately three-fold amongst those who said they had a tendency to fall, whether or not those who described these problems as not disabling are included with the "disabling" category in the analyses (see Table 7.6.3.1.3).

Figure 7.6.3.1.1 Reported problems with balance in relation to follow-up falls rates

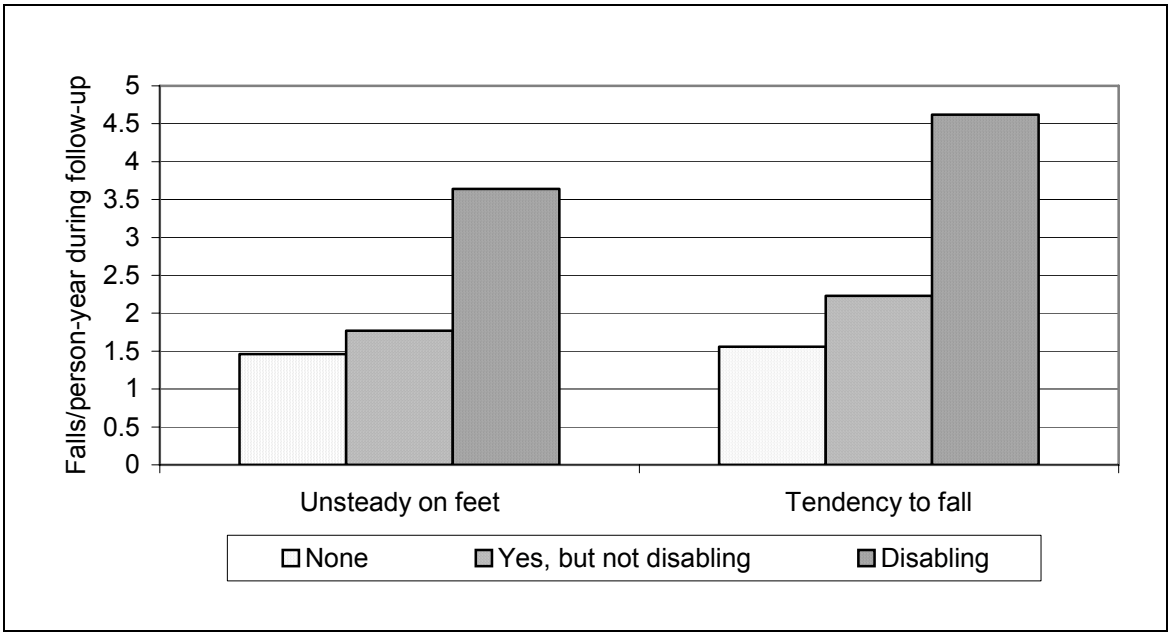


Table 7.6.3.1.2 Reported problems with balance: Odds ratios and relative risks associated with falling, repeated falling & number of falls during follow-up

	CONDITION RATED AS DISABLING		CONDITION PRESENT TO ANY EXTENT, DISABLING OR NOT	
	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)
Unsteady on feet	1.8 (0.8-4.0)	1.6 (0.7-3.6)	2.1 (0.8-5.7)	1.7 (0.6-4.8)
Tendency to fall	**2.2 (0.96-4.9)**	**2.1 (0.96-4.6)**	**2.9 (1.3-6.6)**	**2.2 (1.02-4.8)**

Table 7.6.4.3.3 Reported problems with balance: Relative risks of falls during follow-up comparing effects whether respondents rated problems as disabling or not

	CONDITION RATED AS DISABLING	CONDITION PRESENT TO ANY EXTENT, DISABLING OR NOT
	Relative Risk of falls - unadjusted (95% C.I.)	Relative Risk of falls - unadjusted (95% C.I.)
Unsteady on feet	**2.4 (1.3-4.5)**	**2.3 (1.1-5.0)**
Tendency to fall	**3.0 (1.7-5.3)**	**2.8 (1.6-5.0)**

7.6.3.2 Fear of falling

Worry about falling
Falls Efficacy

Besides assessing the perception of the likelihood of falling examined in the section above and the recall of falling described in Chapter 6 and further examined in the section below, the survey attempted to assess the level of concern about falling with the measures described in Chapter 2 and reported in section 6.6.3.2.

Worry about falling

Falling during follow-up was more prevalent amongst those who were worried about falling again (69%) than amongst those who said they were not worried (51%). 62% of those not asked about this, mainly those for whom a proxy informant provided the fall history, fell at least once during follow-up (not included in Figures and Table opposite).

The same pattern was also found in repeated falling but this was only slightly more prevalent amongst those who were worried about falling again (46%) and amongst those not asked about this (43%), than amongst those who said they were not worried (40%). Despite the consistent pattern illustrated in Figure 7.6.3.2.1, Table 7.6.3.2.3 shows that these differences are not statistically significant.

Although neither ORs for falling or repeat falling during follow-up are significant, negative binomial regression on number of falls gives a significantly increased risk of falls during follow-up predicted by being worried about falling (RR 2.3, 95% C.I. 1.1-5.0)

Falls Efficacy

The simplified FES-UK scores used to measure falls efficacy were divided into tertiles, with the highest scores representing greater confidence in performing daily activities without falling. There was a pattern of increasing prevalence of repeated falling and increasing falls incidence rates with worsening FES score, a trend that produced significant risk estimates only for the number of falls: RR 2.3 (95% C.I. 0.95-5.7). The prevalence of falling at least once during follow-up was highest in the mid tertile, although this increase was not significant (see Figure 7.6.3.2.2 and Table 7.6.3.2.3).

Figure 7.6.3.2.1 Prevalence and incidence of falls during follow-up in relation to worry about falling

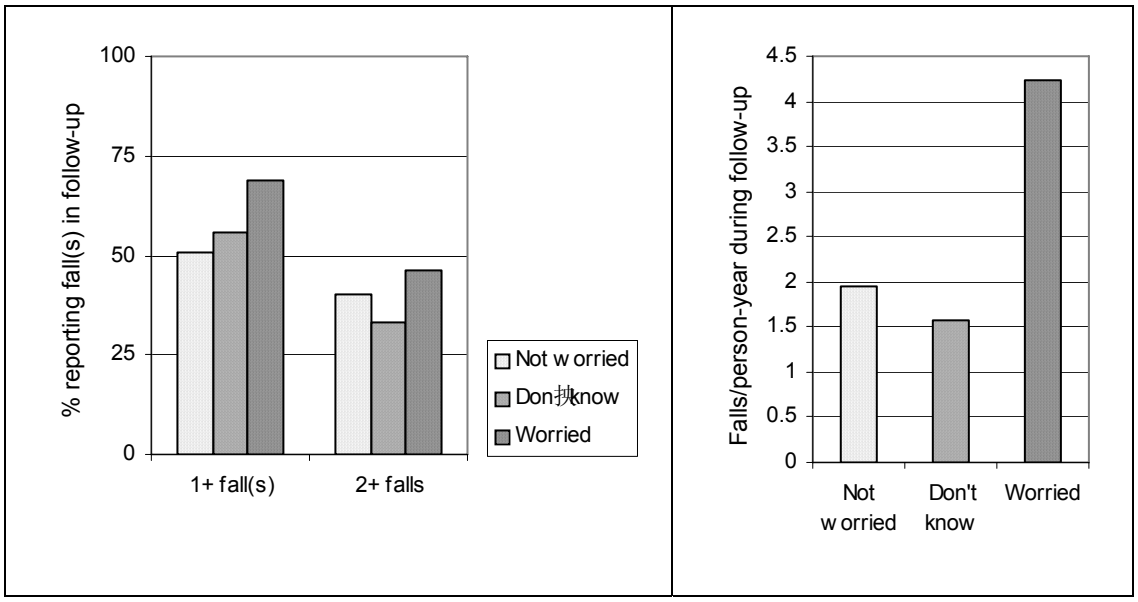


Figure 7.6.3.2.2 Prevalence and incidence of falls during follow-up in relation to falls efficacy

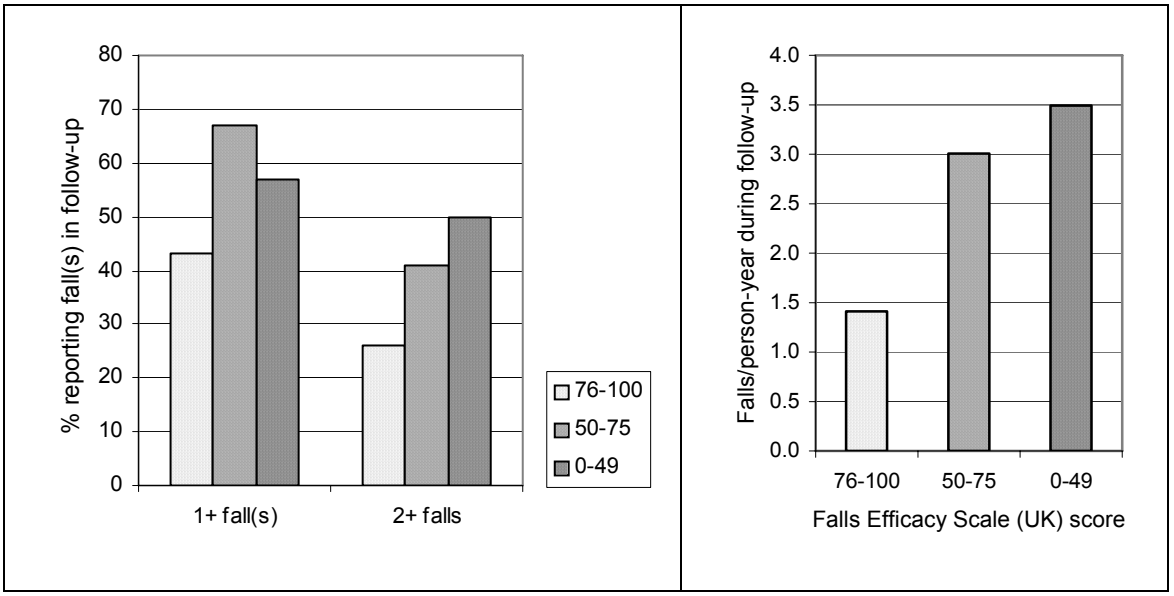


Table 7.6.3.2.3 Fear of falling in relation to falling, repeated falling and falls during follow-up

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Not worried about falls n=43	22 (51)	1.0	17 (40)	1.0	1.0
Worried about falls n=26	18 (69)	2.1 (0.8-6.0)	12 (46)	1.3 (0.5-3.5)	**2.3 (1.1-5.0)**
FES-UK score 76 -100 n=23	10 (44)	1.0	6 (26)	1.0	1.0
FES-UK score 50 - 75 n=27	18 (67)	2.6 (0.8-8.2)	11 (41)	1.9 (0.6-6.5)	2.2 (0.9-5.6)
FES-UK score 0 - 49 n=28	16 (57)	1.7 (0.6-5.3)	14 (50)	2.8 (0.9-9.3)	**2.3 (0.95-5.7)**

7.6.3.3 History of falling

Numerous studies have identified previous fall history as one of the strongest risk indicators for subsequent falls. The falls history in the CC75C study interview allowed for the examination of the effect of having fallen in the year before interview on falls during the following year. Again drawing on earlier findings (see Chapter 1, section 1.2.5.1), analyses explored separately the effects of repeated falling, recognising that this might identify a group at higher risk than the broader category of "any fall in the past year".

The following figures and tables (Figures 7.6.3.3.1 and Tables 7.6.3.3.2-4) show how recent fall history (number of falls in the previous year) relate to falling and to falling more than once during follow-up. The widening disparity in time to first fall was shown in the description of prospective falls data earlier in this chapter (see Fig. 7.4.3), and Table 7.6.3.3.4's Hazard Ratios reflect the greater effect of repeated past falls.

The unadjusted RR for falls during follow-up associated with reporting having fallen in the previous year was 3.6 (2.0 – 6.4). Adjusting for demographic factors (age, sex, education, class and place of residence) and cognitive function reduced this to 2.9 (1.6 – 5.2), but likelihood ratio testing indicated that severe cognitive impairment was the only co-variate in the model that added a contribution approaching significance. Adjusting for cognition alone lowered the unadjusted risk only marginally: RR 3.4 (1.9 – 5.9).

Recalling more than one fall in the previous year was even more predictive of the rate of falling in the following year: unadjusted RR 4.7 (2.8 – 7.9). Adjusting for the same demographic and cognitive variables left the risk estimate unchanged 4.7 (2.7 – 8.0). Of these factors only severe cognitive impairment and education added significantly to the model and using only these two confounders, the adjusted RR drops slightly to 4.4 (2.6 – 7.3).

Odds ratios for suffering any fall or more than one fall during follow-up were likewise barely affected by adjustment for potentially confounding demographic co-variates, and again cognitive function had only a slight, and for ORs insignificant, effect on the effect estimates.

Figure 7.6.3.3.1 Prevalence and incidence of falls during follow-up by history of previous falls

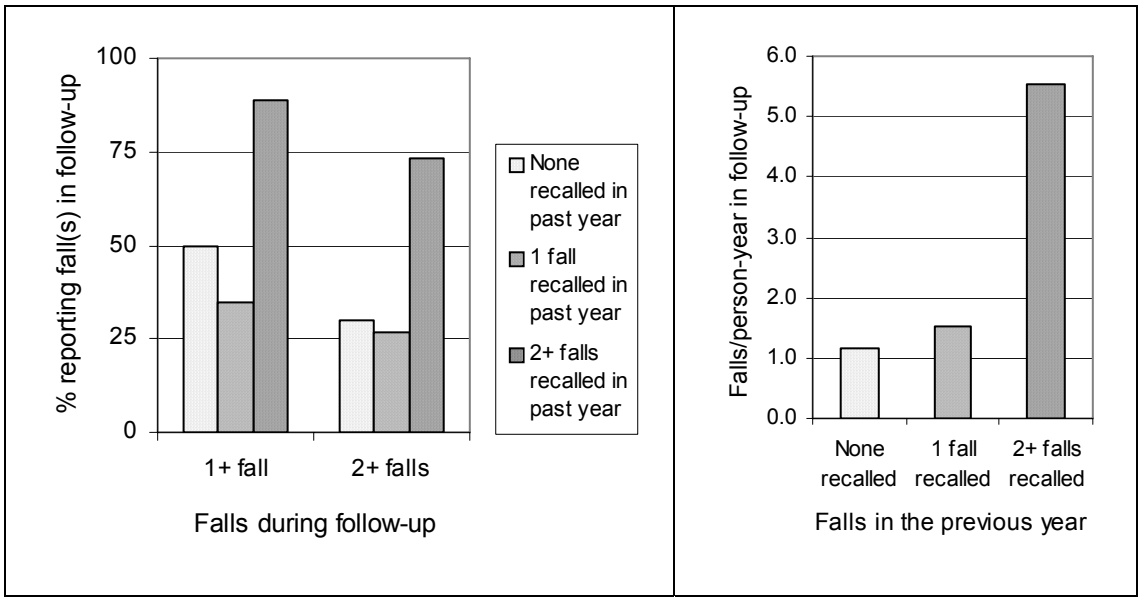


Table 7.6.3.3.2 History of previous falls: Odds ratios for follow-up falling / repeat falling

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)
Not fallen in year before interview n=46	23 (50)	1.0	14 (30)	1.0
Fallen at least once in past year n=63	42 (67)	2.0 (0.9-4.4)	34 (54)	**2.7 (1.2-6.0)**
Fallen only once or not past year n=72	32 (44)	1.0	21 (29)	1.0
Fallen more than once in past year n=37	33 (89)	**10.3 (3.3-32.1)**	27 (73)	**6.6 (2.7-15.9)**

Table 7.6.3.3.3 History of previous falls: Relative risk of falls during follow-up

	Number of falls	Person-yrs follow-up	Incidence falls / 100 person-yrs	Relative Risk - unadjusted (95% C.I.)
Not fallen in year before interview n=46	47	40.8	115	1.0
Fallen at least once in past year n=63	216	54.6	396	**3.6 (2.0-6.4)**
Fallen only once or not past year n=72	80	62.4	128	1.0
Fallen more than once in past year n=37	183	33.0	555	**4.7 (2.8-7.9)**

Table 7.6.3.3.4 History of previous falls: Hazard ratios for time to first fall during follow-up

	Survival time			Hazard Ratio unadjusted
	25% (days)	50% (days)	75% (days)	(95% C.I.)
Not fallen in year before interview n=46	118	292	-	1.0
Fallen at least once in year before interview n=63	41	163	-	**1.7 (1.0-2.8)**
Fallen only once or not in year before interview n=72	126	-	-	1.0
Fallen more than once in year before interview n=37	28	54	181	**3.5 (2.1-5.7)**

7.6.4 Health and disability

7.6.4.1 Visual impairment
7.6.4.2 Hearing impairment
7.6.4.3 Weakness
7.6.4.4 Arthritis
7.6.4.5 Incontinence
7.6.4.6 Depression
7.6.4.7 Co-morbidity
7.6.4.8 Self-rated health
7.6.4.9 Activities of daily living
7.6.4.10 Medication

As explained in Chapter 6, the analyses presented there of associations between reported health variables and measures of falling from retrospective recall were driven by the factors identified in the research literature to date on health risks for falling (see Chapter 1, sections 1.2.4-5). Continuing testing these same hypotheses, the following section now examines whether these health-related factors are predictive of prospectively reported falls. The health measures include interview questions on health-related conditions ("hearing loss", "poor vision", "arthritis" and "marked weakness in arms or legs"), activities of daily living ("getting to the toilet on time" examined separately as well as scores for basic ADLs and instrumental ADLs) and self-rated health; recorded medications and brief assessments of hearing and eyesight.

7.6.4.1 Visual impairment

Neither reported "poor vision" nor impaired reading vision (unable to read print with 3mm capitals) showed consistent associations with prospective falls measures. As Figure 7.6.4.1 and Table 7.6.4.2 show, although the relative risk for falls was non-significantly raised 30% for both reported and assessed visual impairment, the odds ratios for repeated falling showed an opposite effect.

7.6.4.2 Hearing impairment

Reported hearing loss appeared to be weakly related to prospective measures of falling but objectively assessed hearing impairment, which did not concord well with reported hearing loss (see Chapter 4, section 4.3.5), showed a minimal relation with conflicting direction of effects for repeated falling and numbers of falls (see Figure 7.6.4.1 and Table 7.6.4.2).

Figure 7.6.4.1 Incidence of falls during follow-up by reported and assessed visual and hearing impairment

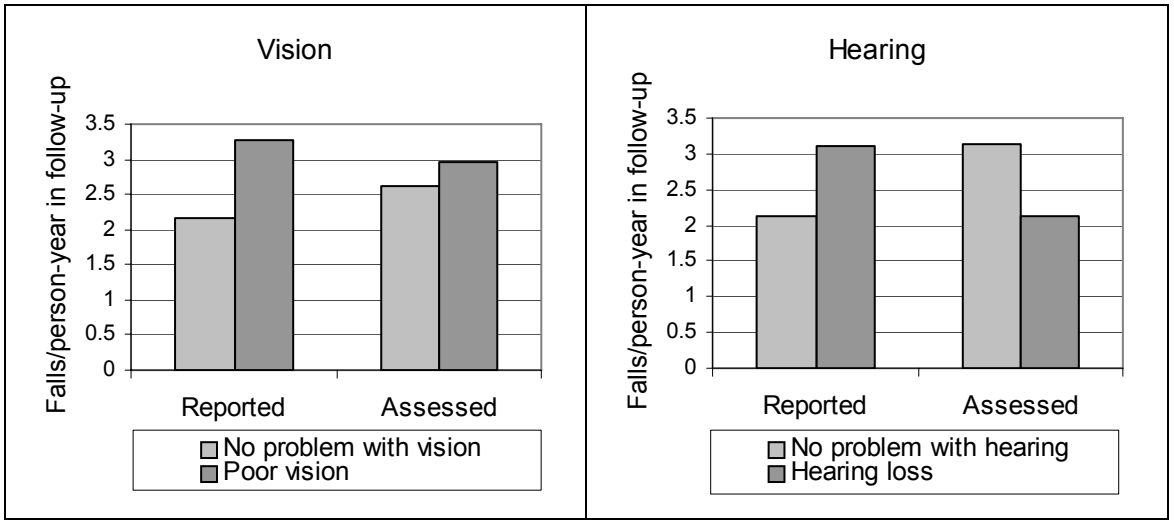


Table 7.6.4.2 Poor vision and hearing – reported and assessed – in relation to falling, repeated falling and falls during follow-up

		At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Reported poor vision *						
No problem reported	n=45	25 (56)	1.0	21 (47)	1.0	1.0
Any - disabling or not	n=62	38 (61)	1.3 (0.6-2.8)	27 (44)	0.9 (0.4-1.9)	1.3 (0.7-2.4)
Visual impairment †						
Able to read 3mm print	n=68	42 (62)	1.0	32 (47)	1.0	1.0
Unable to read 3mm print	n=28	13 (46)	0.5 (0.2-1.3)	7 (25)	**0.4 (0.1-1.0)**	1.3 (0.6-2.8)
Reported hearing loss ‡						
No problem reported	n=37	19 (51)	1.0	13 (35)	1.0	1.0
Any - disabling or not	n=69	43 (62)	1.6 (0.7-3.5)	34 (49)	1.8 (0.8-4.1)	1.5 (0.8-2.8)
Hearing loss §						
Can hear normal speech	n=44	22 (50)	1.0	18 (41)	1.0	1.0
Cannot hear accurately…	n=47	29 (62)	1.6 (0.7-3.7)	20 (43)	1.1 (0.5-2.5)	0.7 (0.3-1.3)

* n=3 had missing data on reported problems with "poor vision"
† n=96 took reading print size assessment
‡ n=4 had missing data on reported problems with "hearing loss"
§ n=91 had hearing assessed with whisper test

The following Figure 7.6.4.3 and Table 7.6.4.4 present falls incidence rates and risk estimates associated with a number of other health-related conditions that the literature suggests are putative risk factors for falling:

7.6.4.3 Weakness

Reportedly being affected by "marked weakness in the arms or legs" (whether or not described as "disabling") bore little relation to the risk of falling, as the minimal and inconsistent risk estimates in Table 7.6.4.4 show.

7.6.4.4 Arthritis

The relative risk of falls associated with reporting any "arthritis/rheumatism" were almost doubled (RR 1.8, 95% C.I. 1.0-3.3), with odds for falling on a similar scale and for repeated falling also consistent in direction of effect although much weaker.

7.6.4.5 Incontinence

Of the specific health-related conditions selected for analysis as potential risk factors for falls, the strongest predictor of falls was incontinence (see Figure 7.6.4.3 and Table 7.6.4.4). Having "accidents more than once a week" more than doubled the odds ratio for falling at least once during follow-up, and conferred an approximately three-fold increase in the relative risk of falls or of suffering recurrent falls.

7.6.4.6 Depression

A high score on the Depressive Symptoms Scale (DSS) doubled the relative risk of falls during follow-up, although the odds ratios were not so strong (see Table 7.6.4.4). There were no significant differences in DSS scores between those who did not fall, who fell at least once and who had recurrent falls.

7.6.4.7 Co-morbidity

Multiple health conditions greatly increased the falls risk estimates. Reporting more than five diagnoses or physical symptoms conferred a five-fold increased odds of falling during follow-up and increased the relative risk of falls almost three-fold (see Table 7.6.4.4).

Figure 7.6.4.3 Incidence of falls during follow-up by health-related conditions

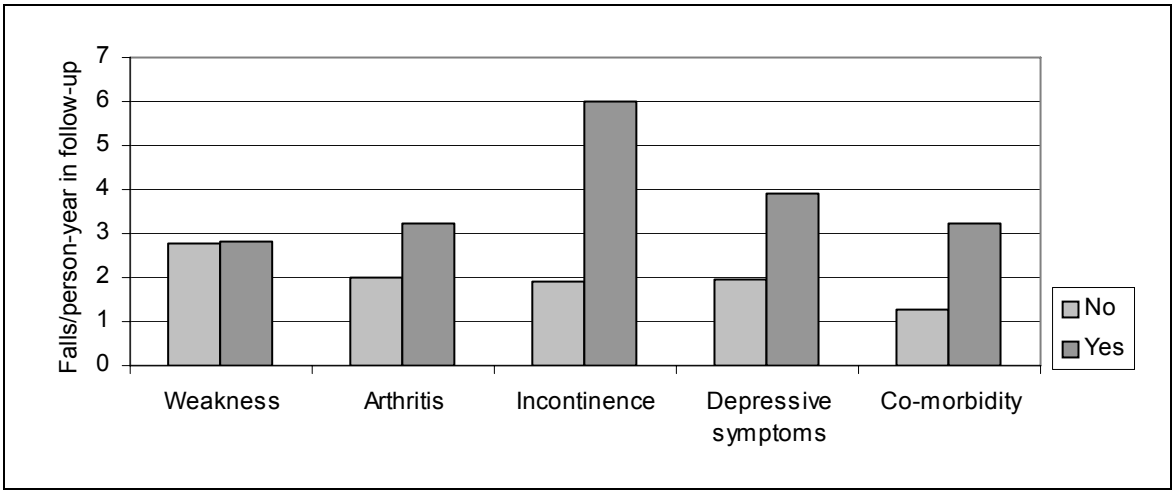


Table 7.6.4.4 Health-related conditions in relation to falling, repeated falling and falls during follow-up

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Reported limb weakness *					
No problem reported n=45	25 (56)	1.0	21 (47)	1.0	1.0
Any - disabling or not n=62	38 (61)	1.3 (0.6-2.8)	27 (44)	0.9 (0.4-1.9)	1.1 (0.6-2.0)
Reported arthritis †					
No problem reported n=38	19 (50)	1.0	16 (42)	1.0	1.0
Any - disabling or not n=69	44 (64)	1.8 (0.8-3.9)	31 (45)	1.1 (0.5-2.5)	**1.8 (0.96-3.3)**
Getting to the toilet on time‡					
No problem/rare accidents n=78	43 (55)	1.0	30 (38)	1.0	1.0
Accidents > once/week n=27	20 (74)	2.3 (0.9-6.1)	17 (63)	**2.7 (1.1-6.7)**	**3.3 (1.8-6.1)**
Depressive symptoms score§					
DSS 0-4 n=59	32 (54)	1.0	24 (41)	1.0	1.0
DSS 5-11 n=27	16 (59)	1.2 (0.5-3.1)	12 (44)	1.2 (0.5-2.9)	**2.1 (1.1-4.3)**
Co-morbid conditions ¶					
0-5 reported/diagnosed n=22	6 (27)	1.0	6 (27)	1.0	1.0
> 5 reported/diagnosed n=85	57 (67)	**5.4 (1.9-15.4)**	42 (49)	2.6 (0.9-7.3)	**2.8 (1.3-6.1)**

* Data on reported problems with "marked weakness in arms or legs" were missing on n=3
† Data on reported problems with "arthritis/rheumatism" were missing on n=3
‡ Data on reported problems with "getting to the toilet on time" were missing on n=5
§ Data on depressive symptoms were missing on n=24 (DSS questions not asked if proxy interview only)
¶ Data on reported physical symptoms or diagnosed conditions were missing on n=3

7.6.4.8 Self-rated health

Figure 7.6.4.8.1 illustrates how rating one's health as fair, poor or very poor in comparison with others of the same age predicted dramatically higher falls incidence than health self-rated as good or very poor. Adjusting for cognitive function and demographic covariates had no effect on the risk estimates associated with self-rated health. Table 7.6.4.8.2 presents the relative risks – for this measure RR 6.0 (95% CI 2.8-12.8) – and show how the associated odds of suffering at least one fall during follow-up were also raised - almost three-fold but not significantly – and the odds of falling more than once were again markedly increased (OR 4.5, 95% C.I. 1.5-14.4).

There was a sizeable minority (1 in 7) who were unable to rate their health by this standard question, replying that they did not know anyone of their own age. Their responses are however included in the data below from a second question asking respondents how they would rate their health at the time of interview in comparison with their own health a year ago. Both these questions were only put to study participants themselves, not to proxy informants.

Comparison with one's own health a year ago showed a similar pattern to comparison with one's peers but showed weaker associations, none reaching significance.

Figure 7.6.4.8.1 Falls incidence by self-rated health compared with peers or with a year ago

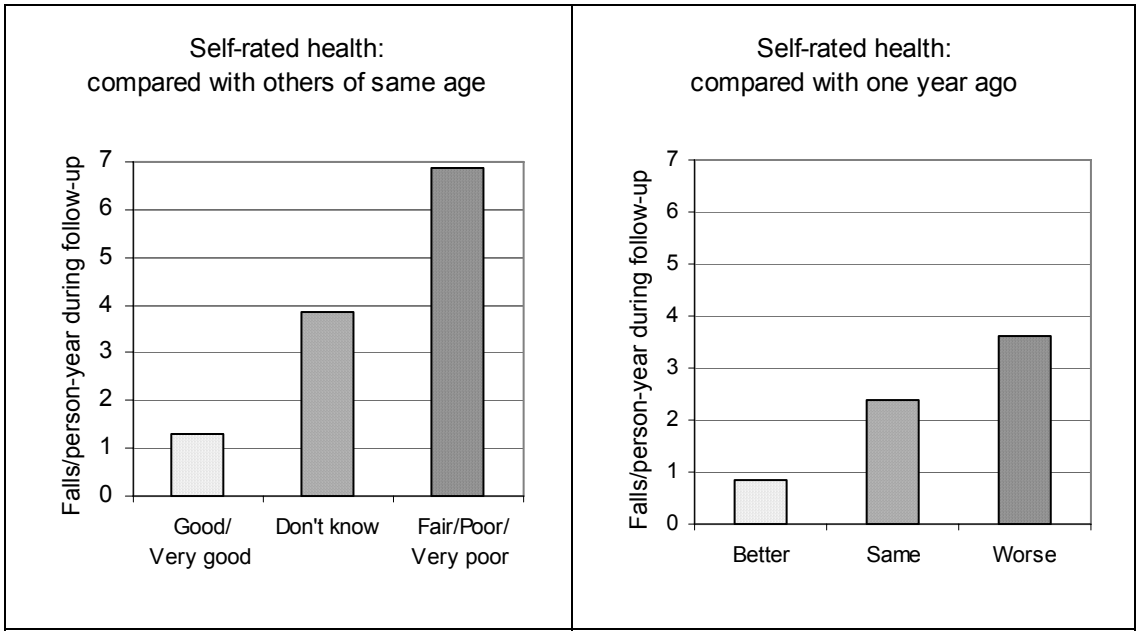


Table 7.6.4.8.2 Self-rated health compared with peers or with own health a year ago in relation to falling, repeated falling and falls during follow-up

		At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Good/very good	n=60	29 (49)	1.0	18 (30)	1.0	1.0
Fair/poor/very poor	n=18	13 (72)	2.8 (0.9-8.8)	12 (67)	**4.5 (1.5-14.4)**	**6.0 (2.8-12.8)**
Better than 1 yr ago	n= 6	2 (33)		1 (17)		
Same as 1 yr ago	n=43	22 (51)	2.1 (0.3-12.6)	19 (44)	4.0 (0.4-36.8)	3.3 (0.7-15.6)
Worse than 1 yr ago	n=41	27 (66)	3.9 (0.6-23.7)	19 (46)	4.3 (0.4-40.3)	4.5 (0.9-21.2)

7.6.4.9 Activities of daily living

The prevalence of falling and repeated falling, as well as the incidence of falls, were all higher amongst those who needed more help with activities of daily living (see Figure 7.6.4.9.1). Reported difficulty in at least two activities in all three ADL groups – "basic", "mobility" and "instrumental" – was highly prevalent (see Chapter 4.3.7), but was most widespread for the instrument ADLs (89%). Consequently differences in falling were most marked for the basic ADLs, mobility ADLs and, as Table 7.6.4.9.2 shows, particularly in the fall measures that reflect repeated falls. Having difficulty with two or more of the basic or mobility activities both predicted at least a doubling of falls risk and a three-fold increase in the odds of recurrent falling.

Two of the ADL scale questions specifically addressed walking difficulties and these will are presented in more detail later in this chapter in the examination on mobility measures.

Difficultly in any of the three mobility-related ADL questions (walking distance, use of walking aid or use of wheelchair) is in effect grouping together all the reported mobility factors that are examined separately later in this chapter. Everyone in this category needed to use a walking aid outdoors, and all but one were unable to walk around their local area. The combined estimate is a little weaker than the separate ones shown under the reported mobility section (section 7.6.5) because the category "Difficulty with 2 or more mobility ADLs" includes also the wheelchair users, those who don't go outside and who can't walk at all who were each excluded from different analyses of the effects of maximum walking distance and walking aid use.

Figure 7.6.4.9.1 Prevalence and incidence of falls during follow-up by difficulty with activities of daily living

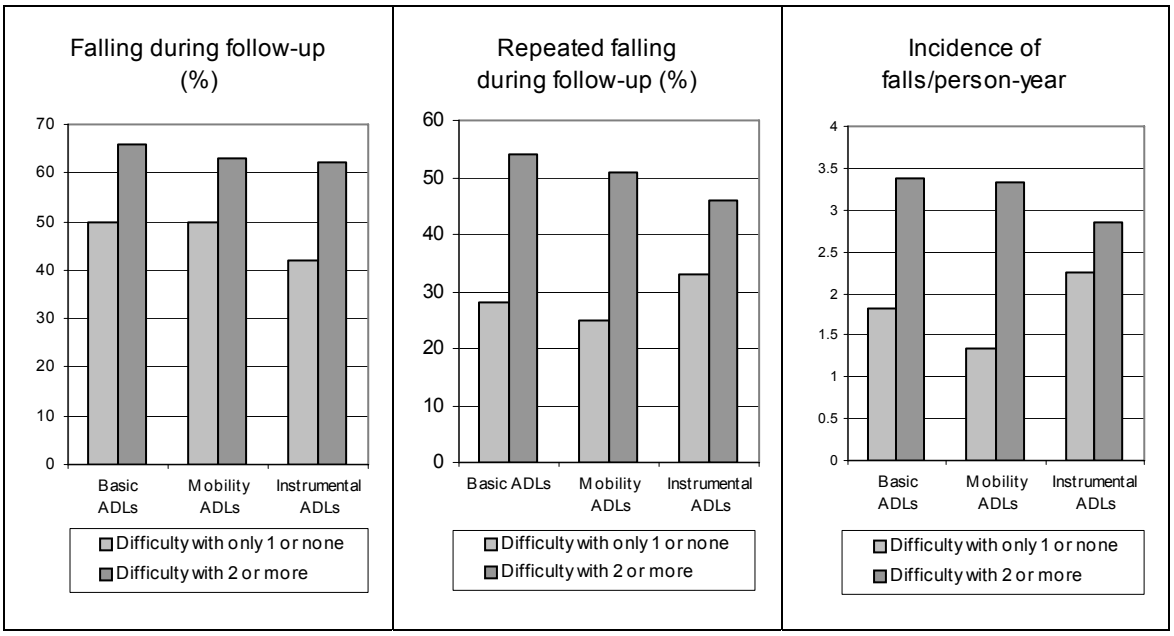


Table 7.6.4.9.2 Difficulty with activities of daily living in relation to falling, repeated falling and falls during follow-up

	≥ 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	≥ 2 falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Difficulty with					
<2 basic ADLs n=40	20 (50)	1.0	11 (28)	1.0	1.0
≥2 basic ADLs n=70	46 (66)	1.9 (0.9-4.2)	38 (54)	**3.1 (1.4-7.2)**	**2.0 (1.1-3.6)**
Difficulty with					
<2 mobility ADLs n=28	14 (50)	1.0	7 (25)	1.0	1.0
≥2 mobility ADLs n=82	52 (63)	1.7 (0.7-4.1)	42 (51)	**3.2 (1.2-8.2)**	**2.5 (1.3-5.0)**
Difficulty with					
<2 instrumental ADLs n=12	5 (42)	1.0	4 (33)	1.0	1.0
≥2 instrumental ADLs n=98	61 (62)	2.3 (0.7-7.8)	45 (46)	1.7 (0.5-6.0)	1.4 (0.5-3.4)

7.6.4.10 Medication

Taking any medication from any of the categories of prescribed drugs that previous studies had identified as increasing falls risk was not found to be associated with falling during follow-up. 68% of those taking one or more of any of these fell during follow-up and 49% of them fell more than once, not significantly higher than the proportions amongst those not on these drugs, of whom 57% fell and 43% fell more than once.

No category of drug identified as potentially increasing falls was found to confer any significantly increased relative risk of falls during follow-up except for SSRI anti-depressants. There were only 4 participants taking SSRIs but between them over 20 falls were reported, even after excluding multiple falls (≥5 within 1 week), conferring a crude relative risk of 4 (95% C.I. 1.2 – 13.9, p=0.03). However, this seeming association disappeared when adjustment was made for cognitive status: RR 1.0 (95% C.I. 0.99-1.01, p=0.7).

Neither of the other over-all medication risk indicators – taking four or more prescribed medications and taking one or more of any "falls risk" category drug – conferred any increased relative risk of falls (see Table 7.6.4.10.1 and Figures 7.6.4.10.2-5).

Table 7.6.4.10.1 Medication use identified in previous studies as increasing falls risk in relation to falling, repeated falling and falls during follow-up

	At least 1 fall n (%)	Odds Ratio - unadjusted (95% C.I.)	2 or more falls n (%)	Odds Ratio - unadjusted (95% C.I.)	Relative Risk - unadjusted (95% C.I.)
Taking any drug identified in previous research as linked to increased risk of falls					
No n=78	45 (57)	1.0	34 (43)	1.0	1.0
Yes n=31	21 (68)	1.6 (0.7-3.8)	15 (48)	1.2 (0.5-2.9)	1.2 (0.6-2.1)
Taking four or more prescribed medications					
No n=48	27 (55)	1.0	20 (41)	1.0	1.0
Yes n=61	39 (64)	1.4 (0.7-3.1)	29 (48)	1.3 (0.6-2.8)	1.2 (0.7-2.0)

Figure 7.6.4.10.2 Falling in the past year by medication risk factors

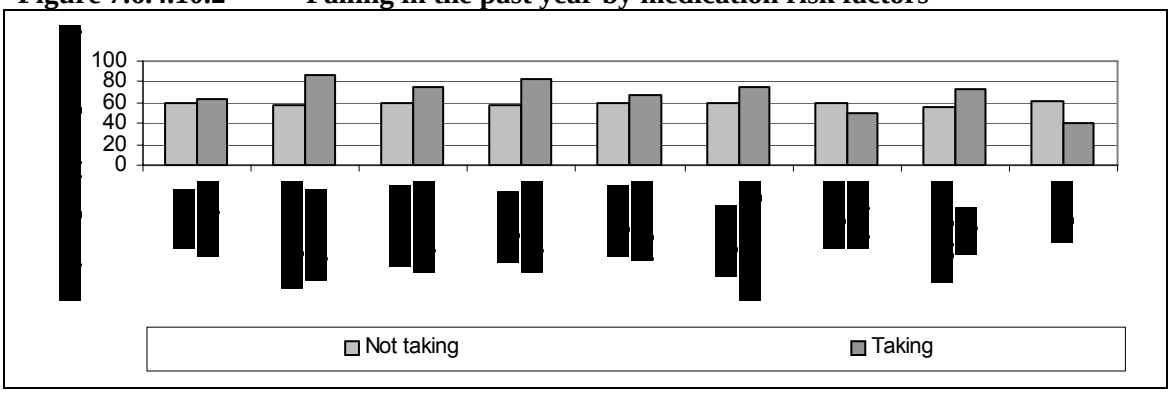


Figure 7.6.4.10.3 Repeated falling last year by medication risk factors

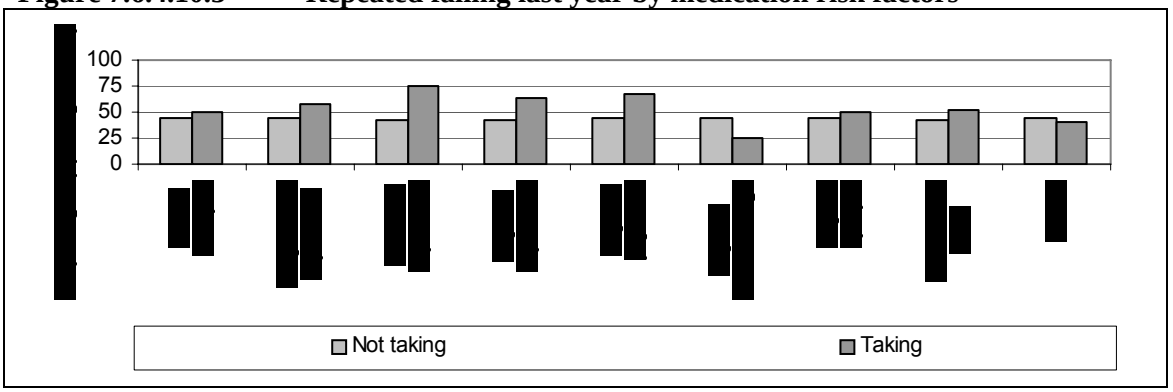


Figure 7.6.3.10.4 Prevalence and incidence of falls in the past year in relation to taking any of the above drugs previously associated with falling

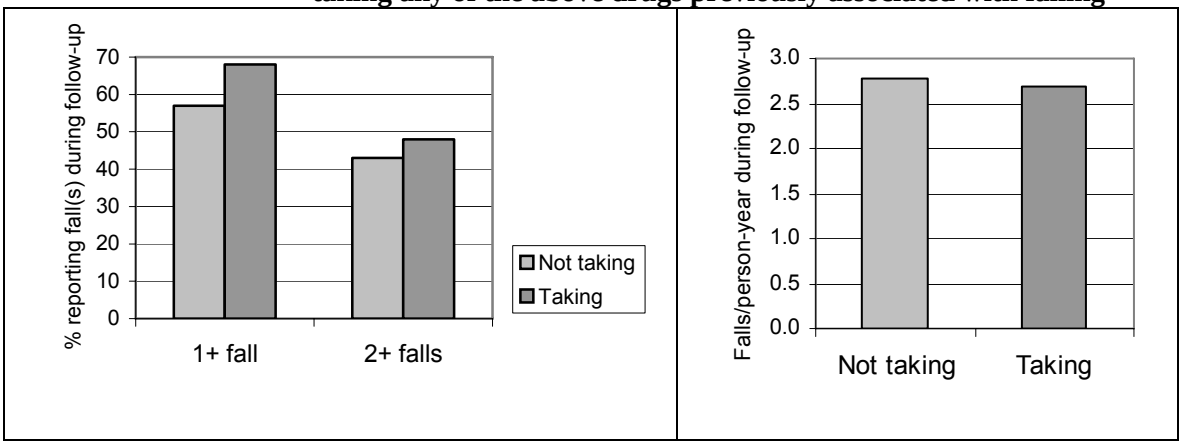
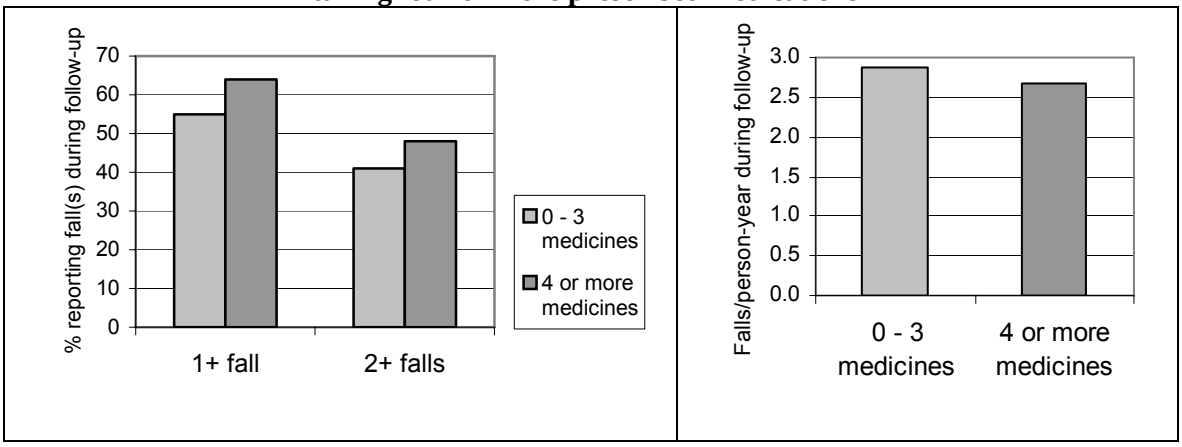


Figure 7.6.3.10.5 Prevalence and incidence of falls in the past year in relation to taking four or more prescribed medications



7.6.5 Mobility – reported measures

7.6.5.1 Limitation in walking distance
7.6.5.2 Use of walking aids
7.6.5.3 Stair climbing
7.6.5.4 Reported physical activity or exercise

Mobility and physical activity, disability and frailty clearly all play a part falls, but these relationships are not straightforward. This section and the next examine uni-variate relations between fall outcome measures and, respectively, the reported and observed measures of mobility described in Chapter 5. The categorical measures of mobility reported at interview are presented in detail first, then dichotomised to provide summary risk estimates.

7.6.5.1 Limitation in walking distance

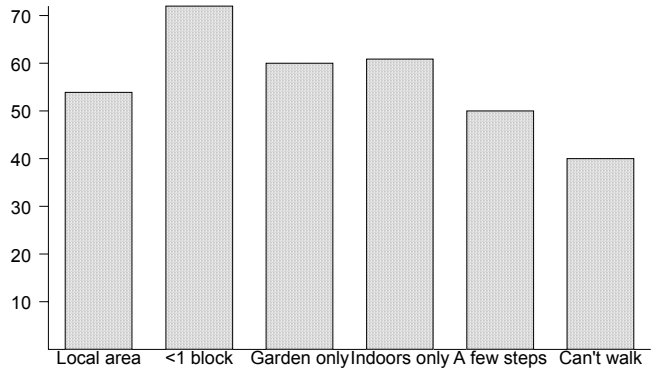
Although falling was highly prevalent across the whole study sample, it was less so amongst both the most and least mobile. The graphs in Figure 7.6.5.1.1 illustrate an inverse U-shaped relationship between falling and the spectrum of walking ability to disability represented by the distance participants reported they were able to walk.

There was a pattern of reduced falls risk and reduced odds of being a faller associated with immobility – being unable to walk at all or only being able to walk a few steps, although those who walked only a few steps had increased odds of falling more than once. With only a tenth of the sample so severely disabled, none of these associations were significant.

Compared with those who could walk around their local area, any degree of limitation in walking distance amongst those who could actually walk was associated with increased odds of being a faller or repeated faller during follow-up, with the relative risk of falls significantly increased between 2 and 3 fold.

Figure 7.6.5.1.1 Prevalence of falling and repeated falling, and incidence of falls during follow-up by reported distance able to walk

Prevalence

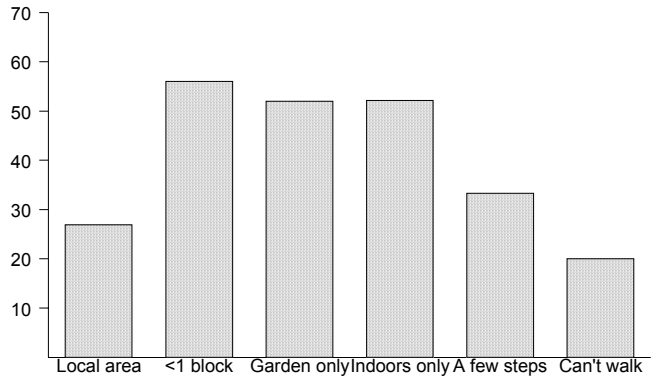


Fell at least once during follow-up

Crude Odds Ratios (95% C.I.s)

for ≥1 fall reports during follow-up if maximum walking distance:

<1 block	2.2	(0.7 – 7.1)
Garden only	1.3	(0.4 – 3.9)
Indoors only	1.3	(0.4 – 4.2)
A few steps	0.9	(0.1 – 5.1)
Cannot walk	0.6	(0.1 – 4.0)



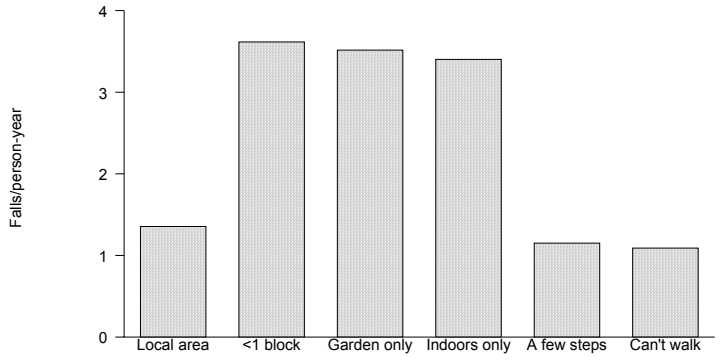
Fell more than once during follow-up

Crude Odds Ratios (95% C.I.s)

for ≥2 fall reports during follow-up if maximum walking distance:

<1 block	3.5	(1.1 – 11.2)
Garden only	2.9	(0.9 – 9.5)
Indoors only	3.0	(0.9 – 9.8)
A few steps	1.4	(0.2 – 9.1)
Cannot walk	0.7	(0.1 – 7.2)

Incidence



Incidence of falls during follow-up

Relative Risk (95% C.I.s)

of falls during follow-up if maximum walking distance:

<1 block	2.7 (1.2-6.1)
Garden only	2.4 (1.1-5.6)
Indoors only	2.9 (1.2-6.8)
A few steps	0.9 (0.2-3.9)
Cannot walk	0.8 (0.1-4.3)

Odds Ratios and Relative Risks for each level of walking distance limitation are in comparison with the baseline level of being able to walk around the local area.

Since the most severe levels of walking disability were associated with reduced falling even compared with those who could walk the furthest, dichotomising the categorical variable that measured walking distance inevitably over-simplifies the relationship. Table 7.6.5.1.2 shows how different cut-points of this measurement alter the effect of limited walking on different outcome measures of falling. The direction and strength of effect are very similar for both measures of repeated falling and are consistently weaker for having fallen at least once. Despite the small sample size, being unable to walk around the local neighbourhood significantly increased the risk of falls during follow-up and the odds ratio for falling repeatedly. When those who could not walk at all were excluded from analyses, these associations were even stronger: RR 2.5 (95% C.I. 1.2-5.1) and the odds ratio for repeated falls rose to almost 3-fold OR 2.9 (95% C.I. 1.1-7.7).

Table 7.6.5.1.2 Walking ability or disability in relation to falling, repeated falling and falls during follow-up

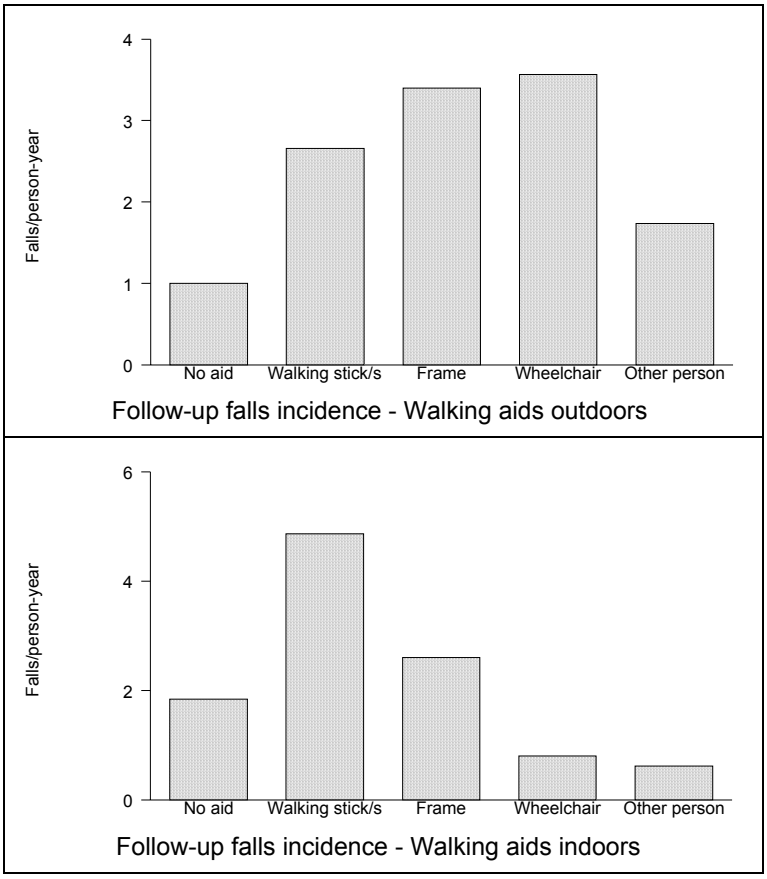
	Odds Ratio for at least 1 fall in follow-up yr - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more in follow-up yr - unadjusted (95% C.I.)	Relative Risk of falls during follow-up yr - unadjusted (95% C.I.)
WALKING DISTANCE			
- UNABLE TO WALK			
Around local area (town/suburb/village)			
Able to walk around locality n=26	1.0	1.0	1.0
Unable to walk so far / at all n=84	1.4 (0.6-3.4)	**2.7 (1.03-7.1)**	**2.4 (1.2-4.9)**
Down street or around local area			
Walks at least down street n=51	1.0	1.0	1.0
Walks only garden/home/not n=59	0.8 (0.4-1.7)	1.3 (0.6-2.7)	1.3 (0.7-2.3)
Outdoors (garden, street or local area)			
Walks outdoors n=76	1.0	1.0	1.0
Walks only indoors/not at all n=34	0.8 (0.3-1.8)	1.0 (0.4-2.2)	1.1 (0.6-2.1)
Unable to walk more than a few steps			
Can walk, at least indoors n=99	1.0	1.0	1.0
Walks only a few steps/not n=11	0.5 (0.1-1.8)	0.4 (0.1-1.7)	0.4 (0.1-1.1)
Unable to walk at all, even a few steps			
Can walk at least a few steps n=105	1.0	1.0	1.0
Unable to walk at all n= 5	0.4 (0.1-2.7)	0.3 (0.03-2.7)	0.3 (0.05-1.9)

7.6.5.2 Use of walking aids

Needing any aid to walk outdoors was associated with increased odds of falling. The relative risk of falls was three-fold compared with those who walked outdoors unaided, and the odds ratio for repeated falls during follow-up was five-fold, as Figure 7.6.5.2.1 illustrates. Mobility aids were more important than needing the aid of another person in these analyses.

As Table 7.6.5.2.2 shows, indoor use of walking aids was less of a factor than outdoor use, although needing any aid indoors still significantly doubled the relative risk of falls during follow-up. This was driven largely by the increased risks associated with using walking frames or sticks. Those who needed a wheelchair or somebody else helping them to walk indoors were the least mobile group who, as shown in the walking distance results in section 7.6.5.1 above, tended to fall less than those who were more mobile.

Figure 7.6.5.2.1 Incidence of falls during follow-up by use of walking aids



* Outdoors excludes n=11 who no longer go outdoors at all
** Indoors excludes n=1 who no longer gets out of bed at all

Table 7.6.5.2.2 Use of walking aids in relation to falling, repeated falling and falls during follow-up

		Odds Ratio for at least 1 fall in follow-up yr - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more in follow-up yr - unadjusted (95% C.I.)	Relative Risk of falls during follow-up year - unadjusted (95% C.I.)
WALKING AIDS - OUTDOORS *				
No walking aid	n=13	1.0	1.0	1.0
Walking stick(s)	n=31	2.2 (0.6-8.7)	3.5 (0.6-19.7)	**2.9 (1.01-8.1)**
Walking frame	n=15	3.2 (0.6-16.6)	**8.3 (1.02-66.7)**	**3.2 (1.01-10.4)**
Wheelchair	n=32	3.1 (0.8-12.3)	**7.1 (1.2-43.2)**	**4.0 (1.4-11.1)**
Assistance of another person	n= 8	2.7 (0.4-18.1)	3.3 (0.4-29.8)	1.9 (0.4-7.9)
No walking aid outdoors	n=13	1.0	1.0	1.0
Any aid outdoors	n=86	2.7 (0.8-9.0)	**5.3 (1.1-25.1)**	**3.2 (1.2-8.7)**
WALKING AIDS - INDOORS **				
No walking aid	n=38	1.0	1.0	1.0
Walking stick(s)	n=27	1.1 (0.4-2.9)	2.1 (0.7-5.8)	**2.6 (1.3-5.2)**
Walking frame	n=36	1.7 (0.6-4.4)	**2.7 (1.0-7.2)**	1.7 (0.8-3.3)
Wheelchair	n= 5	0.5 (0.1-3.4)	0.5 (0.05-4.9)	0.4 (0.1-2.2)
Assistance of another person	n= 3	0.4 (0.1-4.6)	-	0.4 (0.03-4.8)
No walking aid indoors	n=38	1.0	1.0	1.0
Any aid indoors	n=71	1.2 (0.5-2.6)	2.0 (0.9-4.5)	**1.9 (1.02-3.4)**

* Excluding n=11 who no longer go outdoors at all
** Excluding n=1 who no longer gets out of bed at all

7.6.5.3 Stair climbing

Being able to climb stairs regularly is an indicator of mobility that is easily asked, although frequency may be less readily confirmed. As with other reported mobility measures presented so far in this section, it was the falls outcomes reflecting recurrent falling that were found to be significantly associated with climbing stairs. The odds ratio for repeated falls during follow-up was a significant 70% lower amongst those who climbed a flight of stairs at least once a day (OR 0.3 (95% C.I. 0.2-0.8)). Although categorising the sample further by frequency of stair use reduced numbers to the extent that power to detect significance was lost, the direction of effect was such that increased frequency was associated with decreased falling (see Figure 7.6.5.3.1 and Table 7.6.5.3.2).

Figure 7.6.5.3.1 Incidence of falls during follow-up by reported stair climbing

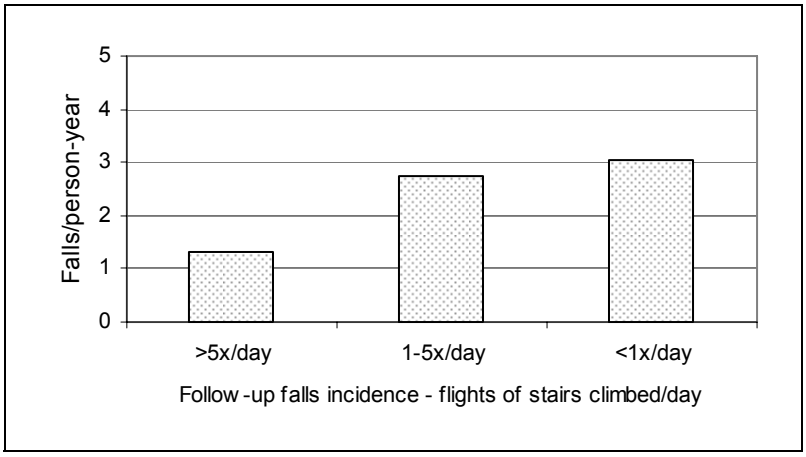


Table 7.6.5.3.2 Stair climbing in relation to falling, repeated falling and falls during follow-up

		Odds Ratio for at least 1 fall in follow-up yr - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more in follow-up yr - unadjusted (95% C.I.)	Relative Risk of falls during follow-up year - unadjusted (95% C.I.)
STAIR CLIMBING				
Climbs a flight of stairs				
< once/day or can't	n=72	1.0	1.0	1.0
1 – 5 times/day	n=26	0.5 (0.2-1.3)	**0.4 (0.1-0.97)**	0.8 (0.4-1.6)
> 5 times/day	n=12	0.5 (0.2-1.8)	0.3 (0.1-1.1)	**0.4 (0.2-1.05)**
Can't climb stairs or < once/day	n=72			
At least one flight of stairs/day	n=38	0.5 (0.2-1.2)	**0.3 (0.2-0.8)**	0.7 (0.4-1.2)

7.6.5.4 Reported physical activity

Taking exercise of any sort was rare so that Figure 7.6.5.4.1 and Table 7.6.5.4.2 show falls incidence rates and risk estimates for only the most commonly reported forms of exercise. Walking as a form of exercise showed only slight or no effect on falls risk. Gardening was linked with greater reductions in falls risk, with a marked reduction in the odds of falling repeatedly (OR 0.3, 95% C.I. 0.1-0.9). Managing to do any other type of physical activity was very weakly associated with lower prevalence of falling and falling repeatedly, but higher incidence rates doubled the relative risk (RR 2.0, 95% C.I. 1.0-3.9).

Figure 7.6.5.4.1 Incidence of falls during follow-up by reported physical activity

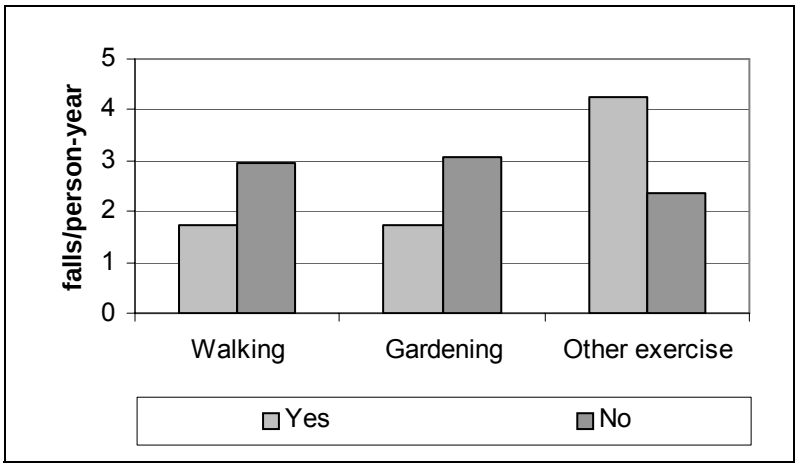


Table 7.6.5.4.2 Reported physical activity in relation to falling, repeated falling and falls during follow-up

			Odds Ratio for at least 1 fall in follow-up yr - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more in follow-up yr - unadjusted (95% C.I.)	Relative Risk of falls during follow-up year - unadjusted (95% C.I.)
REPORTED PHYSICAL ACTIVITY					
Walking	No	n=94	1.0	1.0	1.0
	Yes	n=16	0.8 (0.3-2.4)	1.0 (0.3-2.8)	0.6 (0.2-1.3)
Gardening *	No	n=85	1.0	1.0	1.0
	Yes	n=24	0.8 (0.3-1.9)	**0.3 (0.1-0.9)**	0.5 (0.3-1.1)
Other exercise *	No	n=85	1.0	1.0	1.0
	Yes	n=24	0.9 (0.4-2.3)	0.9 (0.4-2.2)	**2.0 (1.0-3.9)**

* Excluding n=1 not asked about gardening or other exercise

7.6.6 Mobility – observed functional performance measures

Static balance

Tests of static balance showed almost identical relationships to prospectively recorded falls (see Figure 7.6.6.1.1 and Table 7.6.6.1.2) as they did to retrospective falls data recorded at interview (see Chapter 6, section 6.6). Amongst those who completed the simplest stand test – 60 seconds with feet apart – the prevalence of falling (OR 1.7, 95% C.I. 0.7-0.4), falling repeatedly (OR 1.6, 95% C.I. 0.7-3.9) and to a lesser degree the incidence of falls during follow-up (RR 1.2, 95% C.I. 0.6-2.3) were raised compared with those who were unable to hold this stance for the full minute. All three fall outcomes were reduced amongst the small minority who could manage the most challenging test – the tandem stand for ten seconds. Standing balance performance intermediate to these extremes was linked to reduced incidence but slightly increased prevalence of falls in the year after interview, just as they were to falls in the year before interview, and again all confidence intervals were too wide to confer any significance to these findings.

Figure 7.6.6.1 .1 Incidence of falls during follow-up by ability or inability to perform static balance tests

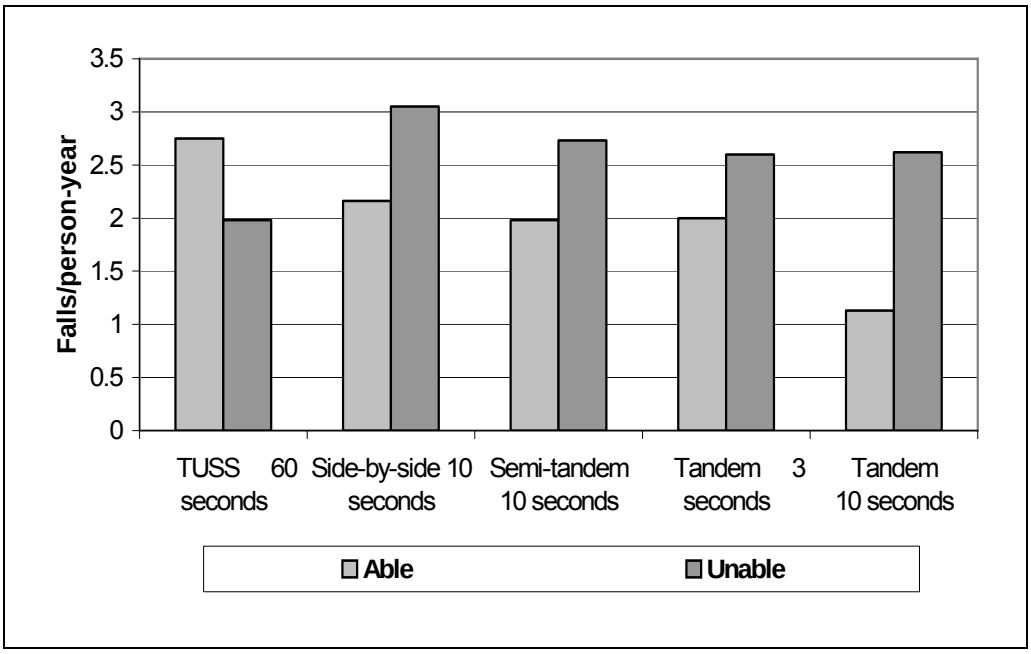


Table 7.6.6.1.2 Static balance measures: Odds ratios and relative risks associated with falling, repeated falling & number of falls during follow-up

	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)	Relative Risk of falls - unadjusted (95% C.I.)
STATIC BALANCE			
Timed Unsupported Stand 60 seconds			
Unable n=37	1.0	1.0	1.0
Able n=53	1.7 (0.7-4.0)	1.6 (0.7-3.9)	1.2 (0.6-2.3)
Side-by-side stand 10 seconds			
Unable n=35	1.0	1.0	1.0
Able n=55	1.7 (0.7-3.9)	1.2 (0.5-2.7)	0.6 (0.3-1.1)
Semi-tandem stand 10 seconds			
Unable n=60	1.0	1.0	1.0
Able n=30	1.1 (0.4-2.6)	1.1 (0.4-2.6)	0.6 (0.3-1.3)
Tandem stand 3 seconds			
Unable n=72	1.0	1.0	1.0
Able n=18	1.1 (0.4-3.2)	1.1 (0.4-3.2)	0.7 (0.3-1.6)
Tandem stand 10 seconds			
Unable n=82	1.0	1.0	1.0
Able n= 8	0.4 (0.1-1.7)	0.4 (0.1-2.2)	0.4 (0.1-1.3)

Dynamic balance

Figure 7.6.6.2.1 and Table 7.6.6.2.2 show how the dynamic balance test results relate to measures of falling during the follow-up year.

Of all the functional performance measures, the only significant predictors of falls during follow-up both involved dynamic balance performance – the repeated chair standing test and the 180˚ turn. The ability to turn 180˚ taking fewer than five steps (RR 3.0, 95% C.I. 0.1-0.6) was also significantly associated with reduced odds of falling repeatedly, despite the lack of clear association in the retrospective falls analysis.

The ability to complete five consecutive chair rises without using arms significantly reduced the risk of falls during follow-up (RR 0.4, 95% C.I. 0.2-0.8), and showed a slightly weaker reduction in the odds for experiencing any falls.

Despite being one of the functional tests most strongly associated with recalled falls, the single chair stand test was a less powerful predictor of whether someone would fall or fall repeatedly during follow-up. The relative risk of falls predicted by being able to rise unaided at least once from a chair was reduced to the same extent using the prospective falls data as with the recalled falls but this was no longer significant (RR 0.6, 95% C.I. 0.3-1.1).

Functional reach, taking the lowest cut-point, showed associations with remembering repeated falls (see Chapter 6, section 6), but in prospective follow-up was not a good predictor. All cut-points gave weak reductions in measures reflecting fall frequency, and conflicting indications of whether any fall was more likely during follow-up.

Figure 7.6.6.2.1 Incidence of falls during follow-up by ability or inability to perform dynamic balance tests

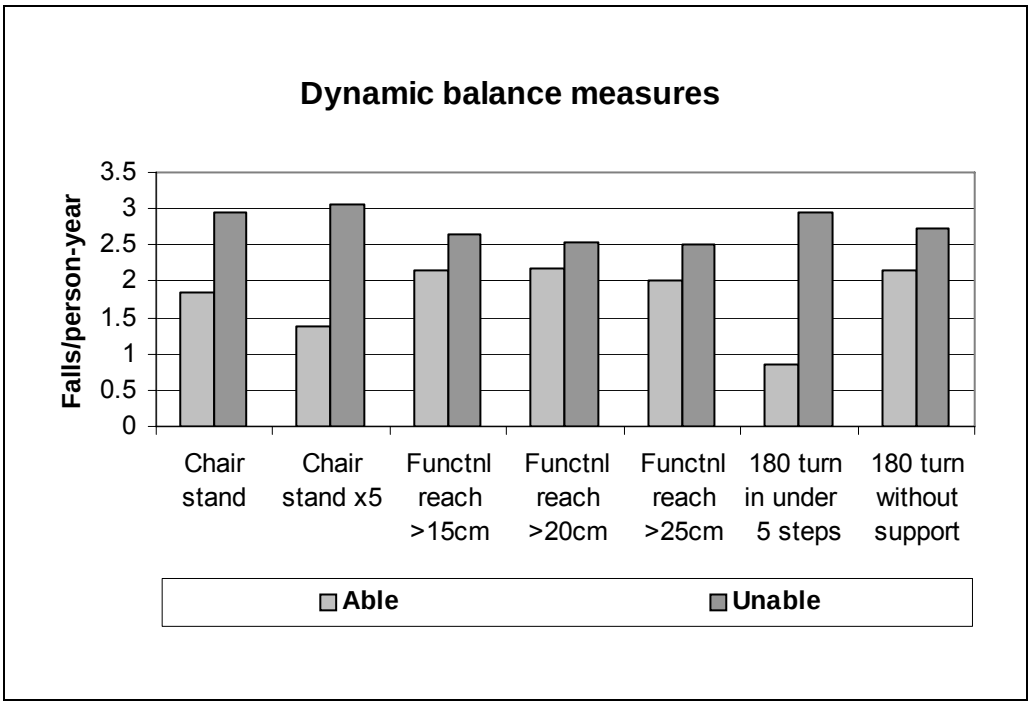


Table 7.6.6.2.2 Dynamic balance measures: Odds ratios and relative risks associated with falling, repeated falling & number of falls during follow-up

	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)	Relative Risk of falls - unadjusted (95% C.I.)
DYNAMIC BALANCE			
Chair stand – single			
Unable n=55	1.0	1.0	1.0
Able n=35	0.9 (0.4-2.1)	0.9 (0.4-2.0)	0.6 (0.3-1.1)
Chair stand – 5 repeats			
Unable n=62	1.0	1.0	1.0
Able n=28	0.7 (0.3-1.8)	0.5 (0.2-1.4)	**0.4 (0.2-0.8)**
Functional reach>15cm			
Unable n=62	1.0	1.0	1.0
Able n=24	1.2 (0.5-3.2)	0.9 (0.4-2.4)	0.7 (0.4-1.5)
Functional reach>20cm			
Unable n=74	1.0	1.0	1.0
Able n=12	0.6 (0.2-2.2)	0.6 (0.2-2.2)	0.8 (0.3-1.9)
Functional reach>25cm			
Unable n=83	1.0	1.0	1.0
Able n= 3	1.4 (0.1-15.9)	0.7 (0.1-7.5)	0.7 (0.1-4.4)
180˚ turn – without support			
Unable n=52	1.0	1.0	1.0
Able n=38	1.4 (0.6-3.2)	1.0 (0.4-2.3)	0.7 (0.4-1.4)
180˚ turn – under 5 steps			
Unable n=71	1.0	1.0	1.0
Able n=19	0.4 (0.1-1.2)	**0.3 (0.1-1.0)**	**0.3 (0.1-0.6)**

Gait speed

Gait speed was strongly associated with remembered falls, and in the follow-up study predicted the same 70% reduced odds of falling after interview as reported before. However, in the prospectively recalled data this effect did not reach significance (OR 0.3, 0.1-1.05), nor did the odds ratio for repeated falling or relative risk of falls (see Figure 7.6.6.3.1 and Table 7.6.6.3.2).

Hand grip strength

In the same figure and table the results for muscle strength are presented alongside those for walking speed. Whilst stronger muscle function, as measured by hand-grip dynamometry, showed a steady relationship with markedly reduced odds for remembered falls, the predictive ability of hand grip strength was not proven by the prospective falls data. The associations with recalled falls had appeared most marked for men, but there were wide confidence intervals around the risk estimates for the small number of men measured. For women the relationship with falls in the last year was weaker, and with falls in the period after interview grip strength showed effects in both directions.

Functional performance tests overall

Figure 7.6.6.4 illustrates the consistently higher incidence of falls found amongst those whose mobility was observed to be more limited. However, as the asterisks highlight, only two of these performance measures were statistically significantly predictive of falls. These were both dynamic balance tests – standing up from a chair without using arms five times and taking fewer than five steps to turn 180˚.

Figure 7.6.6.3.1 Incidence of falls during follow-up by gait speed and hand grip strength

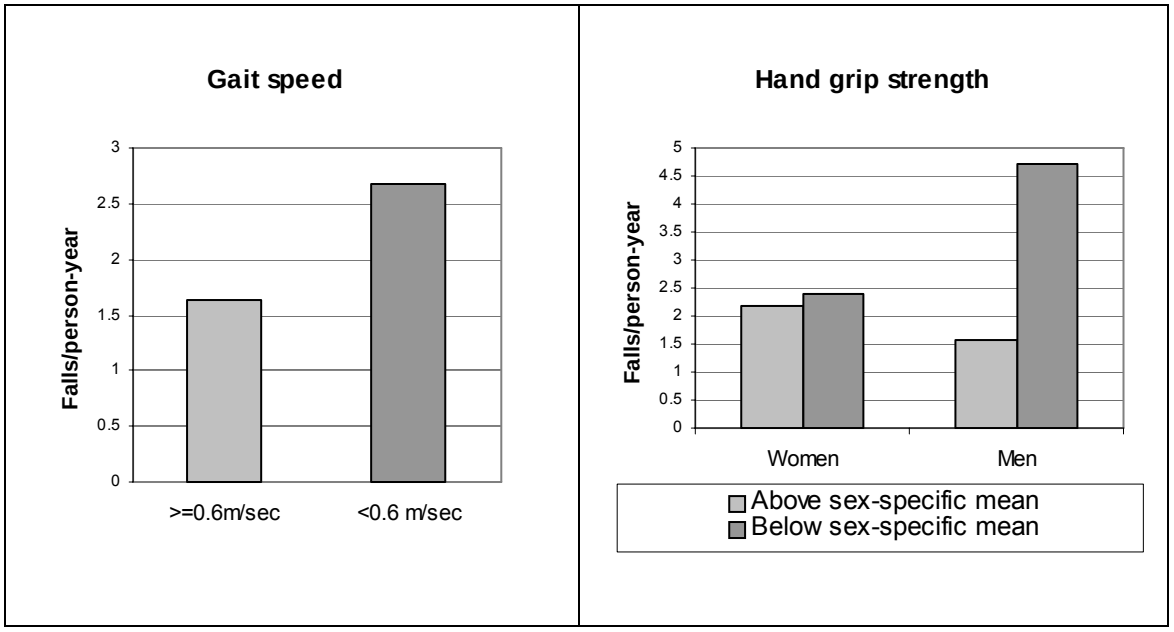
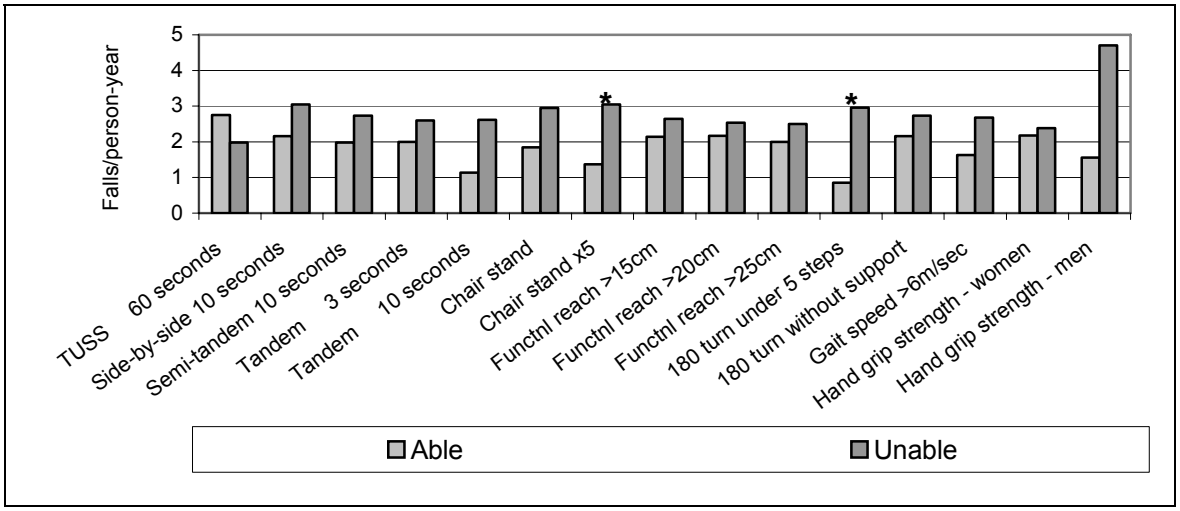


Table 7.6.6.3.2 Gait speed and hand grip strength: Odds ratios and relative risks associated with falling, repeated falling & number of falls during follow-up

	Odds Ratio for 1 fall or more - unadjusted (95% C.I.)	Odds Ratio for 2 falls or more - unadjusted (95% C.I.)	Relative Risk of falls - unadjusted (95% C.I.)
TIMED WALK			
Gait speed – 0.6m/sec or faster			
Unable n=74	1.0	1.0	1.0
Able n=16	0.3 (0.1-1.05)	0.4 (0.1-1.3)	0.6 (0.2-1.3)
MUSCLE STRENGTH			
Grip strength – mean for men			
Below n= 9	1.0	1.0	1.0
Above n= 8	0.5 (0.1-3.4)	0.1 (0.01-1.4)	0.3 (0.04-2.0)
Grip strength – mean for women			
Below n=35	1.0	1.0	1.0
Above n=32	1.4 (0.5-3.9)	1.0 (0.4-2.7)	0.8 (0.4-1.6)

Figure 7.6.6.4 Falls incidence by ability or inability to perform functional mobility tests



7.6.7 Adjusting risk estimates for the effects of covariates

Socio-demographics and cognitive function
Fall history, worry about falling and perception of instability
Health and disability
Reported mobility
Observed mobility in functional testing
Relative strength of predictive estimates from different sets of factors
The model
Adjusted relative risks of falls

This section so far has presented findings from univariate analyses examining the relationship between factors identified from the literature as potentially associated with falling. Clearly many of these factors are inter-related and it is important to consider the possible confounding effects of other covariates on each potential predictor factor.

Chapter 2.4 summarises the analytical approach, which uses multiple variable negative binomial regression modelling to assess the effect of covariates on relative risks. The choice of risk estimate – relative risk rather than either the odds for falling at least once or more than once – was to utilise the maximum amount of falls data collected – fall frequency as well as just fall status. Moreover, statisticians have argued that, when an outcome of interest is common in the population, odds ratios no longer approximate to relative risk[748].

Factors found significantly predictive of falls risk when examined in isolation were grouped in sets of related factors (see Box 7.6.7.1) to identify one from each set for use in a combined model. Likelihood ratio tests assessed the contribution of each variable to regression models within each set and then within the shortlist of factors for the combined model, as described in more detail below. The factors shown in the box in bold are those identified in this way as the strongest predictors of falls for inclusion in the combined regression modelling though not all of these highlighted factors were included in the final adjustment model. Two factors were rejected because they would necessitate restricting analysis to limited sub-samples: as already reported, self-rated health data were missing or not analysable for about a third of the participants, and functional testing was not possible for over a sixth of them. Including recalled recent falls in modelling subsequent fall prediction raises particular issues discussed below.

Box 7.6.7.1 Factors with unadjusted RRs indicating significantly increased risk of falls

	Unadjusted Relative Risk (95% C.I.)	
Demographics		
Age (per year), excluding multiple falls	1.1	(0.96-1.2)
Education (beyond 15yrs vs. ≤14yrs old)	**1.8**	**(1.02-3.2)**
Social class (non-manual vs. manual)	1.9	(1.07-3.4)
Cognition		
Severe cognitive impairment	**1.9**	**(C.I. 1.0-3.5)**
Fall history		
Unsteady on feet – any	2.3	(1.1 – 5.0)
Unsteady on feet – disabling	2.4	(1.3 – 4.5)
Tendency to fall – any	2.8	(1.6 – 5.0)
Tendency to fall – disabling	3.0	(1.7 – 5.3)
Worried about falling again	2.3	(1.1-5.0)
Fallen last year vs. not	3.6	(2.0-6.4)
Fallen >once last year vs. once/not	**4.7**	**(2.8-7.9)**
Health and disability		
Self-rated health Fair/poor/v.poor	**6.0**	**(2.8-12.8)**
Arthritis (to any extent)	1.8	(0.96-3.3)
Incontinence	**3.3**	**(1.8-6.1)**
Depressive symptoms	2.1	(1.1-4.3)
Co-morbidity	**2.8**	**(1.3-6.1)**
Difficulty with 2 or more basic ADLs	2.0	(1.1-3.6)
Reported mobility		
Unable to walk around local area	2.4	(1.2-4.9)
Any walking aid outdoors	3.2	(1.2-8.7)
Any walking aid indoors	1.9	(1.02-3.4)
Limited in 2 or more walking ADLs	**2.5**	**(1.3-5.0)**
Manages to do "other exercise"	2.0	(1.0-3.9)
Observed mobility – functional tests		
Unable to do 5 repeated chair stands	2.4	(1.3-4.5)
Unable to do 180˚ turn in under 5 steps	**3.8**	**(1.6-8.6)**

Factors highlighted in bold emerged as the strongest predictors of falls when adjusted for the effects of other covariates within the same set.

The inclusion of recalled fall history in the falls prediction model may limit the ability to detect the importance of underlying risk factors whose significance may be over-ridden by past fall status. To avoid this possible over-adjustment, whilst still addressing the potential importance of fall history, the adjusted relative risk analysis was repeated stratifying the sample by recalled falling in the past year, comparing these risk estimates for those known to be recurrent fallers at interview with those who recalled only one or no falls in the past year. It has been recommended[219] that fall history should only be included in adjustment models if stratifying by past fall status does not affect the relative risks. This was certainly not the case in the current study, hence the rejection of the variable "2 or more falls in the past year" from the model.

Socio-demographics and cognitive function

As reported in section 7.6.1 no strong associations were found between falls and this set of factors: none with gender or living in institutional care, minimal effects with age, and the less expected socio-demographic factors social class and school leaving age were also only just significant. Since the continuous age variable gave a barely significantly raised relative risk in one analysis (excluding multiple falls), it was tested with class and education. As might be expected, none of these factors emerged as significant predictors when adjusted for the effects of the others. However, adding severe cognitive function to the modelling clarified the stronger effect of education: leaving school aged 15 years or older showed an increased relative risk of falls even when adjusted for severe cognitive impairment. This was the only demographic variable that remained in the model with cognition, and severe cognitive impairment also remained a just significant predictor of falls when adjusted for education.

Fall history, worry about falling and perception of instability

Adjusting for whether or not a "disabling tendency to fall" was reported removed the strong falls risk associated with being "unsteady on your feet", whether disabling or not. Similarly, although recalling at least one fall in the previous year was highly predictive of falls during prospective follow-up, this indicator loses its predictive significance with the far more significant addition to the model of recalling more than one fall in the previous year. This latter variable outweighed being "worried about falling again" as well as having a "disabling tendency to fall". However, rather than adjusting for

recalling "2 or more falls last year", this factor was used to stratify the adjustment regression analyses as described above.

Health and disability

Of the health-related conditions, incontinence far out-weighed the risk estimates associated with arthritis and depression. The derived variable indicating limitation in at least two of the five basic activities of daily living was grouped with the other reported health variables. Adjusting for this removed the slight association of falls with arthritis, but not with incontinence. The other composite variable, co-morbidity, in turn outweighed basic ADL disability and its significance in the model was similar to that of incontinence. All these factors lost significance when adjusted for self-rated health. However, caution is needed in taking this forward as the single health variable in multiple variable analyses with the key factors from other groups of variables because of the missing data on this variable. Not only was this question not asked of n=30 participants (those with only proxy informant data on health and a few others) but it was also not answered by n=12 including those who gave a "Don't know" response.

Reported mobility

The activity of daily living questions on walking limitation – maximum walking distance and use of walking aids indoors or outdoors – were each highly predictive of falls when examined in isolation but, due to collinearity, all lost significance when adjusted for the others. However, whilst this effect was found whichever way round the model was constructed no walking variable was shown to be a significant addition to the model. Instead, the derived variable "Limited in at least two mobility activities of daily living", which codes positive for all participants limited in any of the walking questions, was taken as a combined indicator of walking limitation. Adjusting for this removed the separate walking variables from the model and also the reported mobility measure "other exercise". Stair climbing was not included as, although climbing five flights of stairs a day showed significant risk reduction compared with climbing less than one flight a day, this was not a significant predictor when the data were dichotomised as climbing a flight of stairs ≥5 versus 0-4 times a day.

Observed mobility in functional testing

Only two functional tests significantly predicted falls risk during follow-up. Table 7.6.6.2 reports the reduced relative risks associated with being able to stand up five times from a chair without using arms and of taking fewer than five steps to turn 180˚. As risk estimates for other covariates to be included in these analyses of confounding are all presented as increased risks, the functional test risk estimates shown in Box 7.6.7.1 are reversed to show the equivalent increased risks associated with inability to perform these tests. Adjusting for the need to take at least five steps to turn 180˚ rendered the repeated chair stand test no longer a significant predictor.

Relative strength of predictive estimates from different sets of factors

The shortlist of key predictor variables from each set of factors was examined in the same way as the separate sets of variables, testing the effects of adjusting each factor's risk estimates for the others'.

Observed mobility was a more powerful predictor of falls risk than reported mobility, but functional assessments had not been possible for 20 people. Both mobility variables remained significant predictors even when adjusted for recalled fall history, and vice versa, each contributing significantly to the other's model.

Severe cognitive impairment is not a significant predictor of falls in the sub-sample who had functional performance testing and has minimal effect on the estimate of effect predicted by inability to turn 180 degrees in fewer than 5 steps. The relative risk of falls predicted by reported walking limitation is reduced but not lost when adjusted for severe cognitive impairment, and the cognition variable was not a significant addition to the model. Examined from the opposite perspective, adjusting the effects of severe cognitive impairment for mobility removes the significance of cognitive impairment, and this adjustment is a significant one. Recalling two or more falls in the past year far outweighs the effect on relative risk of severe cognitive impairment.

Only restricted sub-groups of the sample could be used to examine the relative influence self-rated health and other covariates. For example only 59 people had both functional testing and gave an answer to the question on self-rated health. Amongst them self-rated health far out-weighed the otherwise strong effect of the most predictive

functional test. The effects of self-rated health outweighed reported mobility even more. However, adjusting for recall of two or more falls in the past year (a highly significant adjustment to the model) greatly reduces the effect of self-rated health to only just significant. When all "shortlist" factors were included in a model for the sub-group with self-rated health data (with and without functional testing), self-rated health was dropped from the model. Thus despite its striking relative risk for falls in the sub-group measured, its omission from modelling on the full sample because of its missing data is not a significant loss.

The model

To model adjustment for confounding, covariates selected for use with the full sample were therefore:

- severe cognitive impairment (MMSE 0-17 or dementia documented from other sources)
- school leaving age (beyond minimum leaving age, i.e. ≥ 15 years old)
- incontinence (accidents > once a week)
- co-morbidity (≥ 5 reported or diagnosed conditions)
- reported walking disability (limited maximum walking distance and walking aid use)

These were entered in negative binomial regression analyses with each factor reported in Chapter 7.6, for the full sample and again in stratified analyses dividing the sample by their recall of falling in the past year (0/1 fall versus at least 2 falls).

Following the same grouping of variables used in earlier sections of this chapter, Tables 7.6.7.1-6 present the relative risks for falls that were found to be associated with each factor analysed, unadjusted and then adjusted for the full sample and for strata without and with repeated recalled recent falls. These findings are discussed in Chapter 9 placing these and other results presented in Chapters 6 – 8 in the context of other research to date.

Adjusted relative risks of falls

When fully adjusted for confounding covariates, a number of factors that had appeared to predict falls no longer did so to a significant degree. Tables 7.6.7.1 and 7.6.7.2 below show how both severe cognitive impairment and non-manual social class were shown to almost double falls risk in univariate analyses, but their associated risks lost significance after adjustment. The effects of cognitive function were reduced: RR 1.3 (95% C.I. 0.7-2.2), whilst the effects of social class appeared to act weakly in the opposite direction: RR 0.8 (95% C.I. 0.4-1.6). The increased relative risk of falling found with more years of education is unaffected by adjustment, but appears to be insignificant amongst recurrent fallers while stronger amongst those who remembered only one fall or none in the previous year.

Table 7.6.7.1 Adjusted relative risks of falls: demographic covariates

	Unadjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=72]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=37]
AGE-BAND ≥ 95 vs. ≤ 94	1.5 (0.8-2.7)	1.2 (0.7-2.2)	0.3 (0.1-1.2)	0.8 (0.4-1.8)
AGE Each additional year	1.04 (0.9-1.2)	1.0 (0.9-1.1)	0.9 (0.8-1.1)	0.9 (0.8-1.04)
GENDER Women vs. men	0.8 (0.4-1.8)	0.6 (0.3-1.2)	0.6 (0.2-1.9)	0.5 (0.2-1.3)
EDUCATION Full-time education aged ≥15yrs vs. ≤14yrs	**1.8 (1.02-3.2)**	**1.9 (1.1-3.2)**	**2.5 (1.07-5.8)**	1.4 (0.7-2.6)
SOCIAL CLASS Non-manual vs. manual	**1.9 (1.07-3.4)**	0.8 (0.4-1.6)	0.7 (0.3-1.7)	1.6 (0.7-3.9)
PLACE OF RESIDENCE Any supported setting vs. community	1.4 (0.8-2.4)	0.7 (0.4-1.3)	0.6 (0.2-1.7)	0.6 (0.3-1.3)

Multi-variable negative binomial regression adjusted for: school leaving age (except in same regression), severe cognitive impairment, incontinence (accidents >once/week), co-morbidity (≥5 reported conditions) and reported walking disability (limited maximum walking distance and/or need for walking aid).

Table 7.6.7.2 Adjusted relative risks of falls: cognition

	Unadjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=72]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=37]
COGNITIVE IMPAIRMENT Severe vs. moderate impairment/intact	**1.9 (1.0-3.5)**	1.3 (0.7-2.2)	1.3 (0.5-3.3)	1.2 (0.6-2.3)

Multi-variable negative binomial regression adjusted for:
school leaving age, incontinence, co-morbidity and reported walking disability.

It is noteworthy that none of the reported factors relating to past falls in Table 7.6.7.3 retain their significance when adjusted for confounding co-variates, neither in the full nor stratified sample analyses. Perceived balance – being unsteady on your feet and having a tendency to fall – that the analyses described earlier in this section showed were largely influenced by recall of past falls, no longer clearly predicted falls. Likewise the subjective measures – being worried about falling and falls efficacy – showed weak and inconsistent direction of effect on falls risk.

Most striking is the effect of adjusting for confounding on the risk estimates predicted by recalled falls history. Although in univariate analyses the crude relative risks associated with remembering falling in the year before interview were found to be amongst the strongest factors predicting falls during follow-up after interview, the adjusted relative risks predicted by single or repeated falls in the past year were reduced to null effects, both with very precise confidence intervals.

Table 7.6.7.3 Adjusted relative risks of falls: balance, fear and history of falling

	Unadjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=72]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=37]
PERCEIVED INSTABILITY				
Unsteady on feet – disabling	**2.4 (1.3-4.5)**	1.2 (0.6-2.5)	0.5 (0.2-1.2)	1.9 (0.5-6.5)
Unsteady on feet – to any extent	**2.3 (1.1-5.0)**	1.0 (0.4-2.8)	0.9 (0.4-2.5)	0.4 (0.1-2.0)
Tendency to fall – disabling	**3.0 (1.7-5.3)**	1.5 (0.7-3.0)	0.7 (0.3-2.0)	1.2 (0.4-3.3)
Tendency to fall – to any extent	**2.8 (1.6-5.0)**	1.4 (0.7-2.8)	0.9 (0.4-2.2)	0.9 (0.3-2.6)
FEAR OF FALLING				
Worried about falls vs. not worried	**2.3 (1.1-5.0)**	1.1 (0.4-2.3)	0.3 (0.1-1.2)	1.5 (0.5-2.5)
FES-UK score 50 - 75 vs. 76 - 100	2.2 (0.9-5.6)	0.6 (0.2-1.7)	0.8 (0.2-3.2)	0.8 (0.2-2.9)
FES-UK score 0 - 49 vs. 76 - 100	**2.3 (0.95-5.7)**	0.6 (0.2-1.7)	0.7 (0.1-3.1)	1.1 (0.3-4.2)
RECALLED PREVIOUS FALLS				
≥1 recalled fall(s) in past year vs. none	**3.6 (2.0-6.4)**	1.0 (0.97-1.03)	-	-
≥2 recalled falls in past year vs. none/one	**4.7 (2.8-7.9)**	1.0 (0.97-1.04)	-	-

Multi-variable negative binomial regression adjusted for:
severe cognitive impairmnt, school leaving age, incontinence, co-morbidity & reported walking disability.

Table 7.6.7.4 shows that a number of health-related factors are still important falls risk predictors even when adjusted for confounding factors. Self-rated health is no longer the over-riding predictor, its six-fold crude relative risk reduced by adjustment to two-fold, a risk estimate on a par with the adjusted RRs predicted by incontinence, multiple co-morbid conditions, and disability in walking ADLs. Basic ADL disability no longer predicts falls risk when allowance is made for confounders, and depressive symptoms are only predictive of falls amongst repeated fallers. Note that no health-related factor predicts falls by those who gave no history of repeated recent falls.

Table 7.6.7.4 Adjusted relative risks of falls: health-related covariates

	Unadjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=72]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=37]
REPORTED POOR VISION Any problem reported vs. none	1.3 (0.7-2.4)	1.2 (0.7-2.1)	1.2 (0.6-2.8)	1.1 (0.5-2.2)
VISUAL IMPAIRMENT Unable vs. abke to read 3mm print	1.3 (0.6-2.8)	1.0 (0.99-1.01)	1.0 (0.99-1.03)	1.0 (0.98-1.01)
REPORTED HEARING LOSS Any problem reported vs. none	1.5 (0.8-2.8)	0.8 (0.4-1.5)	1.2 (0.6-2.6)	**0.4 (0.1-1.02)**
HEARING LOSS Cannot vs. can hear normal speech accurately	0.7 (0.3-1.3)	1.0 (0.9-1.1)	1.1 (0.9-1.4)	**0.9 (0.8-1.01)**
REPORTED ARTHRITIS Any problem reported vs. none	**1.8 (0.96-3.3)**	1.1 (0.8-1.5)	0.7 (0.3-1.9)	1.1 (0.4-3.2)
REPORTED WEAKNESS IN ARMS OR LEGS Any problem reported vs. none	1.1 (0.6-2.0)	**0.5 (0.3-0.9)**	0.5 (0.2-1.1)	1.0 (0.4-2.4)
INCONTINENCE Accidents > once/week vs. no/rare accidents	**3.3 (1.8-6.1)**	**2.3 (1.2-4.3)**	1.7 (0.6-4.5)	**2.2 (1.1-4.4)**
DEPRESSIVE SYMPTOMS SCORE DSS 5-11 vs. DSS 0-4	**2.1 (1.1-4.3)**	1.2 (0.5-2.7)	0.5 (0.1-1.6)	**2.6 (1.2-5.7)**
CO-MORBID CONDITIONS > 5 vs.0-5 reported/diagnosed	**2.8 (1.3-6.1)**	**2.4 (1.1-5.0)**	2.2 (0.9-5.7)	1.2 (0.3-4.0)
SELF-RATED HEALTH Very poor/poor/fair vs. good/very good	**6.0 (2.8-12.8)**	**2.3 (1.01-5.3)**	1.6 (0.4-5.9)	**3.9 (1.4-10.9)**
Same as 1 yr ago vs. better than 1 yr ago	3.3 (0.7-15.6)	2.3 (0.6-9.6)	2.0 (0.3-11.8)	1.5 (0.7-3.3)
Worse than 1 yr ago vs. better 1 yr ago	4.5 (0.9-21.2)	3.2 (0.8-13.5)	2.0 (0.4-11.6)	1.7 (0.8-3.6)
DIFFICULTY WITH ADLS ≥2 basic ADLs vs. <2	**2.0 (1.1-3.6)**	1.0 (0.5-2.0)	1.0 (0.4-2.9)	0.6 (0.2-1.7)
≥2 mobility ADLs vs. <2	**2.5 (1.3-5.0)**	**1.9 (0.98-3.8)**	1.5 (0.6-3.9)	1.5 (0.5-4.0)
≥2 instrumental ADLs vs.<2	1.4 (0.5-3.4)	0.9 (0.3-2.5)	0.4 (0.1-1.4)	0.9 (0.2-5.0)
MEDICATION Taking any identified falls risk drug vs. not	1.2 (0.6-2.1)	0.9 (0.5-1.8)	0.8 (0.3-2.2)	0.8 (0.4-1.6)
Taking four or more prescribed drugs vs.<4	1.2 (0.7-2.0)	0.9 (0.5-1.7)	0.5 (0.2-1.2)	1.4 (0.7-2.9)

Multi-variable negative binomial regression adjusted for:
severe cognitive impairment, school leaving age, incontinence (except in same regression), co-morbidity (except in same regression) and reported walking disability.

Reported mobility measures remained clear predictors of fall risk, and Table 7.6.7.5 shows how crude and adjusted risk estimates are almost identical. The distinction between being able to walk less than one block and being able to walk around the local area emerges as the measure of maximum walking distance that predicts falls most strongly, with adjusted RR 2.4 (95% C.I. 1.1-5.3), while allowing for confounding co-variates renders more limited walking less important. Needing any aid to walk outdoors continues to predict over a three-fold increase in risk, and use of a walking aid indoors almost doubles the risk. These effects clearly differ depending on remembered past fall history. Almost none of the reported mobility measures predicted subsequent falls amongst recurrent fallers. However, for those who recalled no falls last year, or only one, the risk of falls during follow-up increased even more markedly if they could walk less than a block or needed a walking aid outdoors, a finding of particular clinical importance in the identification of new fallers.

Table 7.6.7.5 Adjusted relative risks of falls: reported mobility

	Unadjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Full sample [n=110]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=72]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=37]
MAXIMUM WALKING DISTANCE				
Street <1 block vs. around local area	**2.7 (1.2-6.1)**	**2.4 (1.1-5.3)**	**2.8 (0.96-8.0)**	1.7 (0.5-5.5)
Garden < gate vs. around local area	**2.4 (1.1-5.6)**	1.1 (0.5-2.6)	0.8 (0.2-2.6)	0.9 (0.3-3.0)
Indoors only vs. around local area	**2.9 (1.2-6.8)**	1.7 (0.7-3.8)	0.5 (0.1-1.8)	1.5 (0.5-4.9)
A few steps vs. around local area	0.9 (0.2-3.9)	0.4 (0.1-1.5)	0.4 (0.1-2.8)	0.3 (0.1-1.6)
Unable to walk at all vs. around locality	0.8 (0.1-4.3)	0.3 (0.05-1.7)	0.6 (0.1-4.3)	-
WALKING AIDS – OUTDOORS				
Any aid outdoors vs. none	**3.2 (1.2-8.7)**	**3.2 (1.2-9.1)**	**8.7 (1.0-76.0)**	1.5 (0.4-6.7)
WALKING AIDS – INDOORS				
Any aid indoors vs. none	**1.9 (1.02-3.4)**	**1.8 (0.95-3.3)**	0.8 (0.4-1.8)	1.9 (0.8-4.6)
STAIR CLIMBING				
1 – 5 flights/day vs. <1/day or can't	0.8 (0.4-1.6)	0.7 (0.4-1.4)	0.7 (0.2-1.8)	1.1 (0.5-2.9)
> 5 times/day vs. <once/day or can't	**0.4 (0.2-1.05)**	0.8 (0.3-2.6)	1.1 (0.3-4.0)	1.9 (0.2-18.2)
≥1 flight of stairs/day vs. <1/day or can't	0.7 (0.4-1.2)	0.7 (0.4-1.4)	0.8 (0.3-1.9)	1.2 (0.5-3.0)
REPORTED PHYSICAL ACTIVITY				
Walking for exercise vs. not	0.6 (0.2-1.3)	1.1 (0.5-2.8)	2.2 (0.8-6.1)	0.7 (0.2-3.2)
Gardening vs. not	0.5 (0.3-1.1)	0.8 (0.3-1.7)	1.7 (0.6-4.5)	0.5 (0.2-1.8)
Other exercise or physical activity vs. not	**2.0 (1.0-3.9)**	**1.9 (0.98-3.7)**	2.0 (0.8-5.2)	**2.6 (1.0-6.8)**

Multi-variable negative binomial regression adjusted for:
severe cognitive impairment, school leaving age, incontinence and co-morbidity.
Reported walking disability dropped from all above reported mobility analyses to avoid over-adjusting.

As Table 7.6.7.6 shows, amongst those who recalled falling twice in the year before interview, the relative risk of falls predicted by observed mobility is little affected by adjusting for confounding factors. By contrast, amongst those who were not known to be recurrent fallers at interview, greater ability in most of the functional performance tests conferred an increased risk of subsequent falls after allowing for the effects of co-variates. For this group, successfully managing the easiest levels of both the static and dynamic balance tests (TUSS, side-by-side stance for 10 seconds, functional reach >15cm and turning 180 degrees without support) all conferred significantly increased adjusted relative risks of falls during follow-up. The same direction of effect was seen with both single and repeated chair standing, but not with gait speed or grip strength. Just one dynamic balance measure was an exception to this pattern: being able to turn 180 degrees in fewer than five steps consistently and strongly predicted a 70% reduction in falls risk. In the full sample who had functional performance assessment, this was the only observed mobility measure that still showed a significantly reduced risk of falls during the follow-up period: OR 0.3 (95% C.I. 0.1-0.8).

Table 7.6.7.6 Adjusted relative risks of falls: observed mobility covariates

	Unadjusted Relative Risk (95% C.I.) All who had functional tests [n=90]	Adjusted Relative Risk (95% C.I.) All who had functional tests [n=90]	Adjusted Relative Risk (95% C.I.) Recalled falls: 0 or 1 last year [n=58]	Adjusted Relative Risk (95% C.I.) Recalled falls: ≥ 2 last year [n=32]
STATIC BALANCE				
Timed UnSupported Stand 60 seconds	1.2 (0.6-2.3)	2.5 (1.2-5.2)	**2.3 (0.95-5.8)**	1.8 (0.7-5.0)
Side-by-side stand 10 seconds	0.6 (0.3-1.1)	1.0 (0.5-2.3)	**4.6 (1.4-15.1)**	**0.3 (0.1-1.05)**
Semi-tandem stand 10 seconds	0.6 (0.3-1.3)	0.9 (0.5-1.8)	1.3 (0.5-3.3)	0.7 (0.3-1.7)
Tandem stand 3 seconds	0.7 (0.3-1.6)	1.1 (0.5-2.4)	1.4 (0.5-4.3)	0.7 (0.3-1.9)
Tandem stand 10 seconds	0.4 (0.1-1.3)	0.6 (0.2-2.2)	1.2 (0.3-4.7)	0.3 (0.02-3.9)
DYNAMIC BALANCE				
Chair stand – single	0.6 (0.3-1.1)	0.9 (0.4-1.9)	1.8 (0.8-4.0)	0.5 (0.1-1.6)
Chair stand – 5 repeats	**0.4 (0.2-0.8)**	0.7 (0.3-1.5)	1.3 (0.5-3.3)	0.5 (0.2-1.2)
Functional reach>15cm	0.7 (0.4-1.5)	1.2 (0.5-2.5)	**2.3 (1.05-5.2)**	1.2 (0.3-5.5)
Functional reach>20cm	0.8 (0.3-1.9)	0.8 (0.3-2.1)	2.0 (0.8-5.1)	0.5 (0.1-2.9)
Functional reach>25cm	0.7 (0.1-4.4)	1.2 (0.3-5.9)	2.1 (0.6-7.5)	1.4 (0.6-3.1)
180˚ turn – under 5 steps	**0.3 (0.1-0.6)**	**0.3 (0.1-0.8)**	**0.3 (0.1-1.03)**	0.3 (0.1-1.1)
180˚ turn – without support	0.7 (0.4-1.4)	1.2 (0.6-2.4)	**2.4 (1.02-5.7)**	0.7 (0.3-2.0)
TIMED WALK				
Gait speed – 6m/sec or faster	0.6 (0.2-1.3)	0.6 (0.2-1.5)	0.8 (0.3-2.2)	1.1 (0.2-6.3)
MUSCLE STRENGTH				
Grip strength above/below mean for men	0.3 (0.04-2.0)	0.5 (0.1-3.7)	0.7 (0.1-7.9)	+++ (0-.)
Grip strength above/below mean for women	0.8 (0.4-1.6)	1.2 (0.6-2.3)	0.9 (0.3-2.2)	1.1 (0.4-3.0)

Multi-variable negative binomial regression adjusted for:
severe cognitive impairmnt, school leaving age, incontinence, co-morbidity & reported walking disability.

7.7 Summary: falls reported in prospective follow-up

Summary points

Methodology for falls research with people of advanced old age

- Intensive prospective falls data collection is possible with a very old population sample.
- Falls are of sufficient concern to old people themselves and their carers that there is great willingness to record or report falls.
- Sufficient time and resources must be allocated and the approach needs to be painstaking, sensitive and flexible to ensure maximum coverage and accuracy.

Summary measures

- 265 valid fall reports were received in a total of 95.7 person-years follow-up.
- Mean length of follow-up was 45 weeks (SD 14); 25% died within the year.
- Incidence of falls during follow-up was 277 falls per100 person-years.
- 60% reported at least one fall, 45% reported more than one fall.
- Three-quarters of "fallers" were "repeat fallers", half the "fallers" had ≥3 falls.

Circumstances

- 60% of falls happened in the daytime, over 90% of them indoors.
- More than 4/5 of falls occurred when the person who fell was alone.
- Half the fall reports received involved an old person being found on the floor.
- More than half the falls were described as accidental.
- The cause of the fall was unknown for over one in five falls.
- 42% of people who fell were in institutional care at the time, incl. ¼ in hospital.

continued…….

Risk factors for falls

- As in the previous chapter, interpretation of the significance or non-significance of the relationships examined between putative risk factors and measures of falling requires caution given the small sample size.

Socio-demographic factors

- In such an elderly population the effect of age on falls risk was negligible.
- There was no clear association between gender and falling.
- Incidence of falls was higher in institutional care than in the community, and even higher in sheltered accommodation, but not significantly so.
- Later school leaving age and non-manual social class were associated with falls.

Fall history and fall-related factors

- The subjective measures being "unsteady on your feet", having a "tendency to fall", being "worried about falling" and having low falls efficacy were all associated with increased falls risk, but all lost significance when adjusted.
- A history of falling, based on recalled falls in the year before interview, was powerfully predictive of follow-up falls. Recalling more than one fall in the past year emerged as the strongest predictor amongst fall-related factors but adjusting for the strongest predictors from other groups of co-variates reduced this association to a null effect.

Health-related factors

- Severe cognitive impairment almost doubled the risk of falls, but this predictor lost significance when adjusted for confounders.
- Arthritis, depressive symptoms, incontinence and multiple co-morbid conditions all add to falls risk, the effects of the latter two dominating other health factors.
- Self-rated health, measured in only about half the study sample, appears strongly associated with falls risk. The strength of association is much reduced by adjusting for the confounding effects of falls history but remains just significant.
- No association was found with use of any category of medication previously identified a increasing falls risk.

Function and mobility factors

- The disability factor that most powerfully predicted falls was reported mobility limitation, far outweighing the role of basic ADL or instrumental ADL disability
- Being able to walk around the local area reduced risk of falls and needing any aid to walk outdoors increased falls risk, even when adjusted for confounding, and especially for those with no previous history of recurrent falls.
- Functional testing showed only dynamic balance measures - 180˚ turn, chair stands and functional reach - to be significantly associated with falls risk.

CHAPTER 8

CONSEQUENCES OF FALLS IN MEN AND WOMEN AGED OVER 90 YEARS OLD

8.1 Introduction

8.2 Methods
- 8.2.1 Immediate consequences of falls
- 8.2.2 Subsequent sequelae
  - 8.2.2.1 Hospital, respite and institutional admissions
  - 8.2.2.2 One year intensive follow-up and end of study censoring
- 8.2.3 Mortality

8.3 Immediate consequences of falls during follow-up
- 8.3.1 Inability to get up – long lies on the floor
- 8.3.2 Use of call alarm systems to summon help
- 8.3.3 Injuries
- 8.3.4 Reporting falls to others

8.4 Subsequent sequelae
- 8.4.1 Hospital admissions
  - 8.4.1.1 Admissions in relation to measures of falling
  - 8.4.1.2 Falling as a cause of admission
  - 8.4.1.3 Frequency of admission and length of stay
- 8.4.2 Moves to care homes
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- 8.4.3 Mortality
  - 8.4.3.1 Falling as a "cause of death"
  - 8.4.3.2 Deaths in relation to measures of falling
  - 8.4.3.3 Deaths following hospital admissions
  - 8.4.3.4 Deaths after moving into care

8.5 Factors predictive of fall consequences and other follow-up outcomes
- 8.5.1 Which outcomes might be predicted?
  - 8.5.1.1 Inability to get up and long lies on the floor
  - 8.5.1.2 Hospital admissions
  - 8.5.1.3 Moving into long-term care
  - 8.5.1.4 Mortality
- 8.5.2 Which factors might be predictive?
  - 8.5.2.1 Socio-demographic factors
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  - 8.5.2.4 Health and disability
  - 8.5.2.5 Reported mobility
  - 8.5.2.6 Observed mobility in functional testing

8.6 Summary

8.1 Introduction

In this chapter some of the more serious consequences of falls recorded during follow-up of this nonagenarian population sample are first described and then examined in relation to a range of potential risk factors. Data concerning injuries sustained or long lies on the floor as a result of falling are presented in the first results section 8.3 *Immediate consequences of falls*, along with information on who was notified about these falls. Follow-up data on admissions – to hospital and to long-term care settings – and mortality are presented in a separate section 8.4 *Subsequent sequelae.* Methods used to ascertain these different outcome measures are described first in section 8.2. Whether the risk factors for falling reported in Chapters 6.6 and 7.6 can also predict the risk of severe fall consequences is examined in section 8.5 *Factors predictive of fall consequences and other follow-up outcomes.*

8.2 Methods

8.2.1 Immediate consequences of falls
8.2.2 Subsequent sequelae
8.2.2.1 Hospital, respite and institutional admissions
8.2.2.2 One year intensive follow-up and end of study censoring
8.2.3 Mortality

The methodology followed for the follow-up study is described fully in Chapter 7.2 but here more details are provided of the ascertainment of outcomes of interest that may follow a fall.

8.2.1 Immediate consequences of falls

The same details were taken of the circumstances and immediate consequences of each fall reported during follow-up as had been collected at interview about the last recalled falls. Information recorded included whether the individual who fell had been able to get up without help, how long they were on the floor, whether they called for assistance or informed anyone about having fallen, whether they hurt themselves, needed any treatment and what contact, if any, they had with health services as a result of the fall.

These data were gathered either at the time a fall was reported by telephone or when the project nurse made contact with the participant or informant after receiving a fall calendar report by post. As explained before, this could involve either a follow-up visit or phone-call**.** Whenever possible information was sought both from the study participant themselves and from proxy informants: in some cases there were multiple sources, for example the individual who fell, a relative, residential home carers and hospital staff. It was beyond the scope of this study to verify every episode in which a fall was reportedly brought to medical attention: no attempt was made to obtain records of GP consultations, district nurse visits or ambulance call-outs. However, any reported contact with secondary care was checked against hospital records (see below).

8.2.2 Subsequent sequelae

8.2.2.1 Hospital, respite and institutional admissions
8.2.2.2 One year intensive follow-up and end of study censoring

8.2.2.1 Hospital, respite and institutional admissions

As part of the continuous follow-up during the year after interview, the study was keeping track of any individuals moving from their place of residence at the time of interview. Dates of admission and discharge to hospital or temporary respite care were logged along with reasons given for admission. Ward staff were informed about the study and contacted at regular intervals (weekly to fortnightly depending on factors such as medical condition and expected date of discharge) to ensure continuity of prospective falls data collection. With ethical approval to consult medical notes already in place, it was possible to check hospital records for everyone admitted during follow-up, both for completeness of falls ascertainment and to verify reasons for admission.

Tracking changes of address to keep administrative records up-to-date for future tracing was in effect monitoring changes in residential status. Dates of transfer and reasons given for moving into care were logged in the fall follow-up records and verified with each institution as part of establishing on-going fall ascertainment with the new care home staff.

8.2.2.2 One year intensive follow-up and end of study censoring

A number of study participants were still in hospital or respite care when their one year follow-up period ended and contact was maintained with the institutions and individuals concerned until time and place of discharge was known. To ensure the administrative database was up-to-date at the close of this interview wave, surviving participants or proxy informants were telephoned in the autumn of 2004 if their last contact was more than three months earlier. Respondents were asked about falls, fractures and admissions since the end of follow-up; although it was not anticipated that the fall reports would be as complete as during follow-up, the administrative survey served as an opportunity to extend fracture data collection. The information gathered included hospital and care home admissions in the intervening months, so data on moves into care are complete to the year end.

8.2.3 Mortality

The CC75C study participants have been flagged for mortality since baseline with the Office of National Statistics / NHS Research Register. Three-monthly reports provide all death certificate information. In the few cases where discrepancies arose between these and reports gathered through informants and GPs in the study, the ONS data have been taken as the confirmed dates of death. In-line with the administrative up-dating of changes in residence, next of kin details and so forth, the final censoring date for the current study was taken as 31.12.2004. This mortality monitoring is still on-going after the follow-up study reported in this thesis ended.

8.3 Immediate consequences of falls during follow-up

8.3.1 Inability to get up – long lies on the floor
8.3.2 Use of call alarm systems to summon help
8.3.3 Injuries
8.3.4 Reporting falls to others

8.3.1 Inability to get up – long lies on the floor

The proportion of people who had difficulty getting up after a fall was higher than the proportion of actual falls from which difficulty getting up was reported (see Table 8.3.1.1). In two-thirds of the falls reported during the year's follow-up the person who fell was unable to get up without help, but 80% of the participants who fell had difficulty getting up from at least one fall. Overall 21% of all reported falls resulted in long lies on the floor of an hour or more, if the 6% for which time was unknown are included, but 30% of those who fell were on the floor this long on at least one occasion.

The length of time on the floor after falling depended both on ability to get up after falling and on whether there was any help at hand (see Table 8.3.1.2). Whilst 43% of all falls led to 5 minutes or less on the floor, those who needed help to get up were helped up in less than 5 minutes in a quarter of these falls, but 30% of these resulted in a long lie of over an hour on the floor.

82% of the falls happened when the person who fell was on their own, and not being able to get up was equally common whether a fall was witnessed or occurred alone. For those who were alone when they fell and could not get off the floor, assistance to help them up arrived in less than 5 minutes in 17% of such falls and within an hour for a further 48%. Thus over a third were on the floor alone and unable to get up for over an hour (see Figure 8.3.1.3). Even if the person who fell was not alone when it happened, those who could not get up unaided were on the floor for up to an hour in a third of these witnessed falls because of the difficulty they and those present had in helping them up.

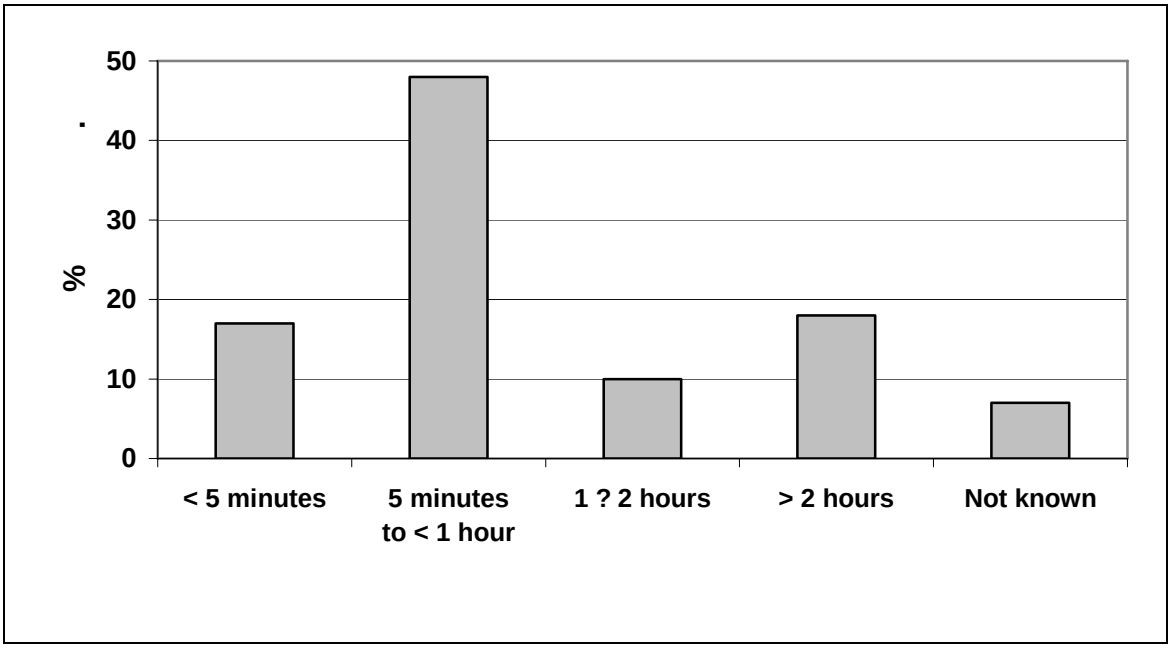
Table 8.3.1.1 Inability to get up from the floor after a fall

	Participants who reported falling during follow-up [n=66]		Falls reported during follow-up [n=265]	
	n	(%)	n	(%)
Needed help to get up	53	(80)	176	(66)
Got up without anyone helping	13	(20)	88	(32)
Not known			4	(2)

Table 8.3.1.2 Time on the floor after a fall

	All falls reported during 1 year follow-up [n=265]		Falls from which unable to get up without help [n=176]		Falls alone from which unable to get up without help [n=143]	
	n	(%)	n	(%)	n	(%)
< 5 minutes	114	(43)	46	(26)	25	(17)
5 minutes to < 1 hour	95	(36)	78	(44)	68	(48)
1 – 2 hours	14	(5)	14	(8)	14	(10)
> 2 hours	26	(10)	26	(15)	26	(18)
Not known	16	(6)	12	(7)	10	(7)

Figure 8.3.1.3 Time on the floor if fell alone and unable to get up (n=143 falls)



8.3.2 Use of call alarm systems to summon help

There was widespread availability of call alarm systems amongst the study population: approximately a third each had either a personal alarm that could be worn as a pendant linked to a call centre when activated or call bells installed in their room or flat (everyone in a care home and a quarter in sheltered schemes), and 12% had the use of both options. Tables 8.3.2.1 and 8.3.2.2 show access to these systems and their use when needed.

In 96% of falls alone (209/219) and 99% of falls by those who could not get up when they fell alone (141/143) the older person had some form of call alarm system installed. Thus excluding those falls where there was no means of calling for help – only two – a third of falls alone from which the faller could not get up (48/141) still resulted in long lies of at least an hour on the floor. In 80% (113/141) of these falls and 96% (46/48) of these falls resulting in long lies the person who fell alone did not use their personal call pendant or call bell system to summon help.

There were two falls that reportedly resulted in long lies despite use of a call system. One arose from a care home resident taking over an hour to crawl round her bed to reach the call bell after falling as she got up. In the other case, the only incident known to involve alcohol, the time on the floor could not be established but was presumed lengthy by the mobile warden team who answered the call.

As Figure 8.3.2.3 shows graphically, when the call alarm was not used the proportion of longer lies (an hour or more) was higher with a correspondingly lower proportion on the floor for less than an hour.

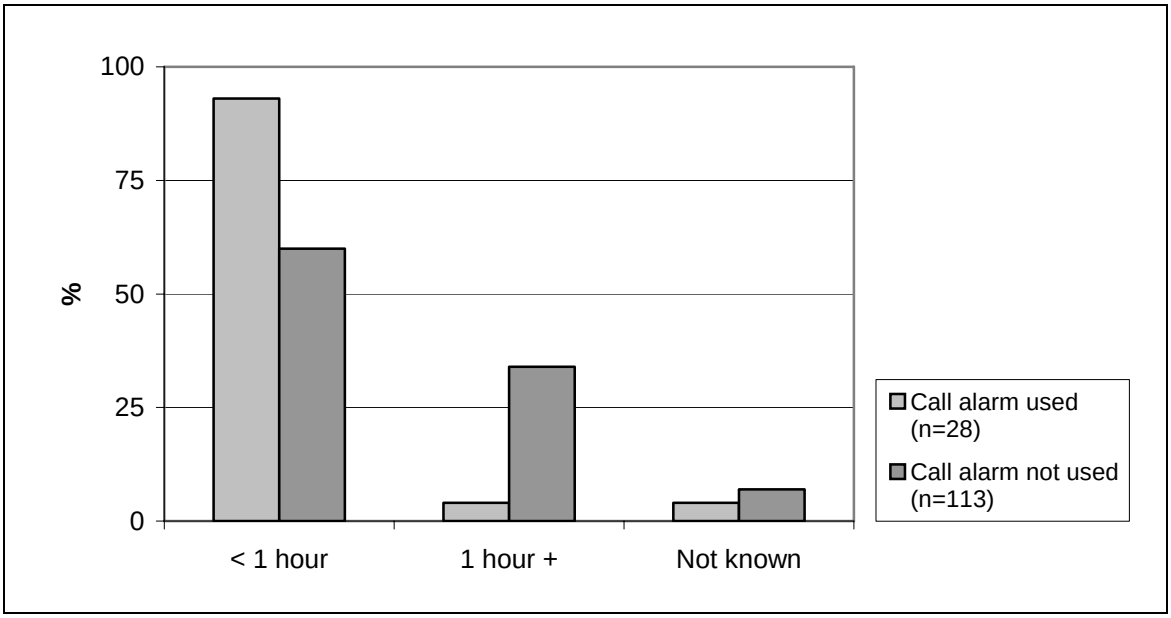
Table 8.3.2.1 Access to call alarm systems in different residential settings

	Community -dwelling [n=62]		Sheltered housing [n=19]		Institutional care [n=29]		All [n=110]	
	n	(%)	n	(%)	n	(%)	n	(%)
None	24	(39)	0		0		24	(22)
Personal call alarm system	36	(58)	2	(11)	0		38	(36)
Call bell in flat/room/by bed	1	(2)	5	(26)	29	(100)	35	(32)
Both systems	1	(2)	12	(63)	0		13	(12)

Table 8.3.2.2 Use of call alarm after falling alone and being unable to get up

	Call alarm not used [n=113]		Call alarm used [n=28]	
	n	(%)	n	(%)
TIME ON THE FLOOR				
< 5 minutes	21	(19)	4	(14)
5 minutes to < 1 hour	46	(41)	22	(79)
1 – 2 hours	12	(11)	1	(4)
> 2 hours	26	(23)	0	
Not known	8	(7)	1	(4)

Figure 8.3.2.3 Time on floor after falling alone and being unable to get up if available call alarm used or not used



8.3.3 Injuries

Whilst 38% of falls recorded during the follow-up year led to some form of injury, more than two-thirds of the people who fell during follow-up (68%) reported hurting themselves on at least one occasion as a result. Table 8.3.3.1 gives details of the injuries reported, shown as proportions of people who fell and of falls. The falls that led to injury are broken down by type and site of injury in Figures 8.3.3.2 and 8.3.3.3.

Only a fraction of falls (3%) resulted in injuries that met the definition of major injury described in Chapter 2.2.3[206], but these affected one in ten of those who fell. In this study these major injuries were all fractures except for one subdural haemorrhage after a head injury. Within their one-year follow-up six women suffered seven fractures (one shoulder, one elbow and five hip – one woman had bilateral hip fractures from two different falls). This was a fracture rate of 887/10,000 person-yrs (all non-vertebral fractures, women only) and a female hip fracture rate of 637/10,000 person-yrs. Before the end of study censoring two more women had fractured a hip and one man had suffered two vertebral fractures and a broken arm.

The vast majority of fall injuries were classed as minor, almost three-quarters of them described as a "bruise, bump or swelling". However, "minor" injuries which remain painful for over a fortnight have been classed as "serious"[232] and, although these made up only 7 out of 94 minor injury falls, this amounted to nearly a fifth of the 38 people who reported only "minor" injuries.

More than half the injurious falls led to lower limb injuries, with bruising to the buttocks accounting for one in four included in this category. Facial or head injuries were the next most common, closely followed by upper limb injuries: 31% and 28% of injurious falls respectively.

A fifth of falls reportedly required some form of treatment – anything from taking a painkiller, having stitches, a wound needing nursing attention for dressings to hip replacement – but this affected 55% of the people who fell. The following section 8.3.4 on reporting falls to others provides more detail on where people presented to medical attention for treatment or otherwise.

Table 8.3.3.1 Injury and treatment as a result of falling during follow-up

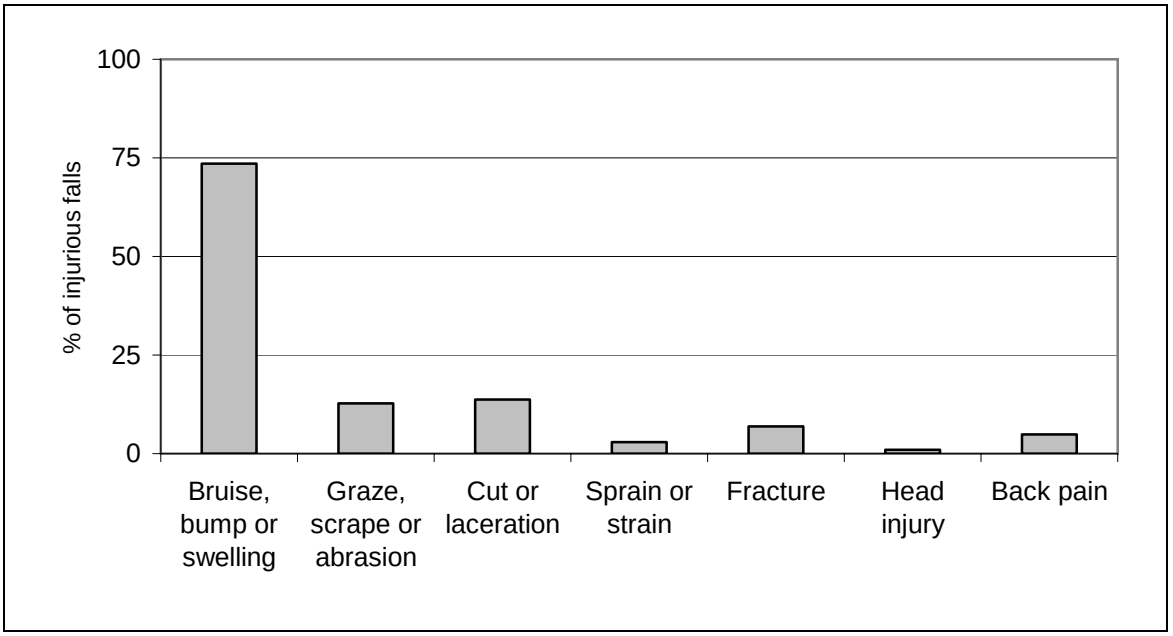
	Participants who reported falling during follow-up [n=66]		Falls reported during follow-up [n=265]	
	n	(%)	n	(%)
ANY INJURY	45	(68)	102	(38)
Major injury *	7	(11)	8	(3)
Serious minor injury †	7	(11)	7	(3)
Minor injury, excluding serious ‡	31	(47)	87	(33)
TYPE OF INJURY				
Bruise, bump or swelling	38	(58)	75	(28)
Graze, scrape or abrasion	10	(15)	13	(5)
Cut or laceration	11	(17)	14	(5)
Sprain or strain	3	(5)	3	(1)
Fracture	6	(9)	7	(3)
Head injury	1	(2)	1	(<1)
Back pain	5	(8)	5	(2)
SITE OF INJURY				
Hips, legs or feet	33	(50)	55	(21)
Shoulders, arms, wrists or hands	22	(33)	29	(11)
Trunk, back or neck	11	(17)	14	(5)
Head or face	25	(38)	32	(12)
Other	1	(2)	1	(<1)
TREATMENT				
No treatment	30	(45)	207	(78)
At home	18	(27)	24	(9)
At GP surgery	1	(2)	1	(<1)
In hospital	22	(33)	33	(12)

* Major injury = fractures, joint dislocations, lacerations needing sutures or intracranial injuries [in this study the only "major" injuries were fractures and subdural haemorrhage]

† Other serious injury = injuries classed as minor that resulted in pain for > 2 weeks [in this study these included severe back pain and injuries to ribs and shoulders]

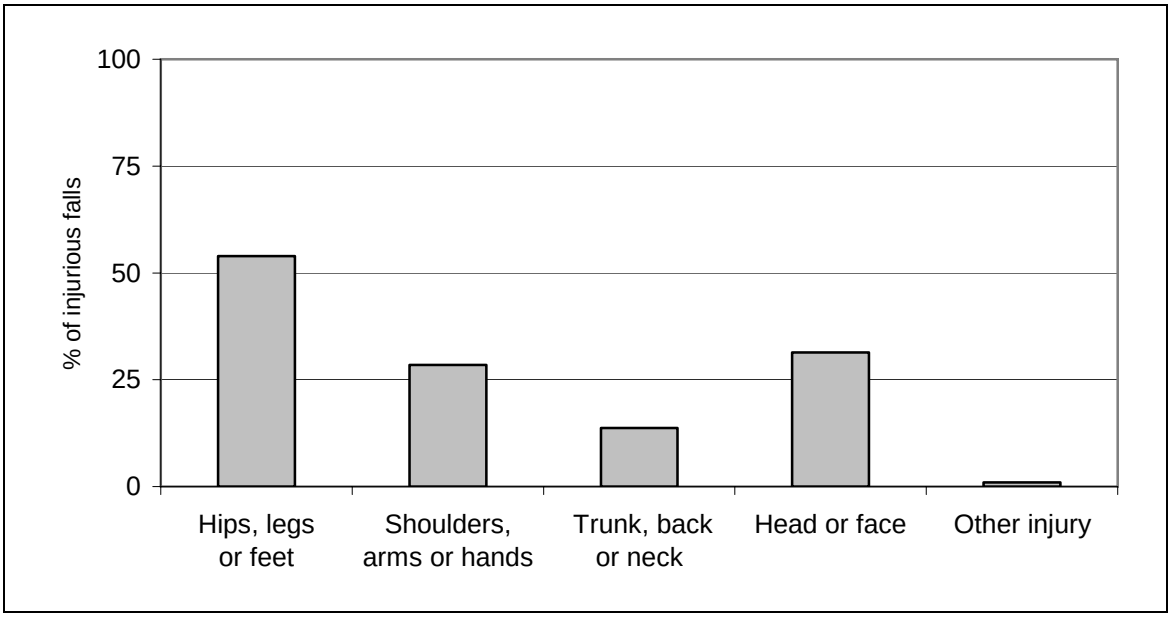
‡ Minor injury = lacerations without sutures, bruises, abrasions, sprains and other minor soft-tissue injuries causing a mark of violence on the body

Figure 8.3.3.2 Types of injury arising from falls reported during follow-up



n=102 falls resulting in injury; % total more than 100% as many falls resulted in more than one injury

Figure 8.3.3.3 Sites of injury arising from falls reported during follow-up



n=102 falls resulting in injury; % total more than 100% as many falls resulted in more than one injury

8.3.4 Reporting falls to others

For each fall reported study participants were asked "Did you tell anyone about that fall?" If the fall report was made by a proxy informant, they too were asked who else had been told about the fall (see Table 8.3.4.1). Forty per cent of all the falls reported presented to health service attention, and a further 6% were in hospital already when they fell (see section 8.4.1 for further findings on hospital admissions). Not surprisingly, these proportions were even higher (64% and 7%) amongst falls resulting in injury. Whilst these high rates clearly have heavy implications for service providers, the other angle on these same figures shows that health services are unaware of more than half the falls amongst over-90-year-olds, and unaware of three in every ten falls that result in injuries.

However, fewer than one in ten falls were not reported to anyone and if any injury had occurred the proportion not reported was only 4%. Family, friends, neighbours, carers and wardens had been told about the vast majority of the falls reported (87% or 92% of injurious falls). As examined in section 8.3.2 above, only a minority of falls led to any call alarm alert and significant others had also been told about the fall in all these cases.

Table 8.3.4.1 Reporting falls to significant others and to health services

	Falls resulting in injury reported during follow-up [n=102]		Falls without injury reported during follow-up [n=163]		Falls (+/- injury) reported during follow-up [n=265]	
	n	(%)	n	(%)	n	(%)
PRESENTING TO SERVICES						
General practitioner	53	(52)	28	(17)	81	(31)
Other healthcare professional	50	(49)	32	(20)	83	(31)
Accident and Emergency Dept.	24	(24)	2	(1)	26	(10)
Hospital admission	21	(21)	3	(2)	24	(9)
Any of the above	65	(64)	39	(24)	105	(40)
Already in hospital	7	(7)	10	(6)	17	(6)
Did not present to health services	30	(29)	113	(70)	143	(54)
TELLING OTHERS ABOUT A FALL						
Family, friend, carer or neighbour	94	(92)	136	(84)	231	(87)
Call alarm:nurse/warden/call centre	14	(14)	17	(10)	31	(12)
Any of the above	94	(92)	136	(84)	231	(87)
Not known whether any above told	1	(1)	1	(<1)	2	(<1)
Did not report fall to any of above	7	(7)	25	(15)	32	(12)
NOT TOLD ANYONE ABOUT FALL	4	(4)	21	(13)	25	(9)

8.4 Subsequent sequelae

8.4.1 Hospital admissions
8.4.2 Moves to care homes
8.4.3 Mortality

8.4.1 Hospital admissions

8.4.1.1 Admissions in relation to measures of falling
8.4.1.2 Falling as a cause of hospitalisation
8.4.1.3 Frequency of admission and length of stay

One in three of the over-90-year-olds in the study were admitted to hospital at least once in the year following interview, with no difference in this rate between men (n=6, 30%) and women (n=30, 33%).

8.4.1.1 Admissions in relation to measures of falling

Almost half the people who fell during follow-up were admitted to hospital at least once, whilst the admissions rate was far lower amongst those who reported no falls within the year's follow-up (48% vs. 9%). The proportion of repeat fallers admitted in the year following interview was more than double that found amongst the rest of the sample (47% vs. 21%). Recalling one fall in the year before interview showed no strong associations with hospital admissions in the year following interview, but recalling having fallen twice or more in the previous year was strongly associated with hospital admissions. Table 8.4.1.1 gives details and shows the powerful odds ratios indicating 3-fold to 9-fold increased risks of admission associated with these different measures.

Tables 8.4.1.1 Hospital admission within a year of interview by falls status

	Hospital stay <1 year after interview n (%)	Odds Ratio - unadjusted (95% C.I.)	Mean length of stay in hospital (days)	Significance* -difference in length of stay
No follow-up falls n=44 At least 1 follow-up fall n=66	4 (9) 32 (48)	**9.4 (3.0-29.3)**	4.8 28.8	**p<0.001**
0 or 1 follow-up fall n=61 ≥2 follow-up falls n=49	13 (21) 23 (47)	**3.3 (1.4-7.5)**	14.3 25.3	**p=0.003**
No falls in past year n=46 At least 1 fall past year n=63	11 (24) 25 (40)	2.1 (0.9-4.9)	7.4 28.1	**p=0.03**
No falls or only 1 fall n=72 ≥2 falls in past year n=37	16 (22) 20 (54)	**4.1 (1.8-9.7)**	9.0 39.6	**p<0.001**

* Mann-Whitney U test

8.4.1.2 Falling as a cause of hospitalisation

The figures above include all hospital admissions, regardless of cause. In the preceding section on falls presenting to medical attention (Chapter 8.3.4) Table 8.3.4.1 shows that 9% of all falls reported during follow-up (21% of falls leading to injury) resulted in hospital admissions. However, this figure understates the extent of hospitalisation amongst people who fall: of the 66 individuals who fell during follow-up 36% had at least one hospital admission during this period that was due at least in part to a fall. All three of the study participants who were in hospital already when interviewed had been admitted due to a fall.

Two-thirds (24/36) of all admissions during the year after interview were due at least in part to falling, and two-thirds of them (16/24) were specifically due to falling. One in four of the remainder whose admission was not due to a fall (3/12) subsequently suffered a fall whilst in hospital.

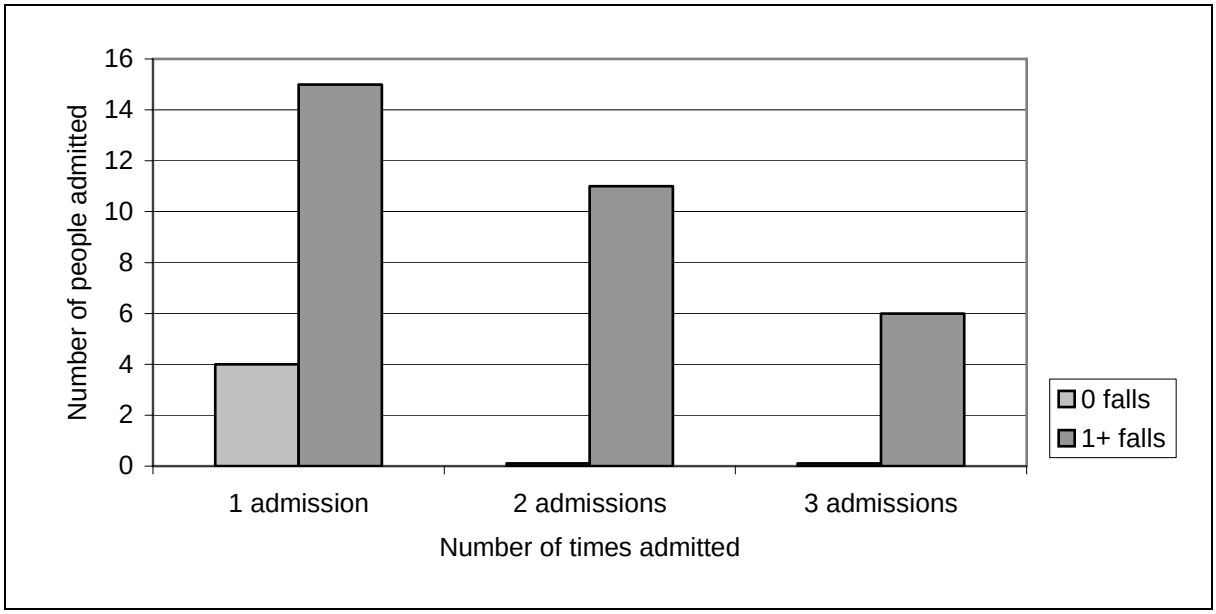
8.4.1.3 Frequency of admission and length of stay

Almost half of those admitted to hospital (17/36) had more than one admission. During the year following interview the people admitted to hospital more than once were all people who had fallen during this follow-up period (see Figure 8.4.1.3).

The mean length of stay in hospital was 19 days, averaged over the full sample, with a highly significant difference in means between those who reported any falls during follow-up and those reporting none (29 days vs 5 days, $p<0.001$ Mann-Whitney U test). However, of the 36 people with at least one hospital stay, the 32 of them who reported falls had a mean total length of stay of 59 days (median 32, IQR 12-88), not significantly different from the 4 people admitted who reported no falls: total length of stay (days) mean 52, median 41, IQR 4-103.

There were no major differences between findings taking data from the follow-up year after interview compared with data up to end of study censoring 31.12.2004, so for simplicity Table 8.4.1.1 presents only the follow-up one year data.

Figure 8.4.1.3 Frequency of hospital admissions by falling during follow-up



8.4.2 Moving to care homes

8.4.2.1 Falling as a cause of moving into care
8.4.2.2 Moving into care in relation to measures of falling

There were no changes of residence other than those to institutional care. In just a couple of cases individuals moved from one care setting to another home nearer to relatives, but the majority involved moving up the ladder of care to a more permanent supported setting, for example to residential care from sheltered housing or to a nursing home after a temporary hospital admission from home. There were no admissions to sheltered accommodation during follow-up.

Within a year from interview 12 people had moved into care, 1 in 7 of those not already living in residential or nursing homes. By the end of follow-up for the last person interviewed, when administrative records were up-dated on the full study sample, half as many again had moved to care homes (n=18), now over a fifth of those not in care when interviewed.

8.4.2.1 Falling as a cause of moving into care

A third of moves into more supported settings were due to falling (or more with longer follow-up), with a further half being partly due to a fall. The stacked bar charts in **Figure 8.4.2.1** show the extent to which this was so for those moving into care from different residential settings, including the three women in hospital at the time of interview, over 80% or 90% overall for the two periods of follow-up shown. Three-quarters of the people who moved into care homes within a year of interview had fallen more than once during follow-up.

8.4.2.2 Moving into care in relation to measures of falling

Falling and repeated falling during the year after interview both showed powerful associations with moving into a care home (see Table 8.4.2.2). The risk estimates were higher using data from the year after interview only, despite the smaller numbers involved, although of course the confidence intervals were therefore wider than for estimates using all the admissions data up to the final follow-up censoring which confirmed the direction of effect.

Figure 8.4.2.1 Falling as a factor in moving into care into institutional care

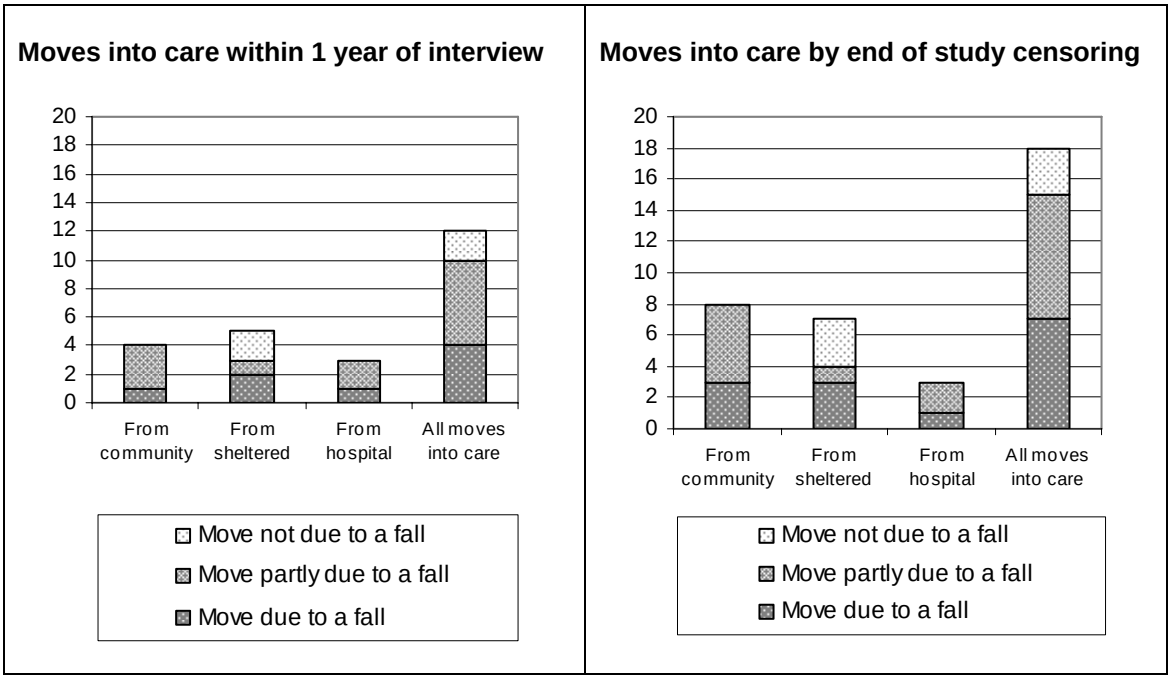


Table 8.4.2.2 Moves into care homes in relation to falling during follow-up

		Moved into care within 1 year of interview n (%)	Odds Ratio - unadjusted (95% C.I.)	Moved into care by final follow-up censoring n (%)	Odds Ratio - unadjusted (95% C.I.)
No falls	n=33	1 (3)		3 (9)	
At least 1 fall	n=51	11 (22)	**8.8 (1.1-71.8)**	15 (29)	**4.2 (1.1-15.8)**
No falls or only 1 fall	n=48	3 (6)		6 (13)	
2 or more falls	n=36	9 (25)	**5.0 (1.2-20.1)**	12 (33)	**3.5 (1.2-10.5)**

n=84 not living in care homes at interview (62 community-dwelling +19 sheltered housing +3 in hospital)

8.4.3 Mortality

8.4.3.1 Falling as a "cause of death"
8.4.3.2 Deaths in relation to measures of falling
8.4.3.3 Deaths following hospital admissions
8.4.3.4 Deaths after moving into care

With the study sample population all over 90-years-old at interview it is not surprising that mortality overall was very high: a quarter of them (6 men and 22 women) had died within a year of interview and by the final censoring date used in the current study (end of December 2004) this had risen to 38% (8 men and 33 women).

8.4.3.1 Falling as a "cause of death"

Death is often used in epidemiological studies as a well-defined end-point, but cause of death is often a less robust measure. In the current study, the causative link between falling and death was rarely indisputable. The following examples arose after each individual's year of follow-up finished but were reported before the end of study censoring. One woman fell as she got up in the night, fractured her hip and was unable to reach the call bell in her residential home room; she not was found until many hours later and died in hospital the following day. On the other hand, even an immediate temporal link is not necessarily relevant: the coroner's report on post-mortem examination after another woman was found dead on her floor – the only such death in this study – noted bruising on impact and heart failure. A number of falls that occurred shortly before death could be described as not so much the cause of death but more as symptomatic of the illness identified as the cause of death, for example falls when delirious due to an acute infection.

However, there were a number of falls from which the person who fell never recovered and died within a few months. Five out of the 28 deaths within a year of interview met this description, with the time from the last fall until death about a week for three of them but ranging from 6 to 71 days. These deaths account for around 1 in 6 of the deaths during follow-up and 1 in 3 of the deaths amongst those who fell during follow-up.

There were further instances of an older person's fall initiating a series of events that ultimately led to death for which the time elapsed before death was much longer. For instance, one woman's hospital admission for severe bruising from a first fall was followed by subsequent hip fracture from a fall on the ward, discharge and re-admission after multiple further falls, a lengthy stay due to hospital acquired infection during which her cognitive function declined rapidly until eventual transfer to residential care where she died within a month – a full four months after the first fall. In a similar case, a woman who had managed to live independently up until a fall was in hospital for over six months with pain from the vertebral fractures she sustained and increasing confusion, eventually dying in a nursing home nearly a year later.

The consequences of falls in examples such as these have enormous impact on the individuals themselves who fall, their family and of course on health and social services, as other sections of this thesis discuss in more detail (see Chapters 1, 9 and 11). However, with the causative link less clear-cut than in the first examples given above, this impact is harder to measure. The following results presented therefore examine the relationship between measures of falling and survival, regardless of any attempts to assess what degree of causation may have been involved.

8.4.3.2 Deaths in relation to measures of falling

There was virtually no difference in the proportions of non-fallers, single fallers and repeat fallers who died within a year of interview, although there seems to be a slight trend (not statistically significant) of increasing mortality amongst those who remembered falling once or more than once in the year before interview compared with those recalling no falls in the last year (see Figure 8.4.3.2.1).

As the cohort is flagged for mortality with the Office of National Statistics, death reports on everyone interviewed continued to be monitored for each individual even after their own follow-up year ended, with 31.12.2004 taken as the final censoring date for the current study. Survival analysis to this date allocates some individuals far longer than one year so obviously includes time beyond the intensive follow-up. Thus any

falls that may have occurred in this extended period would not have been counted in the classification of "non-fallers", "fallers" and "repeat fallers". However, the brief survey of falls since end of follow-up that was carried out with the up-dating of administrative records suggests this potential misclassification problem may be only minimal. Only one individual was identified who had not fallen during follow-up but reported falling in the intervening period.

Figure 8.4.3.2.2 again illustrates the proportions of those who recalled falls in the past year and of those who reported falls during prospective follow-up, this time showing those who had died before this close of study censoring. The relationship to recalled falls follows a similar pattern to that seen with deaths during the follow-up year after interview. The apparently, though non-significantly, lower mortality found amongst repeated fallers is not seen in this longer follow-up.

The Kaplan-Meier survival plots in Figures 8.4.3.2.3-4 and 8.4.3.2.6-7 allow visual examination of the effect of falling during follow-up and recalled fall history on time to death from interview. As with the comparison of proportions above, there is little difference in survival time during the just one year's follow-up, with even a suggestion again that survival is shorter amongst those reporting no falls. The effect, albeit limited, is in the opposite direction with the longer exposure time to the final censoring date, particularly when viewed in relation to recalled falls, on average more distant from death than falls during follow-up. Hazard ratios shown in Tables 8.4.3.2.5 and 8.4.3.2.8 echo this pattern of slight reduction in more immediate mortality risk associated with falling during follow-up and slight increase in longer term mortality risk; however, confidence intervals all cross 1.

It is noteworthy that, regardless of proportions of fallers and non-fallers who died, the mean time to death was longer amongst those who fell and those who fell more than once, whether in the last year or follow-up. Tables 8.4.3.2.5 and 8.4.3.2.8 highlight where some of these differences reach significance.

Figure 8.4.3.2.1 Mortality: death rates within a year of interview by fall status

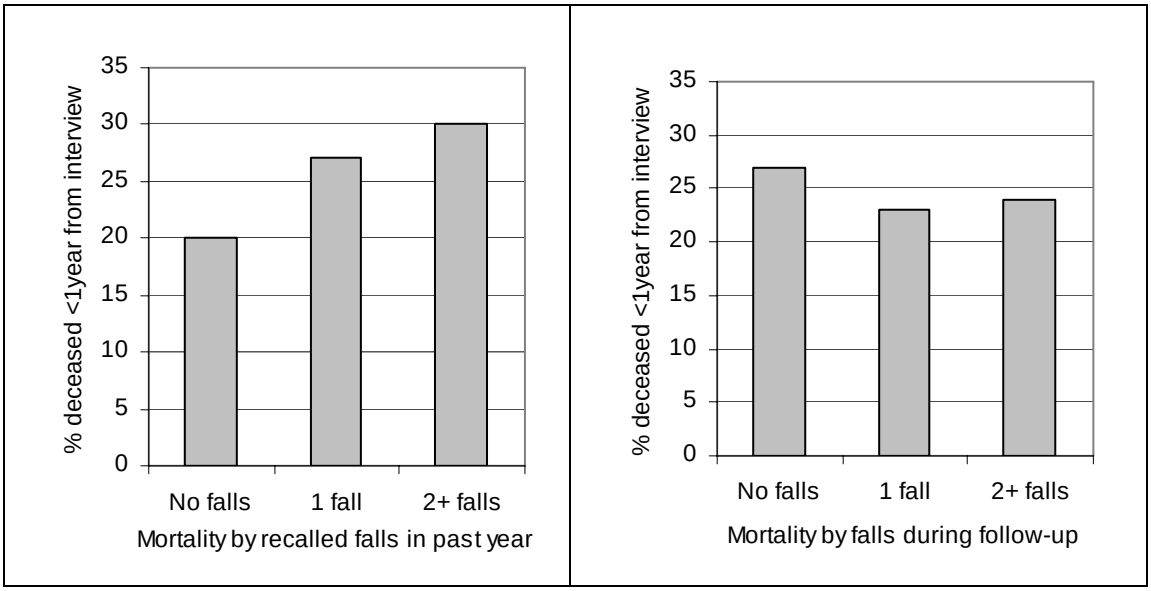
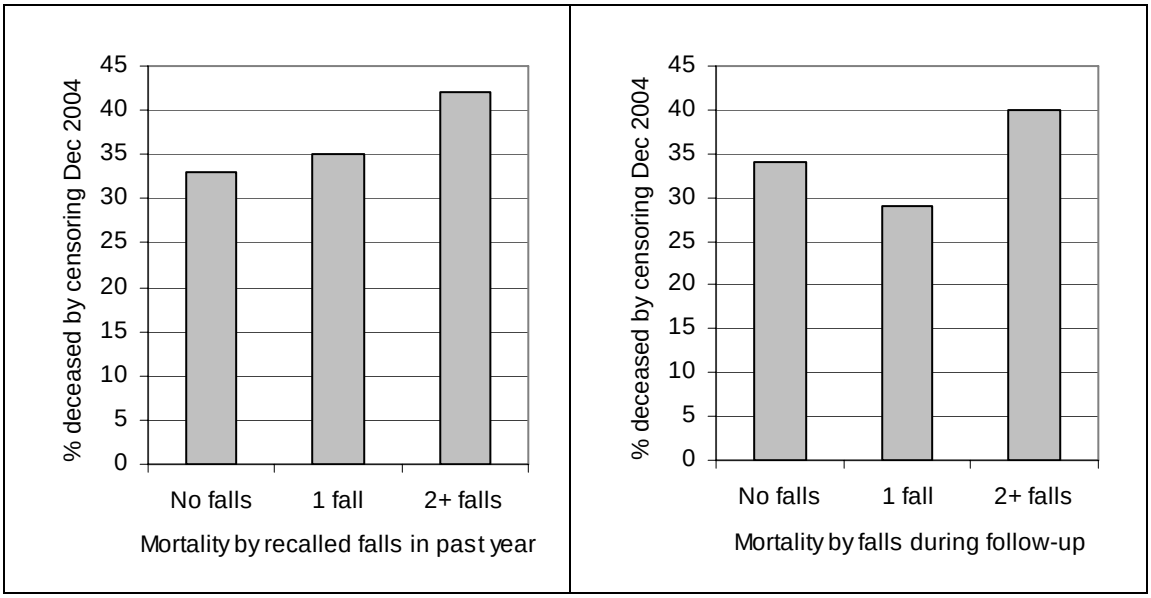
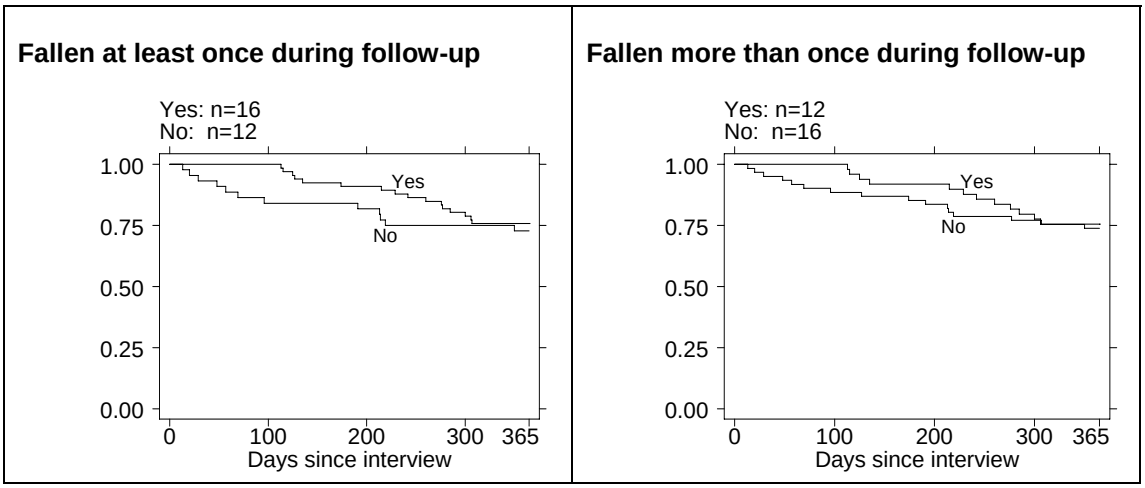


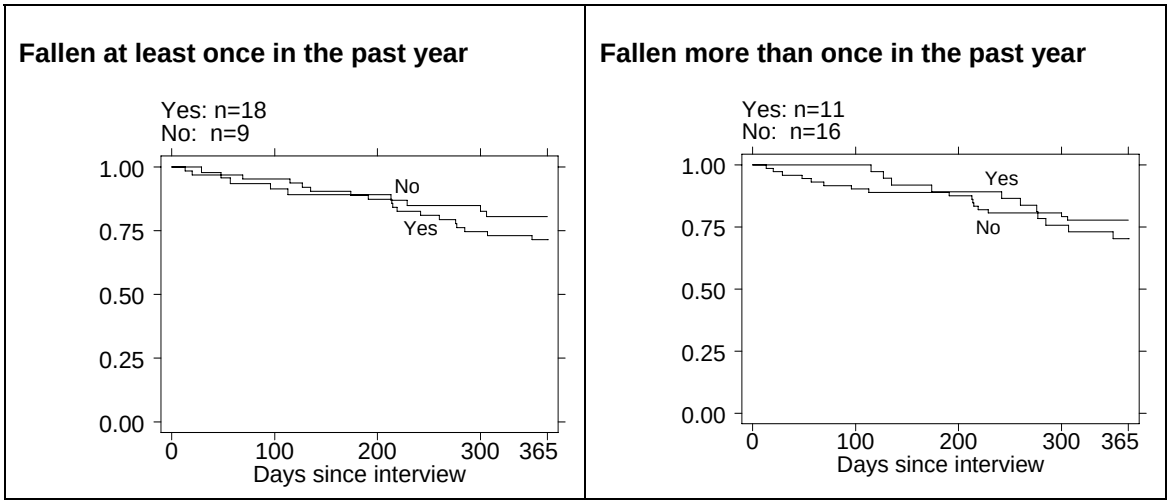
Figure 8.4.3.2.2 Mortality: death rates at final censoring Dec 2004 by fall status



Figures 8.4.3.2.3 Kaplan-Meier survival plots of time to death during 1 year follow-up by falling during follow-up



Figures 8.4.3.2.4 Kaplan-Meier survival plots of time to death during 1 year follow-up by recalled fall history

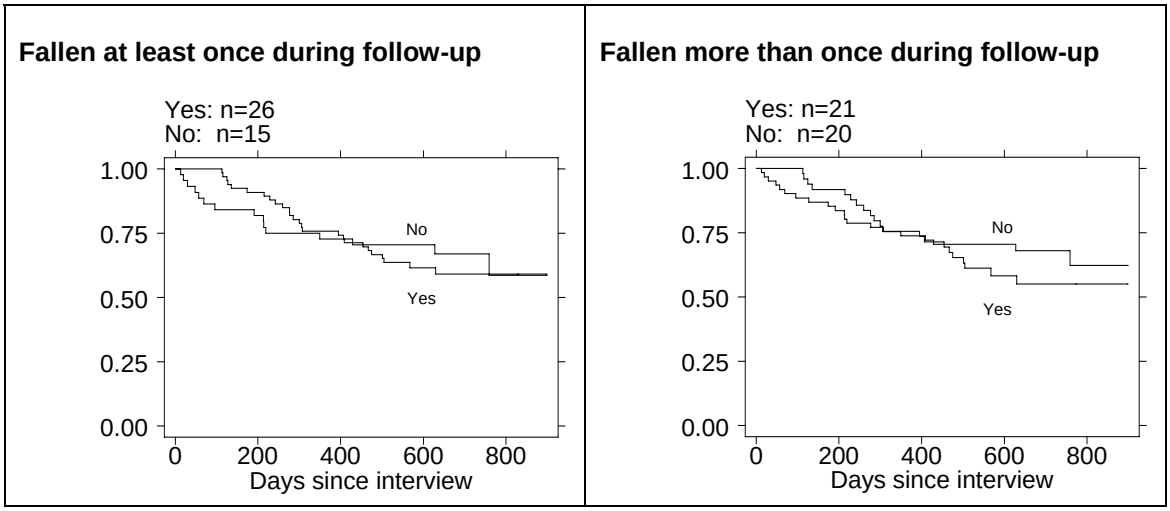


Tables 8.4.3.2.5 Mortality within a year of interview by falls status

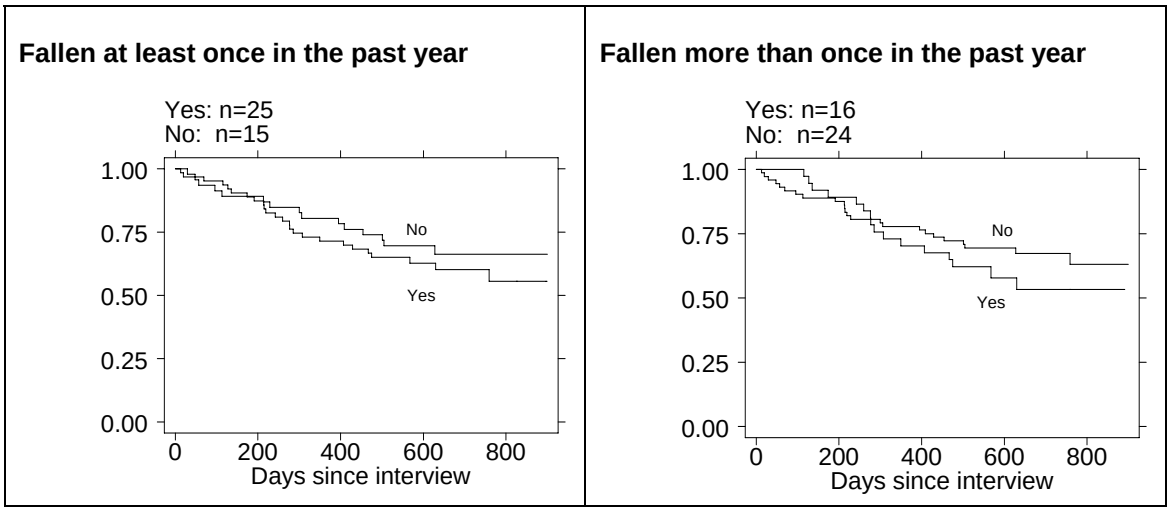
	Died within 1 year of interview n (%)	Hazard Ratio - unadjusted (95% C.I.)	Time to death from interview (days)	Significance* -difference in time to death
No follow-up falls n=44 At least 1 follow-up fall n=66	12 (27) 16 (24)	0.8 (0.4-1.7)	127 218	**p=0.01**
0 or 1 follow-up fall n=61 ≥2 follow-up falls n=49	16 (26) 12 (24)	0.9 (0.4-1.8)	150 217	p=0.07
No falls in past year n=46 At least 1 fall past year n=63	9 (20) 18 (29)	1.5 (0.7-3.3)	155 194	p=0.4
No falls or only 1 fall n=72 ≥2 falls in past year n=37	16 (22) 11 (30)	1.3 (0.6-2.8)	146 232	**p=0.02**

* Mann-Whitney U test

Figures 8.4.3.2.6 Kaplan-Meier survival plots of time to death at censoring Dec 2004 by falling during follow-up



Figures 8.4.3.2.7 Kaplan-Meier survival plots of time to death at censoring Dec 2004 by recalled fall history



Tables 8.4.3.2.8 Mortality at censoring Dec 2004 by falls status

	Died by final censoring at end of 2004 n (%)	Hazard Ratio - unadjusted (95% C.I.)	Time to death from interview (days)	Significance* -difference in time to death
No follow-up falls n=44 At least 1 follow-up fall n=66	15 (34) 26 (39)	1.1 (0.6-2.1)	222 319	**p=0.02**
0 or 1 follow-up fall n=61 ≥2 follow-up falls n=49	20 (33) 21 (43)	1.3 (0.7-2.4)	231 333	**p=0.03**
No falls in past year n=46 At least 1 fall past year n=63	15 (33) 25 (40)	1.3 (0.7-2.4)	192 189	p=1.0
No falls or only 1 fall n=72 ≥2 falls in past year n=37	24 (33) 16 (43)	1.3 (0.7-2.5)	267 318	p=0.2

* Mann-Whitney U test

8.4.3.3 Deaths following hospital admissions

As might be expected, death rates are higher amongst those admitted to hospital for any reason, fall-related or not, compared with those who had no admissions (see Figure 8.4.3.3.1). In the year following interview 42% of the 36 people admitted to hospital died, and by the end of December 2004 study censoring this had risen to 54% out of 43 admissions. Mortality amongst those who did not go into hospital was 18% and 27% respectively for the same periods.

Over half the people who died within a year of interview (15/28) had needed at least one admission in that period, and for three-quarters of them (11/15) falling had been a factor in their hospital stay. The latter group amounted to 40% of all deaths in the year after interview. Figure 8.4.3.3.2 clarifies the breakdown of deaths by sub-groups based on reasons for hospital admission.

A third of those whose hospitalisation was at least in part due to a fall died in hospital (seven within a year from interview and two more before the final censoring date). A further fifth died after transfer from hospital to a care home (four within a year from interview and another two before the end of December 2004, a mean of seven months after discharge from hospital).

8.4.3.4 Deaths after moving into care

Mortality within a year of transfer to institutional care was higher amongst those who had moved because of a fall or partly because of a fall (70%) compared with those who moved for other non-fall reasons (50%). Figures 8.4.3.4 illustrates this with data on moving into care within a year of interview. Although the numbers affected were small, the data censored at the end of the current study also showed raised mortality (64% vs 50%) and examining all known reasons for care home admissions before as well as after admission showed an even starker difference. In this larger group, 36% of those whose move into care was prompted at least in part by falling died within a year of institutional admission, as compared with only 7% of those whose admission was for other reasons.

The difference in mortality at one year after moving into care is less between those who moved due to a fracture (38% died < 1 year) and the remainder including those admitted due to falls but not fractures (23% died < 1 year).

Figure 8.4.3.3.1 Deaths: hospital admissions related or un-related to falling

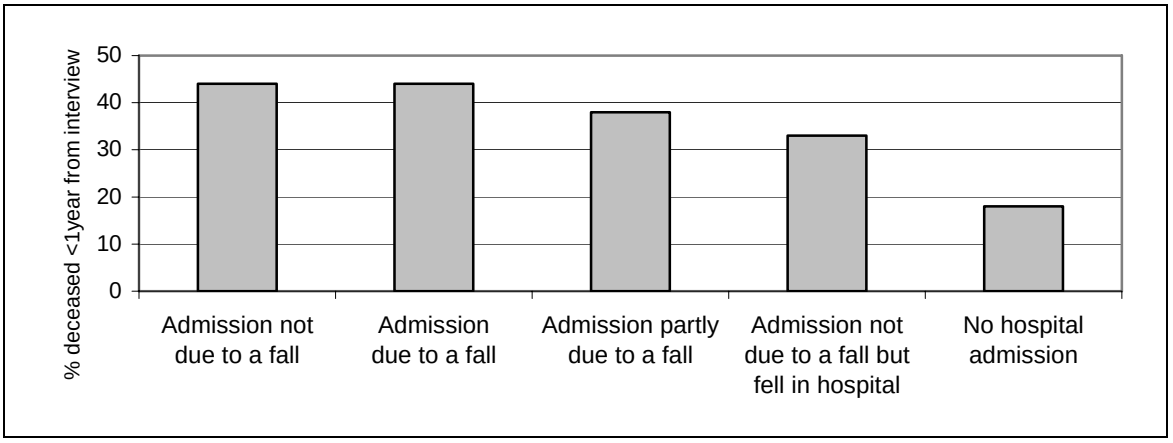
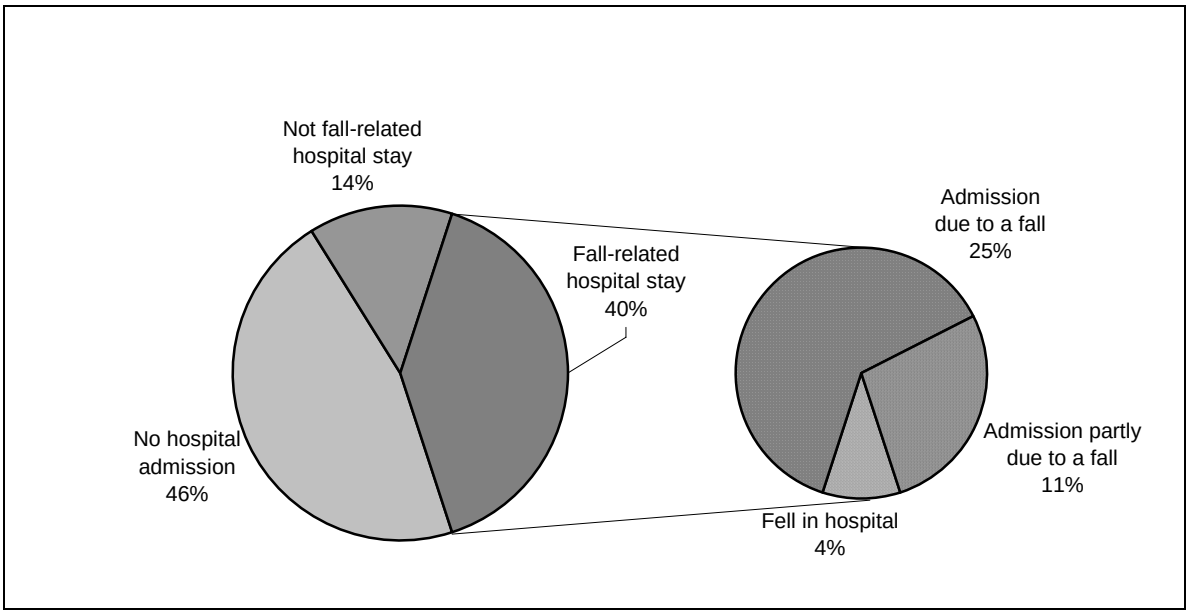
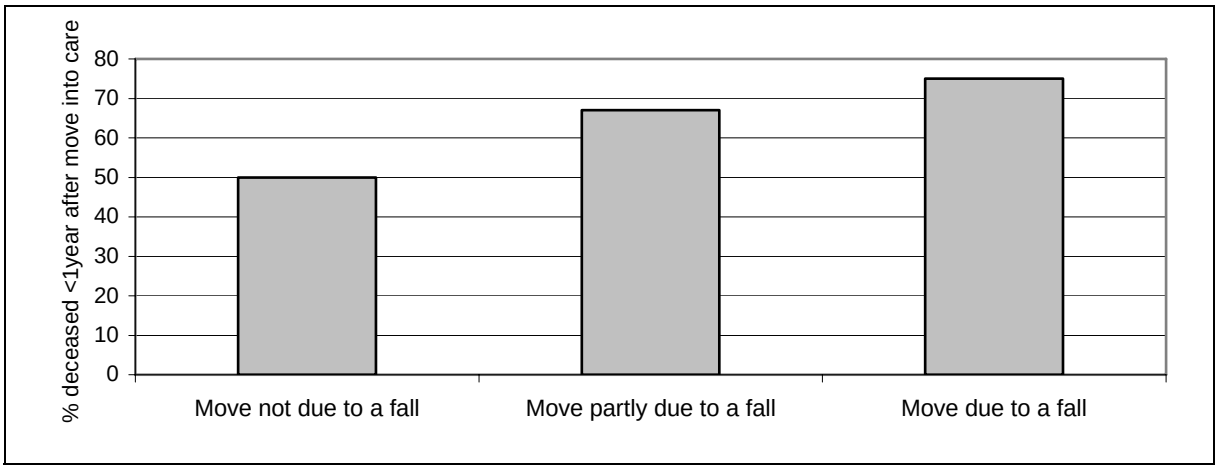


Figure 8.4.3.3.2 Deaths in relation to hospital admissions and reasons for admission



Figures 8.4.3.4 Deaths in relation to moves into care and reasons for moving



8.5 Factors predictive of fall consequences and other follow-up outcomes

8.5.1 Which outcomes might be predicted?
8.5.2 Which factors might be predictive?

Six of the consequences of falling described in the preceding sections (8.3 and 8.4) were identified as serious outcomes to examine in relation to the potential risk factors for falling already presented in Chapters 6 and 7. The aim was to identify which of these risk factors, if any, might predict the serious consequences of falls as well as the risk of falls per se. It was hypothesised that fall-induced injuries were more likely to be determined by extrinsic factors than by the intrinsic characteristics to be examined, so the following results do not address injuries, major or otherwise.

An overview of the findings relating to each of the outcomes in Box 8.5.1 is given first, followed by examination of the predictive value of the different groups of risk factors listed in Box 8.5.2. Tables 8.5.2.1-6 present crude odds ratios for each of the outcomes found to be associated with each risk factor, with a table for each set of predictor variables shown in sections 8.5.2.1-6 but also referred to in sections 8.5.1.1-4

Denominators for some analyses vary, for example those already living in residential or nursing homes are excluded from analyses of the risk of moving into long-term institutional care. Likewise some of the potentially predictive factors could not be measured in everyone: questions such as those on self-rated health and worry about falling elicited many "Don't know" responses and functional testing was not possible if only a proxy interview was obtained. Boxes 8.5.1 and 8.5.2 summarise the extent of missing data but it is worth noting that in a few analyses, for which both risk factor and outcome were measured incompletely, the sub-sample is reduced yet further.

Box 8.5.1 Outcomes recorded during follow-up

	n	Denominator	(%)
Unable to get up after a fall	53	66 *	(80% of those who fell)
Long lie on the floor after a fall	20	66 *	(30% of those who fell)
Hospital stay due to a fall	24	110	(22% of the full sample =36% of those who fell)
Hospital admission	36	110	(33% of the full sample)
Moved to care home	18	84 †	(21% of those not in care)
Deceased by study end	41	110	(37% of the full sample)

* Reported at least one fall during follow-up year after interview (n=66)
† Community-dwelling (n=62) or in sheltered accommodation (n=19) or hospital at interview (n=3)

Box 8.5.2 Potential predictors examined in relation to follow-up outcomes

	Not asked / Don't know / Not applicable	Denominator used in analyses
Socio-demographic factors		
Age, sex, education and residence	0	110
Social class	4	106
Cognition		
Severe cognitive impairment	0	110
Perception of balance and falling		
Unstable on feet	5	105
Tendency to fall	3	107
Worried about falling	45	65
Falls efficacy	35	75
Recalled falling in past year	1	109
Recalled ≥2 falls in past year	1	109
Health and disability		
Observed visual impairment	14	96
Reported poor vision	3	107
Observed hearing impairment	19	91
Reported hearing loss	4	106
Arthritis, weakness in arms or legs	3	107
Incontinence	5	105
Depressive symptoms scale	24	86
Co-morbidity score	3	107
Self-reported health	42	68
Limited in ≥2 basic ADLs	0	110
Limited in ≥2 instrumental ADLs	0	110
Taking falls risk medication	0	110
Taking ≥4 prescription drugs	0	110
Reported mobility		
Walking distance	0	110
Use of walking aid outdoors	11	99
Use of walking aid indoors	1	109
Limited in ≥2 walking ADLs	0	110
Stair climbing	0	110
Observed mobility		
All physical function performance tests	20	90
except Functional reach	24	86

8.5.1 Which outcomes might be predicted?

8.5.1.1 Inability to get up and long lies on the floor
8.5.1.2 Hospital admissions
8.5.1.3 Moving into long-term care
8.5.1.4 Mortality

For data referred to in the following sections see Tables 8.5.2.1-6

8.5.1.1 Inability to get up and long lies on the floor

Inability to get up from the floor after a fall
Long lies – on the floor for over an hour

Inability to get up from the floor after a fall

Cognitive impairment, a recalled history of falling (especially falling twice or more) in the past year, and most measures of mobility were strongly associated with being unable to get up after a fall. This difficulty was more prevalent with increasing age, for women and, as would be expected, amongst those living in sheltered or institutional settings. In all the observed functional tests better performance reduced the odds ratios, most significantly for gait speed, dynamic balance (single and repeated chair stands, functional reach </>15cm and, almost significantly, </>5 steps to turn 180 degrees) and one of the static balance tests (semi-tandem stance). It is interesting to note that the pure muscle strength measure – hand grip dynamometry – did not predict inability to rise from the floor amongst women.

Long lies – on the floor for over an hour

Long lies are determined not only by the ability of the person who falls to get up but also the availability of help to get up. Indeed all the risk factors that predicted inability to rise from the floor gave odds ratios for subsequently being on the floor over an hour that were much reduced by comparison. The only factor associated with significantly increased risk of suffering a long lie on the floor after falling was severe cognitive impairment: 5.9 (95% C.I. 1.9-18.5).

8.5.1.2 Hospital admissions

Demographic factors bore little relation to hospital admissions for whatever cause, except for the finding that non-manual social class was associated with a markedly lower rate of admissions whether due to falling or other reasons. The striking predictors of hospital admission, and especially of fall-related hospitalisation, were recalled recent

falls and the subjective measures self-reported health and being worried about falling. Reported mobility and disability measures showed a pattern of increased risk of admission, only reaching significance in one analysis. Those who could not walk outdoors had three-fold odds of being in hospital because of a fall: OR 3.1 (95% C.I. 1.2-8.5). Observed mobility showed a consistent effect as well, with gait speed and the chair stand test significantly predicting all-cause hospital admissions: being able to manage even just a single chair rise gave a 70% reduction in admission risk OR 0.3 (95% C.I. 0.1-0.9) and gait speed >0.6m/sec was an even more powerful predictor OR 0.1 (95% C.I. 0.01-0.9).

8.5.1.3 Moving into long-term care

Many factors were strongly associated with moving into institutional care, the most powerful predictor being severe cognitive impairment: OR 10.0 (95% C.I. 2.9-34.8). As might also be expected, those already living in sheltered accommodation or in hospital when interviewed were far more likely to move up the ladder of care than those still living in the community. Subjective measures were also surprisingly firm predictors, with reportedly having a tendency to fall, being worried about falling, having low falls efficacy and poorer self-rated health all more highly predictive of care home admission (odds ratios ranging from 5.6 to 8.6) than the also strongly associated falls history and mobility factors (odds ratios in the range 2.9-4.6). Almost all functional tests gave much reduced odds of transfer into care, the large effect showing significance in the chair stand tests and the timed unsupported stand (odds ratios 0.1-0.2). Having fallen more than once in the past year conferred a three-fold increased odds of moving into a care home: OR 2.9 (95% C.I. 1.0-8.4)

8.5.1.4 Mortality

Most observed tests of mobility and all the reported mobility measures were strongly associated with death before the close of study censoring date. To a lesser degree, but still significantly so, limited function in basic activities of daily living, severe cognitive impairment and age were also significant predictors of mortality. Non-manual social class halved the odds of death in this period: OR 0.5 (95% C.I. 0.2-1.0). The effect of a history of recent falls on mortality - a slight increase - was not significant.

8.5.2 Which factors might be predictive?

8.5.2.1 Socio-demographic factors
8.5.2.2 Cognition
8.5.2.3 Perception of balance, fear of falling and recalled falls
8.5.2.4 Health and disability
8.5.2.5 Reported mobility
8.5.2.6 Observed mobility in functional testing

8.5.2.1 Socio-demographic factors

Associations between possible fall consequences and the factors described in this section are tabulated in Table 8.5.2.1. Within the limited age-range of the study sample population (91-106 years), age might not be expected to be a helpful predictor of any outcome. It was linked to mortality naturally, but the association of age with inability to rise from the floor also touched significance. The latter was also the only factor on which gender had a clear effect, women being six times a likely to have difficulty getting up.

More years in full-time education consistently reduced the risk of all the adverse outcomes examined but no effects were significant. By contrast, social class differences in mortality and hospital admission were marked.

The factors found to be strongly associated with place of residence are not unexpected. It is interesting to note that, whilst having difficulty getting up from the floor is more likely in supported living settings, the odds of suffering a long lie on the floor were not reduced by the additional level of care, although the increased risk of a long lie was not significant.

8.5.2.2 Cognition

Severe cognitive impairment was found to be a highly significant predictor of inability to rise from the floor, resultant long lies on the floor, admission to residential or nursing care and death (see Table 8.5.2.2). Neither of the conflicting directions of effect on hospital stays due to falling compared with all-cause hospital admissions were significant.

Table 8.5.2.1 Demographic factors in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
AGE Each year older	**1.4 (0.96-2.1)**	1.0 (0.8-1.2)	1.1 (0.9-1.3)	1.0 (0.9-1.2)	1.2 (0.9-1.5)	**1.3 (1.07-1.6)**
GENDER Men Women	**6.0 (1.4-25.5)**	1.9 (0.4-9.8)	1.4 (0.4-4.5)	1.2 (0.4-3.3)	2.8 (0.6-13.3)	0.9 (0.3-2.3)
EDUCATION Left school ≤14yrs In education ≥15yrs	0.6 (0.2-1.9)	0.9 (0.3-2.5)	0.9 (0.4-2.2)	0.7 (0.3-1.6)	0.8 (0.3-2.3)	0.6 (0.3-1.4)
SOCIAL CLASS Manual Non-manual	0.7 (0.2-2.4)	1.6 (0.6-4.7)	0.4 (0.2-1.07)	**0.4 (0.2-0.9)**	0.6 (0.2-1.8)	**0.5 (0.2-1.02)**
RESIDENCE Community Supported setting	**15.7 (1.9-129)**	1.2 (0.4-3.4)	1.0 (0.4-2.5)	1.05 (0.5-2.3)	**5.6 (1.8-17.2)***	1.9 (0.9-4.2)

* In sheltered accommodation or in hospital at interview (n=19 + n=3) vs. other community-dwelling (n=62)

Table 8.5.2.2 Cognition in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
COGNITIVE IMPAIRMENT None / Moderate Severe impairment	**9.2 (1.1-76.0)**	**5.9 (1.9-18.5)**	1.4 (0.5-3.4)	0.9 (0.4-2.2)	**10.0 (2.9-34.8)**	**2.9 (1.2-6.6)**

8.5.2.3 Perception of balance, fear of falling and recalled falls

Feeling "unsteady on your feet" did not mark any increased risks, but reporting a "tendency to fall" strongly predicted moving into care and showed weaker associations with other outcomes (see Table 8.5.2.3). The question "Are you worried about falling (again)?" distinguished those at high risk of admission to long-term care or to hospital, for falls or other reasons. The other fear of falling questions – the Falls Efficacy Scale – showed raised odds of all adverse outcomes with lower scores, significantly raised in association with care home admission and mortality.

A history of recent falls, particularly recalling more than one fall in the past year, was strongly associated with all adverse outcomes except death and suffering a long lie.

Table 8.5.2.3 Perception of balance, fear of falling and recalled falls in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
Not unsteady on feet Unsteady on feet	0.6 (0.1-4.9)	1.8 (0.3-9.3)	1.0 (0.3-3.1)	1.6 (0.5-4.9)	1.4 (0.4-5.6)	2.7 (0.8-8.7)
No tendency to fall Any tendency to fall	2.1 (0.6-7.8)	1.3 (0.4-4.0)	1.9 (0.8-4.7)	1.9 (0.8-4.3)	**7.6 (2.0-30.0)**	1.4 (0.6-3.0)
No worry about falls Worried about falls	1.9 (0.4-8.5)	1.6 (0.4-7.2)	**4.3 (1.3-14.5)**	**4.5 (1.5-13.3)**	**5.4 (1.4-20.1)**	0.8 (0.3-2.3)
FES-UK score 76 -100 FES-UK score 50 - 75 FES-UK score 0 - 49	2.2 (0.4-11.2) 6.5 (0.94-45.1)	3.0 (0.3-31.6) 4.5 (0.4-45.2)	2.6 (0.6-11.6) 1.9 (0.4-8.7)	2.4 (0.7-8.6) 2.1 (0.6-7.5)	1.4 (0.2-9.4) **5.6 (1.04-30.2)**	2.6 (0.6-11.6) **6.2 (1.5-25.8)**
Not fallen in past year ≥1 fall in past year	**3.9 (1.1-14.0)**	1.0 (0.3-3.1)	**2.6 (0.99-6.8)**	2.1 (0.9-4.9)	1.2 (0.4-3.6)	1.4 (0.6-3.0)
0 / 1 fall in past year ≥2 falls in past year	**8.1 (1.6-40.4)**	1.3 (0.4-3.7)	**5.3 (2.1-13.4)**	**4.1 (1.8-9.7)**	**2.9 (0.99-8.4)**	1.5 (0.7-3.4)

8.5.2.4 Health and disability

Table 8.5.2.4 overleaf summarises the relations examined between health and disability factors and the possible consequences of falls. No associations were found between any health conditions reported and being unable to get up from the floor or suffering a long lie, but the majority of these health-related factors were positively but non-significantly associated with admissions to hospital (due to falling or other reasons) or institutional care.

The discrepancies between reported and observed visual and hearing impairment noted in earlier chapters are evident again, but none of these measures showed any clear pattern of association with adverse fall consequences. Arthritis was not only a weak predictor of the sequelae examined, and reporting weakness in the arms or legs was an even less informative factor.

Self-rated health, measured in less than two-thirds of the sample, was a strong predictor of admissions to hospital or long-term care and showed a similar order of effect, though not statistically significant, in relation to being able to get up from the floor. No significant association with mortality was found.

Disability in basic and instrumental activities of daily living slightly raised the odds of every outcome examined, just reaching statistical significance in only one analysis: the odds ratio for death of 2.4 (95% C.I. 1.01-5.6) associated with basic ADL limitation.

The only other health factor significantly associated with mortality was incontinence, which also showed a pattern of increasing the odds for most unfavourable outcomes, especially for moving into care. Besides self-rated health, the strongest predictor of institutionalisation was a high depression score, and a high number of co-morbid conditions showed a similar scale effect without reaching significance.

There was a striking lack of association between either of the medication risk factor categories and any of the consequences of falling or longer-term outcomes.

Table 8.5.2.4 Health and disability in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
Reported poor vision No problem reported Any - disabling or not	0.8 (0.2-3.2)	0.4 (0.1-1.2)	1.4 (0.6-3.5)	1.8 (0.8-4.1)	2.5 (0.7-8.7)	0.8 (0.4-1.8)
Visual impairment Can read 3mm print Cannot read 3mm print	2.0 (0.4-10.2)	0.2 (0.1-1.6)	1.0 (0.4-2.8)	0.8 (0.3-2.0)	1.0 (0.2-5.0)	1.7 (0.7-4.2)
Reported hearing loss No problem reported Any - disabling or not	2.2 (0.6-8.4)	1.5 (0.6-5.0)	0.9 (0.4-2.2)	0.9 (0.4-2.0)	1.2 (0.4-4.0)	0.9 (0.4-2.1)
Tested hearing loss Can hear normal speech Cannot hear accurately..	0.9 (0.2-3.4)	0.7 (0.2-2.3)	1.2 (0.4-3.1)	1.3 (0.6-3.0)	2.1 (0.6-6.9)	1.0 (0.4-2.4)
Arthritis No problem reported Any - disabling or not	1.2 (0.3-4.6)	0.7 (0.2-2.2)	1.9 (0.7-5.1)	1.7 (0.7-3.8)	2.4 (0.6-9.4)	1.2 (0.5-2.7)
Weakness in limbs No problem reported Any - disabling or not	0.3 (0.1-1.4)	1.0 (0.3-3.0)	0.8 (0.3-1.9)	1.1 (0.5-2.4)	1.5 (0.5-4.9)	0.7 (0.3-1.5)
Incontinence Accidents rare / none Accidents > once/wk	No-one who was incontinent >once /week could get up after a fall	1.4 (0.4-4.3)	1.6 (0.6-4.0)	0.8 (0.3-2.1)	2.9 (0.7-11.5)	**3.5 (1.4-8.6)**
Depression DSS 0-4 DSS 5-11	2.7 (0.5-15.6)	0.7 (0.2-2.8)	1.6 (0.6-4.7)	1.7 (0.7-4.2)	**4.4 (1.3-13.8)**	1.2 (0.5-3.3)
Co-morbidity 0-5 reported/diagnosed > 5 reported/diagnosed	0.9 (0.1-8.9)	0.4 (0.1-2.3)	1.8 (0.5-5.8)	2.0 (0.7-5.5)	4.0 (0.5-33.1)	1.4 (0.5-3.7)
Self-rated health Good/very good Fair/poor/very poor	4.2 (0.5-39.4)	3.4 (0.7-17.3)	**3.8 (1.05-13.5)**	**3.5 (1.03-11.5)**	**8.6 (2.1-34.8)**	1.4 (0.4-5.0)
Difficulty with <2 basic ADLs ≥2 basic ADLs	2.4 (0.7-8.3)	1.5 (0.4-4.7)	1.5 (0.6-3.8)	1.2 (0.5-2.8)	2.7 (0.9-8.6)	**2.4 (1.01-5.6)**
Difficulty with <2 instrumentl ADLs ≥2 instrumentl ADLs	3.0 (0.5-20.4)	1.8 (0.2-17.3)	1.7 (0.4-8.4)	2.7 (0.6-12.8)	3.4 (0.4-28.3)	7.6 (0.94-61.1)
Any falls risk drug No Yes	6.5 (0.8-54.5)	1.0 (0.97-1.05)	1.0 (0.97-1.03)	1.0 (0.96-1.02)	1.0 (0.8-1.1)	1.0 (0.99-1.03)
Taking ≥4 drugs No Yes	1.8 (0.5-6.2)	1.0 (0.97-1.05)	1.0 (0.97-1.03)	1.0 (0.96-1.02)	1.0 (0.9-1.1)	1.0 (0.99-1.06)

8.5.2.5 Reported mobility

Reported mobility was a good predictor of being unable to get up from the floor after a fall, with limited walking measures conferring approximately four- to six-fold increased odds (see Table 8.5.2.5). Climbing less than a flight of stairs per day or being unable to manage stairs at all was the strongest predictor found for this serious fall consequence: OR 16.3 (95% C.I. 3.7-71.3). The associations between reported mobility and mortality or moving into care are also unequivocal.

Excluding those who cannot walk at all from reported mobility analyses had no effect on the significance of risk estimates for any outcomes except one. When this least mobile group were excluded, being unable to walk outdoors any more was associated with increased odds for admission to hospital due to a fall: OR 3.1 (95% C.I. 1.2-8.5).

Answers to the question "Do you manage any form of physical activity or exercise?" that showed weak relations to falls measures – walking for exercise, gardening and other forms of physical activity – were not found to be associated with any consequences of falling, admissions or mortality.

Table 8.5.2.5 Reported mobility in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
Able to walk around local area						
Unable	**4.8 (1.4-15.9)**	1.3 (0.5-3.1)	2.1 (0.6-2.7)	2.5 (0.8-7.2)	4.3 (0.9-20.3)	**4.3 (1.4-13.7)**
Able walk outdoors						
Unable	6.2 (0.7-51.3)	0.5 (0.2-1.8)	**3.1 (1.2-8.5)**	1.7 (0.7-4.0)	**7.9 (2.5-25.4)**	**3.7 (1.6-8.7)**
Walking aid No need outdoors						No-one died who walked outdoors without aid
Needs aid outdoors	**6.6 (0.97-44.9)**	1.8 (0.2-17.7)	1.8 (0.4-2.7)	2.9 (0.6-14.2)	2.9 (0.3-24.5)	
Walking aid No need indoors						
Needs aid indoors	**4.5 (1.3-15.9)**	2.6 (0.7-8.9)	0.9 (0.4-2.2)	1.3 (0.6-3.1)	**4.4 (1.2-16.8)**	**3.1 (1.2-7.6)**
Limited in <2 walking ADLs						
≥2 walking ADLs	**4.8 (1.3-18.1)**	1.8 (0.4-7.2)	1.7 (0.6-5.0)	2.1 (0.8-5.8)	**4.6 (0.98-21.6)**	**4.9 (1.6-15.5)**
Climbing stairs At least 1 flight/day						
Cannot or < 1/day	**16.3 (3.7-71.3)**	1.9 (0.6-6.8)	1.7 (0.6-4.5)	1.3 (0.6-3.1)	**3.5 (1.04-11.8)**	**3.2 (1.3-7.9)**

8.5.2.6 Observed mobility in functional testing

Higher levels of performance in the physical function tests were associated with lower odds for unfavourable fall sequelae and other follow-up outcomes, almost without exception (see Table 8.5.2.6). Gait speed, in a timed eight foot walk at a comfortable pace, was the test most highly predictive of most outcomes – failure to get up, hospital admission and death. Chair standing also showed a strong relation to these and also to moving into care. The test that Chapter 7 showed was most predictive of falling – taking five steps or more to turn 180˚ – only significantly predicted mortality, though its direction and scale of effect on other measures was comparable.

It is noteworthy than the only two exceptions to the pattern of lower risk with higher functional performance, both non-significantly raised odds of a fall-related hospital stay, were associated with successfully attaining the lowest levels of the two dynamic balance tests – functional reach and the 180˚ turn (see Chapter 9 for discussion of possible implications).

Caution is needed drawing conclusions from the first two sets of analyses (inability to rise from the floor and resultant long lies) that take less than half the full sample because only 53 people (9 men and 59 women) out of the 90 who had functional tests fell during follow-up. However, this 59% is no different from the 60% of the full sample who fell.

Odds ratios could not be obtained for some outcomes that did not arise amongst those with higher levels of performance, the longest stance in the most difficult static balance position (10 seconds tandem stand), functional reach further than the lengthier cut-points and hand grip strength higher than the male mean.

Table 8.5.2.6 Observed mobility in functional testing in relation to the consequences of falls

	Unable to get up Unadjusted OR (95% C.I.)	Long lie on floor Unadjusted OR (95% C.I.)	Hospital stay due to a fall Unadjusted OR (95% C.I.)	Hospital admission Unadjusted OR (95% C.I.)	Moved to care home Unadjusted OR (95% C.I.)	Deceased by study end Unadjusted OR (95% C.I.)
TUSS 60 seconds Unable Able	0.3 (0.1-1.5)	0.9 (0.2-3.1)	0.8 (0.3-2.2)	0.7 (0.3-1.8)	**0.2 (0.1-0.6)**	**0.3 (0.1-0.7)**
Side-by-side 10 secs Unable Able	0.6 (0.1-2.5)	0.8 (0.2-2.8)	0.9 (0.3-2.6)	1.0 (0.4-2.4)	0.4 (0.1-1.4)	**0.2 (0.1-0.6)**
Semi-tandem 10 secs Unable Able	**0.2 (0.04-0.65)**	0.8 (0.2-3.2)	0.6 (0.2-1.8)	0.6 (0.2-1.5)	0.3 (0.1-1.3)	**0.4 (0.1-0.99)**
Tandem 3 seconds Unable Able	0.2 (0.1-1.01)	0.6 (0.1-3.4)	0.6 (0.2-2.5)	0.8 (0.3-2.6)	0.4 (0.1-2.1)	0.3 (0.1-1.2)
Tandem 10 seconds Unable Able	0.1 (0.01-1.5)	No-one who stood feet in tandem for 10 sec.s suffered a long lie on floor	No-one who stood feet in tandem for 10 sec.s stayed in hospital due a fall	No-one who stood feet in tandem for 10 sec.s had any hospital admissn	No-one who stood feet in tandem for 10 sec.s moved into care	No-one who stood feet in tandem for 10 seconds died
1 chair stand Unable Able	**0.2 (0.1-0.8)**	0.7 (0.2-2.5)	0.4 (0.1-1.4)	**0.3 (0.1-0.9)**	**0.1 (0.03-0.7)**	**0.2 (0.1-0.5)**
5 chair stands Unable Able	**0.2 (0.04-0.7)**	0.4 (0.1-2.0)	0.5 (0.1-1.6)	0.4 (0.1-1.1)	**0.2 (0.04-1.01)**	**0.2 (0.1-0.7)**
F. reach>15cm Unable Able	**0.2 (0.05-0.7)**	0.4 (0.1-1.8)	1.3 (0.4-3.8)	0.7 (0.2-1.9)	0.4 (0.1-1.8)	**0.3 (0.1-0.9)**
F. reach>20cm Unable Able	0.3 (0.1-1.5)	No-one with a functional reach >20cm suffered a long lie on floor	0.7 (0.1-3.4)	0.4 (0.1-1.9)	No-one with a functional reach >20cm moved into care	0.1 (0.01-1.1)
180˚ no support Unable Able	0.5 (0.1-1.7)	0.7 (0.2-2.5)	1.2 (0.4-3.1)	0.8 (0.3-2.0)	0.3 (0.1-1.07)	**0.2 (0.1-0.6)**
180˚ <5 steps Unable Able	0.2 (0.04-1.05)	0.4 (0.04-3.5)	0.6 (0.2-2.3)	0.5 (0.2-1.7)	No-one who could turn 180˚ in < 5 steps moved into care	**0.2 (0.04-0.8)**
Walks ≥0.6m/sec Unable Able	**0.1 (0.02-0.66)**	No-one with gait speed >0.6m/sec suffered a long lie on floor after fall	0.2 (0.02-1.5)	**0.1 (0.01-0.9)**	0.2 (0.03-1.9)	**0.1 (0.01-0.8)**
Grip strength Below mean for men Above mean for men	No men with grip strength above mean could not get up after a fall	No men with grip strength above mean suffered a long lie on floor	No men with grip strength above mean stayed in hospital due a fall	0.3 (0.02-3.5)	1.3 (0.1-25.9)	**0.3 (0.1-0.9)**
Grip strength Below mean women Above mean women	0.3 (0.05-1.6)	0.3 (0.1-1.4)	0.7 (0.2-2.1)	0.9 (0.3-2.4)	0.4 (0.1-1.5)	0.4 (0.1-3.3)

8.6 Summary: the consequences of falls

The 265 falls reported during a year's follow-up of 110 people aged over 90 years old were not minor incidents. They usually involved serious consequences for the older person themselves and other people (see summary points in the following boxes). Chapter 9 discusses the findings of this chapter along with results from the previous two chapters on recalled falls and prospectively recorded falls during follow-up, relating them to each other and putting them in the context of previous research results.

Summary points

Immediate consequences of falls

- Four out of five people who fell were unable to get up without help on at least one occasion. A third of those who couldn't get up from a fall were on the floor over an hour, and in the majority of these cases it was many hours before help arrived.

- Over 4/5 of falls occurred when the person who fell was alone. Despite widespread access to emergency call systems, call alarms were activated to summon help to only a fifth of falls alone from which the person who fell could not get up.

- Fracture rates amongst women were high – one in ten of the women who fell during a year's follow-up – and these were predominantly hip fractures. Although three-quarters of fall injuries were bruises or swellings, a fifth of "minor" injuries were painful for over a fortnight, and more than half of those who fell needed some form of treatment.

- Whilst family or other carers were usually aware of the falls, more than half the falls never presented to health service attention.

Subsequent sequelae of falls

- Two-thirds of all hospital admissions during the year after interview were due at least in part to falling, of which two-thirds were specifically due to falling. Frequency of admission and length of stay were both significantly higher amongst those who fell during follow-up.

- One in seven of those not already living in residential or nursing homes moved into long-term institutional care within a year of interview and falling played a part in the majority of these moves.

- Causative links between falls and subsequent deaths are often difficult to establish. Analyses of the current study's high mortality rates in relation to falls measures, without linking particular falls to deaths, did not detect any clear pattern of association. However, when a fall contributed to a hospital stay, one third of those admitted died in hospital and a further fifth died on average seven months after discharge from hospital to a care home. Deaths within a year of moving into long-term care were higher if falling had prompted the move.

Factors predictive of serious consequences of falls

- Some sequelae of falls, for example inability to rise from the floor, can be predicted by factors that also predict falling
- Stronger predictors include severe cognitive impairment, a history of more than one fall in the past year, being worried about falling, self-rated health and many measures of both reported and observed mobility.

CHAPTER 9

FALLS AND THEIR CONSEQUENCES IN EXTREME OLD AGE: DISCUSSION

9.1 Estimates of falling
9.2 Findings in the context of study methodology
9.3 Circumstances of falls
9.4 Consequences of falls
- 9.4.1 Immediate consequences of falls during follow-up
- 9.4.2 Subsequent sequelae

9.5 Risk factors
- 9.5.1 Socio-demographics
- 9.5.2 Subjective perceptions of falling and fall history
- 9.5.3 Physical and mental health
- 9.5.4 Mobility

9.6 Overview

This chapter draws together the results presented in Chapters 6, 7 and 8 on recalled falls reported at interview, falls reported during subsequent follow-up and the reported circumstances and consequences of falls. The discussion addresses methodological issues highlighted by the comparison of retrospective and prospective data, and sets the findings in the context of other previous research.

9.1 Estimates of falling

Intensive prospective data collection following-up all participants in the 2002-3 CC75C survey found 60% of these over-90-year-old men and women fell at least once in the year after interview, 45% of the sample fell more than once and the incidence rate was 277 falls / 100 person-years.

Few other studies have reported fall prevalence specific to the oldest old (see Chapter 1, Tables 1.2.4.1.1 and 1.2.4.1.2). The two "old old" studies that have reported falls, with recalled data only, each found very similar proportions had fallen at least once in the year before interview: 45% of the men and women in the Umeå 85+ study[88], and 44-49% of the Leiden 85-plus Study women at first and second interviews[94]. Thus the CC75C findings are between a fifth and a third higher than recorded in these slightly younger cohorts. Cross-sectional and prospective studies of a broader age-range of older people that have presented age-specific results report the proportion who fall each year as between 35% and 51% of people aged 85 or more[3;94;137;138], and between 29% and 41% of people aged 80 or older[137;139;143;147;149;151;179;239] except in one small volunteer study that reported annual fall prevalence as 58% based on only 12 individuals aged over 80[171;224].

Estimates of repeated falling – more than one fall in a year – range from 14% to 29% in the couple of studies that have reported these proportions for age-bands over 80-years-old[143;147], even the higher figure only two-thirds of the proportion of recurrent fallers in CC75C.

Annual fall incidence rates have also rarely been reported for very old people. The Montreal study reported identical rates for men and women aged 80 or older (65.9 falls / 100 person-years)[143], notably lower than in New Zealand's Dunedin study[142;205] which did not report sex-specific rates but broke down their over-80-year-olds into three age-bands: incidence rose from 94 to 152 falls / 100 person-years between the 80-84 years and over-90s age-bands (see Table 1.2.4.1.2). This puts the CC75C incidence at over 80% higher than the previously reported rate for nonagenarians.

Thus the current study's prospective findings add important new data to what is known to date about falling in old age, revealing both prevalence and incidence are markedly higher that has previously been reported. Methodological differences between CC75C and other studies make it difficult to be sure that these higher rates are entirely due to the older age range, and the following section discusses the effects of study methods on the findings and their interpretation.

9.2 Findings in the context of study methodology

Prospective and retrospective reports of falling
Period of reporting effects on fall estimates
Consistency of reporting falling
Potential under-reporting of falls
Effects of mortality on fall estimates
Sources of information on falls

Prospective and retrospective reports of falling

Fall reports gathered prospectively found 60% of the CC75C study participants fell in the year after interview, closely matching the proportion who remembered falling in the year before interview (58%). However, recalled falls may under-estimate the extent of repeat falling. Three-quarters of the study participants who fell, or 45% of the full sample, had more than one fall during follow-up, but only a third reported having fallen more than once in the previous year.

Not many other studies have reported both retrospective and prospective falls data from the same sample, but two published studies that identified both showed a trend in reporting repeated falls in the opposite direction to CC75C data. In the Australian Randwick Falls and Fractures study more women aged ≥65 years recalled falling at least twice in the previous year than fell at least twice during the follow-up year (20% vs. 13%)[162;232], and similar differences were found in the Netherlands amongst men and women aged ≥70 years in a general practice survey from Maastricht (26% vs 16%)[182]. The Australian study found slightly higher fall prevalence in follow-up than recall, while the Dutch study reported the opposite, but both samples were of only a few hundred people, too small for these differences to be significant. The Leiden 85-plus Study found minimal difference between the proportions of women who reported at least one fall at first interview (49%) and a year later (44%), as would be expected since both these measures relied on recall[94].

Period of reporting effects on fall estimates

It has long been known that the proportion of people who report past falls varies with the length of recall period questioned, with shorter intervals not necessarily providing the most accurate recall[167]. Because different recall periods were used in different interview waves of the CC75C study, the current survey gathered data in a format that allowed measurement of different recall time periods – 1, 3, 6 and 12 months. The time

lapsed since the last recalled fall was also recorded, this longer time frame revealing that a fall within the previous five years was remembered for 87% of the participants. As expected, the percentage remembering falls rose with longer time intervals but, as found in the EVOS study[228;235], prevalence does not increase in proportion to length of recall period.

The fact that the prevalence of falling appears lower but incidence appears higher for shorter periods of retrospective recall (see Table 6.4.3.4) can be interpreted in different ways. It is plausible that falls which happened longer ago are less likely to be remembered, particularly non-injurious falls (see section 9.5 below). Certainly in the current study the time lapsed since a "near fall" was generally short, suggesting these were often dismissed as unimportant and soon forgotten. On the other hand, it could be that people remember falls as having happened more recently than they actually did.

Recall interval is also relevant when comparisons are drawn with falls reported from previous prospective studies, not all of which used daily recording in fall calendars. A Japanese study illustrated how differential follow-up methods affected reporting: the prevalence of falling during a year in three comparable groups of men asked about their falls every month, every three months and just once at the year end was 21%, 16% and 6% respectively, though no such pattern was found amongst women followed-up with the same three methods (26%, 18% and 21% respectively) [215]. Markedly lower reporting of recalled falls than follow-up falls by men but not women has also been noted elsewhere[819], but this gender distinction was not found in CC75C.

Consistency of reporting falling

A recent systematic review of falls monitoring[140] took prospective data collection using on-going monitoring by weekly or monthly calendars as their recommended criterion standard, though the authors found insufficient evidence to advise what time interval was optimal. This review concluded that recall methods could be highly specific (91-95%) but less sensitive (80-89%) than prospective. The broad concordance between retrospective and prospective findings shown in the few studies described above, and close agreement found in the current CC75C survey, would fit these conclusions. However, it is important to remember that, even where similar proportions of people falling are reported for pre- and post-interview periods, these figures will not

necessarily represent the same individuals. The Gloucestershire Longitudinal Study of Disability[184] reported that, across three years of GP checks on over-75-year-olds' health and disability, falling was the measure most inconsistent from year to year: about 70% of people who had reported a fall in the previous three months no longer reported recent falls at the following year's interview, while 11% of those who had reported no fall became new reporters of falling. Such discrepancies are particularly large for shorter recall times but the same point applies to longer periods as well.

Potential under-reporting of falls

Falls follow-up methods were intensive with telephone follow-up covering those who missed returning one of the weekly calendar pages or who decided they preferred telephone to postal reports. Nevertheless, the possibility that there was under-reporting of some falls cannot be ruled out. Over-reporting is far less likely as the detailed accounts taken of each fall ensured that in the very few cases where the same fall was mentioned twice this was soon detected. If there was significant under-reporting, the prevalence of falling could be even more widespread than found and falls incidence rates even higher. The impact of possible under-reporting on the risk estimates for different potential predictors is harder to assess, particularly when unmeasured circumstances may underlie hidden reasons for not revealing a fall[210;216;217]. Recall bias is an expected source of under-reporting in any study, is an anticipated problem in falls studies[167] and in the age-group of this population cognitive impairment is a likely reason for forgetting falls[140]. The most cognitively impaired in this study all had proxy informants reporting on their behalf, but they themselves may not always have been aware of every fall. There is more scope for under-reporting from those with milder impairment, not all of whom had a proxy source. If falls amongst this group were missed, the results presented may under-estimate the association of mild cognitive impairment with falling.

Effects of mortality on fall estimates

All analyses of prospective falls data included four people who died less than 8 weeks after interview, all with no reported falls, contributing a total of only 0.3 person-years of follow-up. Although incidence rates are clearly unaffected, and therefore also relative risk estimates, this approach may under-estimate the prevalence of falling because the true denominator was lower for most of follow-up period.

Conversely, as discussed in Chapter 7's section 7.4.2 *Repeated falling*, the inclusion of multiple falls by a small minority of participants shortly before they died gives a higher incidence rate than if these are excluded, but does not affect prevalence. Other studies have also described such 'clustering' of falls prior to death[187].

Sources of information on falls

A systematic but flexible approach was needed to maximise data collection for the current study, especially in the prospective phase and, since a combination of respondent and proxy information was used, attention was paid to tracking the source of fall reports. Study participants who were able to continue reporting for themselves proved as reliable as proxy informants with follow-up falls reports, but changing circumstances often intervened. People who had stayed in full-time education beyond school leaving age were more likely to report falls themselves and those of non-manual social class, and were more likely to accept the fall calendars and continue using them, a point worth noting given the associations found between these characteristics and falling.

9.3 Circumstances of falls

Falls or people who fell
Location and timing
Activities, explanations and un-witnessed falls

Falls or people who fell

Prospective data collection allowed more detailed gathering of information about the circumstances of falls reported by the very old participants in the latest CC75C survey than it was possible to collect retrospectively. Fall circumstances presented in Tables 6.5.1.1 in Chapter 6 and Table 7.5 in Chapter 7 are therefore not directly comparable, as the retrospective fall details use only data describing a single most recent recalled fall before interview, whereas Table 7.5 includes all the follow-up falls. Thus percentages given for the recalled falls in effect represent the proportion of people who experienced the circumstances described, whereas percentages shown for the prospective data indicate the proportion of falls that fit each description. Both measures are informative but it is important to be aware of which approach other researchers have taken before making comparisons with earlier findings. When considering the consequences of falling (see sections 6.5.2-3 and Chapter 8), in public health terms it is arguably more important to measure the proportion of people who fall and thereby suffer injuries or other events, rather than the proportion of falls that lead to these.

Location and timing

Prospective data are not tabulated for the number of "fallers" affected by each circumstance, but broadly similar proportions in recalled and follow-up reports fitted key descriptors, including timing and location. The predominance of day-time falls is in line with reports from injury surveillance studies that three-quarters of falls for which the time was known happened during day-light hours[201]. In line with some previous findings[201;572;734], indoor falls happened most frequently in the rooms where people spend most time (bedrooms and living areas) rather than in the areas often viewed as most hazardous (bathrooms and stairs). However, the overall proportion of indoor falls is far higher than other studies have reported – more than 9 out of 10 falls compared with, say, 60% in a study of over-75-year-olds[226] – but previous research has suggested that the ratio of indoor to outdoor falls increases with age[145;223]. Men who fell during follow-up were 2.5 times as likely to have fallen outdoors than women who fell, a pattern reported elsewhere too[171;205;236].

Activities, explanations and un-witnessed falls

The descriptions provided by study participants' and their carers' reports during follow-up of how the falls happened were far more informative than interview descriptions that classed the majority of recalled falls as just "accidents". Walking, transferring (usually standing up) and bending down were the activities most frequently reported as preceding a fall, everyday actions rather than risky tasks as the literature has suggested[437 272;573]. It was beyond the scope of the study to assess the contribution of home hazards or other environmental risk factors to the falls reported.

A fifth of follow-up falls were still of unknown explanation, similar to the quarter of last recalled falls so described. This is hardly surprising given that in a staggering half of prospective fall reports the person had been "found on the floor". Four-fifths of all the prospectively recorded falls happened when the individual was alone, predominating regardless of place of residence. It has been reported that recovery from a fall is poorer if no-one is present at the time[335], and there is a suggestion that living alone increases the risk of fall-related injury[275].

9.4 Consequences of falls

9.4.1 Immediate consequences of falls during follow-up
9.4.2 Subsequent sequelae

The summary findings from a year's prospective monitoring of the consequences of falls in advanced old age are sobering (see Chapter 8, section 8.7). Not only are the prevalence and incidence notably higher than previously reported for very old people (taking younger definitions – over 75, 80 or 85), but the over-90-year-old men and women in the current study were more likely to suffer serious consequences as a result of these falls.

9.4.1 Immediate consequences of falls during follow-up

Inability to get up and summoning help
Injuries and presenting to health services

Inability to get up and summoning help

Four out of five people who fell were unable to get up without help on at least one occasion, even higher than the three-fifths who recalled at interview having such difficulty when they last fell. This far exceeds reported levels of difficulty in the published literature regarding younger old people in which up to a quarter could not manage to get up in clinic test situations[297-299] and between a third to a half could not when they fell in the community[168;300;301]. Both recalled and prospective data in the current study showed that about a third of those who couldn't get up after a fall were on the floor over an hour, although the proportion of total follow-up falls in which this occurred was lower: one in five. The fact that the overwhelming majority of people who couldn't get up had access to a call alarm system but did not use it to summon help raises very important questions for care providers. Only a few studies to date have explored older people's views on assistive technology devices, some reporting overall positive attitudes[820] including specific mention that fall alarms improve confidence[821], but there is also a considerable literature examining reluctance to seek or accept help[822]. Comments from study participants revealed pertinent concerns – "I was afraid that if I called them they'd whisk me off to hospital and I'd probably never be allowed back home again" – and qualitative methods in future research might shed more light on these complex issues.

Injuries and presenting to health services

Caution is always needed with data derived only from recall of past events, but this is especially so in interpreting their reported consequences. There is a natural tendency to remember more serious incidents longer and, as Chapter 6 showed (see Figures 6.4.1 and 6.4.2 in section 6.4), injurious falls were reported from earlier before interview than non-injurious falls. The fact that in the retrospective fall data fractures (27%) were reported as a slightly more common fall injury than a "cut or laceration" (23%) may be an illustration of this tendency to forget minor injuries. Thus, retrospective data are not a reliable method of assessing the prevalence of major injury or hospitalisation as a result of a fall.

The percentages of falls during follow-up that resulted in injuries (38%), minor or major, are towards the upper end of previously reported ranges, but the proportion of people injured on at least one occasion is higher (68%). Although three-quarters of fall injuries reported during follow-up were bruises or swellings, a fifth of "minor" injuries were painful for over a fortnight. More than half of the people who fell needed some form of treatment for at least one fall, higher than other studies have reported (see Chapter 1, section 1.2.4.4 *Implications for health and social care*). However, the finding that more than half of all the falls, and nearly a third of falls leading to injury, never presented to health service attention also has important implications for service providers. The classic Scottish primary care study[823] that revealed over 40 years ago how unaware GPs were of the extent of disability and other health problems amongst their older patients is as relevant today, given that government indicators of fall-related accidents are necessarily based on data for injuries sufficiently serious to trigger a visit to a medical practitioner[824].

In marked contrast to the reported small percentage of falls that result in fracture and only 1% of falls that lead to hip fractures by older people aged 65 or more[180;271;283], one in ten of the women who fell in the CC75C prospective follow-up study sustained a fracture: four women with five hip fractures plus two more with upper arm fractures. Although the CC75C survivor study sample is clearly too small to consider fracture endpoints, it is worth noting that these rates are seven times those reported amongst Dutch women aged over 70 years[825] and the incidence of any non-vertebral fracture far exceeded the rates amongst Finnish community-dwelling and even institutionalised over-80-year-olds[206].

9.4.2 Subsequent sequelae

Hospital admissions
Moves to care homes
Mortality

Hospital admissions

Two-thirds of all hospital admissions during the year after interview were due at least in part to falling, of which two-thirds were specifically due to falling, and a quarter of the people admitted for non-fall-related reasons then fell while in hospital. The proportion of people admitted and the frequency of admission were both significantly higher amongst those who fell during follow-up than those who reported no falls, the most striking differences being in length of stay (mean 28.8 days vs. 4.8 days). There are many complex inter-related factors that determine the likelihood of hospitalisation for any health event in old age, when social factors such as the availability of support at home, multiple co-morbid conditions and cognitive status all contribute to a decision on the need for admission as well as the timing and destination of discharge[826]. These complicate the interpretation of the study findings regarding hospitalisation during the follow-up period and raise questions about the classification of fall-related admissions, admittedly not always clear-cut. It has long been recognised that going into hospital in itself poses risks of health complications for the very elderly, frail or cognitively impaired[338] that could confound measures such as length of stay, but for older people who are admitted because of a fall in particular increased disability risk has been reported[339]. Other previous studies have found, as shown in the CC75C results, that admissions due to falls as well as falls while in hospital are associated with increased length of stay[198;199;252;253] and more often lead to discharge into institutional care[253].

Moves to care homes

Chapter 4's description of the sample population showed graphically in Figure 4.3.5.8 how more than half the people already living in a care home when interviewed, and nearly half those in sheltered housing, reported at interview that a fall had prompted their move there, just slightly higher than previous reports[132]. Within a year of interview one in seven of those not already living in residential or nursing homes moved into long-term institutional care and the proportion rose to a fifth with longer follow-up to the administrative censoring date at study end; falling played a part in the majority of these moves (see Figure 8.4.2.1 in Chapter 8). The Canadian Study of Health and

Aging reported a third of their over-85-year-olds had moved into care by the five year follow-up[827] suggesting rates continue to rise with longer monitoring. The current study's findings fit previous reports of the greatly increased risks of admission to care associated with falls[155;177;184] (see Chapter 1, section 1.2.4.4).

Mortality

The complexities of assigning a fall as a "cause of death" are discussed in Chapter 8's section 8.4.3.1 prior to the presentation of follow-up mortality data in section 8.4.3.2 . Comparisons with mortality in other previous studies are also difficult given the far greater age of the current study sample. No differences were found in the proportions of people who died during follow-up when comparisons are made between those reporting no falls (in the year before or after interview), any falls or repeated falls. The shorter time to death found for non-fallers (see section 8.4.3.2) could in part be a consequence of those who died early on in follow-up having a shorter period at risk of falls monitored in the study. It could also be hypothesised that falling becomes less common amongst those closest to death, perhaps with mobility so decreased that exposure to falling risk is less. The suggestion of slightly increased mortality associated either with falling longer ago (recalled falls) or with a longer analysed exposure time (censoring at study end) raises the hypothesis that a fall may mark the start of a period of decline towards death longer than the one-year data could detect.

9.5 Risk factors

9.5.1 Socio-demographics
9.5.2 Subjective perceptions of falling and fall history
9.5.3 Physical and mental health
9.5.4 Mobility
9.5.5 Adjusting for confounding covariates

In general there was surprising consistency between the factors found to be associated with retrospectively recalled falls and those predictive of prospective measures of falling. Some of these factors also predicted some of the serious consequences that were reported to result from falls in the follow-up period, in particular the inability to get up from the floor after a fall. However, other considerations have more of an influence on the less immediate outcomes: the availability of help is more relevant to the chances of suffering a long lie than any intrinsic risk factor, social circumstances greatly influence admission to hospital or long-term care, and the over-riding effect of short life expectancy in the tenth decade clearly drives the mortality patterns observed.

9.5.1 Socio-demographics

Age and sex
Place of residence
Education and social class

Age and sex

The age range of the participants was only 15 years, far less than the three or four decades that may be covered in studies of old people starting from 65 years and up, so the minimal effect on fall rates of age differences across the study sample is hardly surprising. However, as discussed in section 9.1 above, all measures of falling were found to be markedly higher in this sample of advanced age than previous studies have reported for even those just a decade younger.

The lack of clear gender effect on falls fits with data from previous waves of CC75C interviews: earlier in the study, when the age-range was broader, women recalled recent falls more than men in younger age-bands but equally with men when aged over 90[732]. Other studies have reported no differences in fall incidence rates for men and women over 80 years[142;143;205;236], nor in the prevalence of falling in this age-band from other cross-sectional surveys[3;137].

Place of residence

While one study has suggested that the need for a carer was more strongly related to falls risk than place of residence[184], most studies have found far higher prevalence and incidence of falls in institutional settings (see Chapter 1, section 1.2.4.1 *Falls frequency estimates in different populations*). This was clearly born out in the CC75C study results. Interestingly both retrospective and prospective data showed a pattern of raised fall risks amongst people living in sheltered accommodation that appears to be even slightly higher than the risks in long-term care homes. Comparisons with other studies on this point are difficult given cross-national differences in housing and care provision with wide variation in what terms such as "apartments for the elderly", "hostels" and "sheltered housing" mean in different countries. The fact that communal settings with higher care support include many residents with the most severely impaired mobility, and thus likely to have a reduced fall risk, lends support to the finding that "transitionally frail" people in less supported sheltered schemes may well have a higher risk level.

Education and social class

Although there is limited evidence that hospital admission rates for falls[828] as well as fracture rates[829] may be higher from socio-economically deprived areas, and hip fracture mortality is higher in manual social classes[295], few studies have examined the relation between educational level and falls risk, there being no obvious aetiological association. Lower school leaving age was identified as an independent risk factor for falling in the Australian Longitudinal Study of Ageing[608], but Swedish studies have found no link with either falls[830] or hip fractures[831], while one Dutch study reported that lower educational level was associated with marginally increased risk of falling but significantly decreased risk of recurrent falling[227].

Higher falls risk is associated with more years of full-time education in the current study, even when adjusted for confounders. This unexpected finding has also been reported in one other study whose authors also found no other previous work suggesting a link: recurrent falling was more common amongst men and women with more than 11 years of schooling in the Longitudinal Ageing Study Amsterdam (LASA): OR 1.36 (95% C.I. 1.04-1.77), a factor that remained in their multivariate model as well[357;832]. It

might be hypothesised that this could be an artefact of differences in reporting of falls during follow-up, and it is interesting to note that the CC75C study used very similar fall calendars to LASA's. Whether the same argument might explain a similar effect associated with non-manual versus manual social class is open to debate. More people who had attained a higher level of education reported their own falls, and this proportion amongst those of non-manual social class was double that from manual social classes by the end of follow-up. If this were to explain the effects of education and class on falls the explanation would be premised on self-report being more accurate than proxy-report. Stratified analyses found no association between education and falling amongst people with recurrent past falls, perhaps suggesting that individuals with more schooling for whom falling was a new problem took particular care to report their falls. The issues are complex and exploration of these data cannot provide a full explanation.

By contrast with the increased falls risk, the effects of more years schooling and non-manual social class on other outcomes during the follow-up period is generally to reduce risk. Whereas education was more strongly related to falls than social class, it showed no significant association with any other outcome measure. Even in the 10th decade of life or more, non-manual social class reduced the mortality during follow-up by 50%.

9.5.2 Subjective perceptions of falling and fall history

Perceived problems with balance
Fear of falling
Recalled falls in the past year

Perceived problems with balance

Half the study participants described themselves, or were described by a proxy informant, as having a "tendency to fall" and four-fifths were said at interview to be "unsteady on their feet". The extent of these difficulties was said to be disabling for the majority who reported these problems. Each of these highly prevalent characteristics were strongly related in univariate analyses with both retrospective and prospective fall outcomes. It may at first appear surprising that such ill-defined lay terms show such strong associations, but other researchers have also found self-reported balance

problems both to distinguish recent fallers from non-fallers and to predict subsequent falls. Similar terms reported in the literature as showing these relationships include "balance difficulty"[833], "self-reported imbalance"[391], "frequent balance problems while dressing"[158] and the equivalent "self-reported tendency to fall"[830].

Fear of falling

A third of the participants asked reported being worried about falling and there was broad variation in the levels of confidence about ability to manage daily activities without falling. However, the proportion who said they were worried rose to almost half of the people who recalled more than one fall in the previous year and two-thirds of those who remembered falling at all last year. The extensive literature on the associations between fear of falling, activity limitation for fear of falling and actually falling is described in Chapter 1, section 1.2.4.2 *Psychological and social consequences*, but the debate continues as to which comes first[333]. The current findings are also open to interpretation in more than one way as it was beyond the scope of the study to accurately evaluate activity restriction following falls. What is striking are the strong associations between participants' reported worry about falling and some of the serious consequences of falling that older people seem to worry about most[317;834] – at least 4- to 5-fold increased risks of admission to hospital or long-term care – sadly suggesting that these concerns may often be well justified.

Recalled falls in the past year

A history of falling stands out among the univariate analyses as one of the factors of prime importance in determining risk of subsequent falls, with "repeated falls in the past year" more highly predictive than just recalling having had "at least one fall". It is noteworthy that this effect is so clear-cut despite the data relying on only recalled falls rather than documented falls. However, the multiple variable regressions using key potential predictors altered the importance of fall history showing that, although the fall risks associated with many factors varied depending on previous fall status, having suffered recurrent falls in the last year had little effect on overall risk level when adjusted for other factors (see Chapter 7, section 7.6.7 *Adjusting risk estimates for the effects of covariates*, section 9.5.5 *Adjusting for confounding covariates* below in this chapter and further discussion in Chapter 11).

9.5.3 Physical and mental health

Chapter 1.2.5 reviewed the literature to date on a wide range of health conditions that have been shown to be potential risk factors for falls. This guided the selection of factors that could be assessed within the current study, not all of them possible in these data. Chapters 6.6 and 7.6 present these in relation to falls, and Chapter 8 in relation to other outcomes. Several of the factors selected to model the effects of potentially confounding covariates because of their strength of association with falls, were also most predictive of other outcomes. For example, limited mobility ADL function – indeed almost all the reported mobility variables – strongly predicted inability to get up, transfer into long-term care and death.

Incontinence and severe cognitive impairment predicted a similar cluster of serious sequelae during follow-up, except that incontinence was more weakly predictive of moving into care, perhaps a reflection of the extent to which this is still a hidden condition. Although incontinence appears to strongly predict falls in the current study, it has been argued that it is difficulty with toileting rather than incontinence itself that may be a contributory cause of falling[521]. A further hypothesis is that, as indicators of frailty, incontinence and falls share common predisposing factors, that may also be shared with other characteristics such as cognitive impairment found to classify a risk group.

Cognitive impairment also predicted 'long lies', the only factor found to do so and most likely indicating that the most cognitively impaired are the least likely to summon help when they cannot get up. A pattern of decreased fall risk has been reported amongst nursing home residents at the most severely affected extreme of cognitive impairment[451], that the current study did not detect perhaps because of the choice of too broad a classification of severe impairment.

By contrast, having multiple co-morbid conditions – a strong fall predictor – was not significantly associated with hospitalisation, moving into care or death, while self-rated health was a powerful predictor.

There were no clear effects of any medication variables – either multiple prescriptions or taking one of the "culprit drugs" – but the association found between falls and the use of any of these medications suspected of increasing fall in the last month, although none was found with falls in the last year, might suggest that a shorter time period more closely reflects current prescriptions.

9.5.4 Mobility

Reported and observed measures of mobility
Limitation in walking distance
Use of walking aids
Limited utility of functional performance testing in advanced old age
Static balance tests and dynamic balance tests
Gait speed and hand grip strength

Reported and observed measures of mobility

Mobility factors were assessed in the current study using both reported measures of daily function that depend on mobility levels and observational measures from functional performance testing. Chapter 5 presents results from both of these and describes how closely the interview reports of physical activity and mobility capability or disability were reflected in the physical performance tests, as other researchers have also found[434;634]. It is interesting to note that previous research has found self-reported walking ability to be the most predictive of functional status[815]. Despite this close link between reported and observed mobility, analysis of these measures in relation to falling showed that in general reported mobility gave clearer risk estimates than most of the functional tests. Both tended to show similar direction of effect: in broad terms high mobility function lowered fall risk but, as discussed in Chapter 1 (see section 1.2.5.2 *Muscle weakness, balance, mobility and functional limitation*) the non-linear relationships between mobility disability, physical activity, function and falling are complex. Dichotomous comparisons – able or unable to carry out a given task or test – thus over-simplify the picture.

Limitation in walking distance

The most informative exploration of how mobility relates to falls in the current study came from the categorical variable describing different levels of walking ability using responses to the ADL question about maximum walking distance (see Chapters 6 and 7,

sections 6.6.5.1 and 7.6.5.1). These more detailed breakdowns of mobility levels reveal not only that falling is less prevalent and falls are less frequent in the most mobile, but also that falls are most rare amongst the least mobile. This pattern has been described in other studies that include the very frail, such as residents living in institutions[355;188;191;192;352;438;440;546], but tends to be over-looked in studies of more active community-dwellers that include too few people of such limited mobility to detect this effect. Diagrammatic representations of these data also illustrates why different cut-points in the spectrum of maximum walking distance would be less helpful indicators of fall risk: amongst people who are able to walk at all there appears to be little risk difference between various levels of walking limitation – from being able to go out but not very far to only managing to walk around indoors (see Figures 6.6.5.1.1-4 in Chapter 6, and Figure 7.6.5.1.1 and 7.6.5.2.1 in Chapter 7).

Use of walking aids

Many other studies have reported an association between falling and the use of walking aids[546;149;188;352], but no references were found in the literature to distinguish indoor from outdoor use. As shown in sections 6.6.5.2 and 7.6.5.2 of Chapters 6 and 7, this distinction revealed different patterns (see Figure 6.6.5.2 in Chapter 6, and Figure 7.6.5.2.1 in Chapter 7). The lower effect size of using walking aids indoors than outdoors reflects the fact that those who needed assistance to walk indoors were generally less mobile than those who used the same aid only outdoors, and their immobility reduced their time exposure to falling. Mobility aids are clearly a marker of disability, at times avoided for this very reason[822] despite a therapist's recommending their use to improve balance, and neither walking sticks nor frames are postulated as causative factors. Indeed, one previous study[835] has reported a protective effect of using a walking aid amongst older people with intermediate high activity levels by residential care standards, but this study had more detailed physical activity assessment than the current study gathered so comparison is not possible.

Limited utility of functional performance testing in advanced old age

The consistent pattern shown by the wide range of performance measures assessed indicated that, even in very old age, people who maintain good physical function generally fall less than others. However, only a few tests were significantly associated with recalled fall history, all of them reflecting an element of dynamic balance – single

or multiple chair stands, functional reach and gait speed. Only one of these plus one other dynamic balance test – repeated chair rising and the 180° turn – predicted falls prospectively, and when adjusted for confounding covariates only the 180° turn remained a significant predictor. All the functional measures selected for the current study's test protocol had been shown to predict falls amongst younger old people, except for the Short Physical Performance Battery (SPPB) as a whole, though its component tests all have been. However, there are other studies in the literature that also found these measures were not useful predictors[159;164;251;313;620;634;635;642].

Almost all the functional tests were highly predictive of mortality, and their direction of effect on other outcomes – care home placement, hospital admissions (any and fall-related), long lies and being unable to get up off the floor – was consistent, although the strength of association was variable. It is noteworthy than the only two exceptions to the pattern of lower risk with higher functional performance, both non-significantly raised odds of a fall-related hospital stay, were associated with successfully attaining the lowest levels of the two dynamic balance tests – functional reach and the 180˚ turn – again supporting the suggestion that a limited level of mobility can increase risks.

Other research groups have recently reported they also found that "the more time-consuming objective functional tests were of limited importance for fall prediction" in a population-based sample of over-75-year-old women, amongst whom falls were better predicted by clinical history and a clinician's subjective assessment of biologic age[830]. The greater predictive value of self-reported function over performance-based measures has also been documented for other outcomes including functional decline and hospital costs[669-671].

Non-linear associations may partly explain why the binary outcome performance tests were not always informative. The SPPB can be scored on a 0-12 scale, however this was not analysed as such because scores in this study sample were all heavily skewed to the lower extreme of the scale. It should also be remembered that 20 people out of the full sample of 110 did not have these functional assessments, and 11of them were those whose interview data came only from a proxy informant – generally people at the frailer end of the spectrum – so the impact of this missing data cannot be discounted.

Static balance tests and dynamic balance tests

The least informative stand test was the one-minute Timed Unsupported Stand (TUSS). Perhaps because even those with very poor mobility could attain success in this test, it showed negligible effect on falls risk. Others have also reported quiet stance does not predict falls[620]. It was found that the higher of the functional reach test cut-points was an unhelpful predictor, the 15 cm cut-point being the most useful, as also reported for over 70-year-olds in a primary care study[182].

Gait speed and hand grip strength

Although walking speed has been widely reported to predict many adverse outcomes for older people including falls[634] (see Chapter 1's section 1.2.5.2 *Muscle weakness, balance, mobility and function*), in the current study the consistent reduction in falls rates did not reach significance but there was a clear relation between gait speed and many outcomes. Others have found gait speed to be related to fear of falling but not falling itself[313], while others have reported that it was related to falling only across the full sample, not in women or in men separately[353]. Grip strength has also been reported to lose its effect if adjusted for age and sex[147], despite other studies finding it to be the factor most strongly predictive of single and recurrent falls[168]. Despite the small number of men in the current study, higher hand grip strength significantly predicted lower male mortality, fall-related hospitalisations, long lies and inability to get up, but the relation to fall measures was significant only for recalled falls in the past year and only in univariate analyses. For women there were no clear cut associations between grip strength and any of these measures.

9.6 Overview

Non-linear risk relationships
The multi-factorial nature of falling

Each of the preceding three chapters ends with a summary of findings that together build up an alarming picture of the extent to which falling affects people in extreme old age (see also Chapter 11, section 11.1 *Brief resumé of findings*). Rates of falls and of serious events that may follow on from a fall are all even higher than has been previously reported for very old people from other research that classified the oldest old to include those a decade or more younger than participants in the current study. This study confirms that falling can be a major problem for older people and those that care for them, impacts hugely on health and social care services and should be of equal concern for policy-makers, planners and service providers.

Non-linear risk relationships

Assessing the risk of falling and the consequences of falls is complex, given that relationships between risk factors and outcomes are not straightforward. Some of the characteristics describing this study's 'old old' sample population were associated with increasing falls risk across categories of increasing disability, though the risk difference could be more stark beyond a certain threshold, for example the severely cognitively impaired appeared markedly more at risk than the moderately impaired. Other factors appeared to be non-linearly related, most notably covariates reflecting mobility, disability and function. Such patterns have been remarked by other researchers before: at the frailest end of the ability-disability spectrum, for instance within the more limited range of function found amongst older people living in care homes, the least able are often found to be at lower risk of falls than those with greater, but impaired, functional abilities[438;440]. For example, the German research group that has pioneered observational and intervention studies in this field reported that for all the multi-categorical Minimum Dataset variables assessed intermediate levels were associated with higher odds for falling and repeated falling than the lowest levels of function[191]. Their refinement of multiple risk factors into a useable falls risk screening algorithm likewise assigned higher risk to those with a history of falling who could get up from a chair without help than to those who could not[192].

The multi-factorial nature of falling

The preceding chapters and discussion above illustrate the multi-factorial nature of falling, with raised risk estimates found to link falls with many of the wide range of factors examined. As the research literature suggests, retrospectively gathered fall reports appeared highly predictive of falls in prospective follow-up of this study sample. Initial modelling pin-pointed a history of falling, and particularly repeated falling, in the previous year as a key predictor, apparently over-riding the predictive effect of many other variables. However, in order to examine possible causal effects 'up-stream' of any previous falls, the analysis strategy followed a method suggested in one of the seminal fall research methodology papers[219] and subsequently followed by a few other researchers[630]. Thus regression models were also constructed omitting the variable "fallen more than once in the past year" from the covariate list, and examining each model's effects on those with and without a history of repeated falls separately. This approach revealed that, when adjusted for other strong predictors, fall history had little effect on the predicted risk of falling. Risk factors that emerged as independently predictive of falls, regardless of previous fall status, included several which could be viewed as markers of generally poor health and functional status – multiple co-morbidity, incontinence, limited mobility and low self-rated health. Other covariates that could also be considered characteristic of frailty – severe cognitive impairment, reported poor balance, ADL limitations and fear of falling – lost significance in multivariable modelling, not surprising given the considerable collinearity in this very old population. The implications of such modelling in practice are discussed further in Chapter 11, section 11.4.2.3

CHAPTER 10

SKELETAL FRAGILITY IN MEN AND WOMEN AGED OVER 90 YEARS OLD

10.1 Introduction

10.2 Methods

10.3 Quantitative ultrasound measures of skeletal fragility

10.4 Factors associated with skeletal fragility

10.4.1 Socio-demographics
10.4.2 Cognitive function
10.4.3 History of falls and fractures
10.4.4 Health and disability
10.4.5 Reported mobility
10.4.6 Reported past mobility
10.4.7 Functional performance tests
10.4.8 Fracture risk indices

10.5 Asymmetry in quantitative ultrasound measurements

10.6 Discussion and summary

10.1 Introduction

This chapter presents the findings from heel ultrasound scans of the majority of the people who took part in the latest CC75C survey. Despite the acknowledged seriousness of rising fracture rates in advanced old age, data on skeletal strength in a population-based sample of this age are rare. The current study aimed to collect these important descriptive data, bearing in mind an underlying hypothesis that very elderly people at high risk of falling are likely to also be those with high fracture risk.

An initial overview of the ultrasound measurements taken describes the skeletal fragility of this sample of very old men as well as women in relation to physical factors that can affect bone strength, and explains the choice of factors included when adjusting subsequent estimates. The ultrasound parameter Broadband Ultrasound Attenuation (BUA) has been shown in other studies to predict fracture risk so in this study was examined in relation to factors that could potentially indicate fracture risk. Many of these factors overlap with the fall risk factors examined in Chapters 6 and 7 so these analyses are presented in a similar order with additional exploration of specific fracture risk factors. Figures throughout this chapter plot mean BUA with error bars indicating 95% confidence intervals around these estimates of the mean. A longitudinal analysis of the relation between present skeletal measures and past reported walking (section 10.4.6) offers a novel approach in the section examining associations. A separate section presents findings of asymmetry between left and right heel measurements that were analysed post-hoc in relation to reported past injuries and long-standing lower limb joint problems. The final section discusses the limitations of using ultrasound results as a surrogate measure given the impossibility of taking fracture as an endpoint in this small sample, and acknowledges factors that could not be addressed in these data.

10.2 Methods

Participants interviewed in the latest CC75C study survey were asked whether, in addition to the standard interview, they would agree to a second visit by the nurse to have some measurements made of "bone and muscle strength, balance, height and weight". With the participants' consent, a portable ultrasonometer (CUBA Clinical) was brought to this next appointment and ultrasound scans of the os calcis were performed in the participant's usual place of residence with this dry system device, as described in detail in section 2.2.2.2 of Chapter 2 *Study Methodology*.

Set up and running the calibration and quality assurance tests allowed participants a short break if desired after the physical function performance tests and time to remove socks and shoes. Depending on the level of assistance required, this and obtaining the repeat scans of each heel required by the protocol usually took between 20 and 30 minutes.

Height and weight were measured prior to scanning (see again Chapter 2, section 2.2.2.2), recorded as required in the scanner software programme. Height data are missing on those unable to stand (five of the women and one of the men scanned), and weight is also missing for those unable to stand unsupported long enough to use standing scales, except in care homes with seated scales (only one of those scanned, a man).

10.3 Quantitative ultrasound measures of skeletal fragility

Recruitment

Most participants interviewed in person agreed to be visited a second time for further study measurements (83/99 or 84%) and the majority of these (78/83 or 94%) consented to have calcaneal quantitative ultrasound scans. This amounted to 79% of those interviewed in person or 71% of all participants in the survey including those with proxy data only (70% of men and 71% of women).

Gender differences in extreme fragility

Table 10.3.1 summarises results from these scans both in units (dB/MHz) of the quantitative measure Broadband Ultrasound Attenuation (BUA) – see section 10.2 *Methods* for further explanation – and, for a more generic measure, with T-scores that provide comparison with the young adult mean. The wide disparity between the sexes is immediately striking (see also Figure 10.6.1 at the end of this chapter which includes these data graphically).

Ultrasound measurements were low in all the women, with mean BUA for women literally half that for men (37.7 versus 78.5 dB/MHz). The corresponding T-scores revealed 86% of the women were -2.5 SD from the young adult mean or lower, and all had T-scores ≤ -1. The proportion of men with T-scores worse than -2.5 SD was about half that of women (43%), and a further 29% of men were in the -1 to -2.5 SD range. These T-score cut-points used by the WHO to define osteoporosis relate to axial DEXA bone density measurements and cannot be directly converted to other modalities or peripheral bone assessment. However, the levels of skeletal fragility found clearly indicate high fracture risk.

Correlations

The scatter graphs in Figure 10.3.2 plot BUA against other continuous measures that previous studies have found related to various bone strength parameters – age, weight, height and body mass index. Summary descriptive statistics for these anthropometric measures are given on the following page in Table 10.3.3, with the next three tables (Tables 10.3.4-6) presenting the strength of the correlations found between them. The inter-relation of these factors merits examination as these informed the selection of

Table 10.3.1 Heel ultrasound parameters: men and women aged over 90 years

	Men [n=14]	Women [n=64]	All [n=78]
Broadband Ultrasound Attenuation (dB/MHz)			
Mean (SD)	78.5 (25.9)	37.7 (16.8)	45.0 (24.3)
Median	76.5	37.1	42.7
Inter-quartile range	61.8 – 97.6	23.4 – 51.7	27.2 – 55.5
Range	42.1 – 127.6	7.2 – 80.2	7.2 – 127.6
BUA T score (SD below young adult mean)			
Mean (SD)	-1.9 (1.4)	-3.4 (0.9)	-3.1 (1.2)
Median	-2.0	-3.4	-3.3
Inter-quartile range	-2.9 – -0.9	-4.2 – -2.6	-4.0 – -2.5
Range	-4.0 – -0.8	-5.1 – -1.0	-5.1 – -0.8

Men vs Women: $p<0.001$

Figure 10.3.2 Scatter plots of Broadband Ultrasound Attenuation against age, weight, height and BMI of men and women aged over 90 yrs old

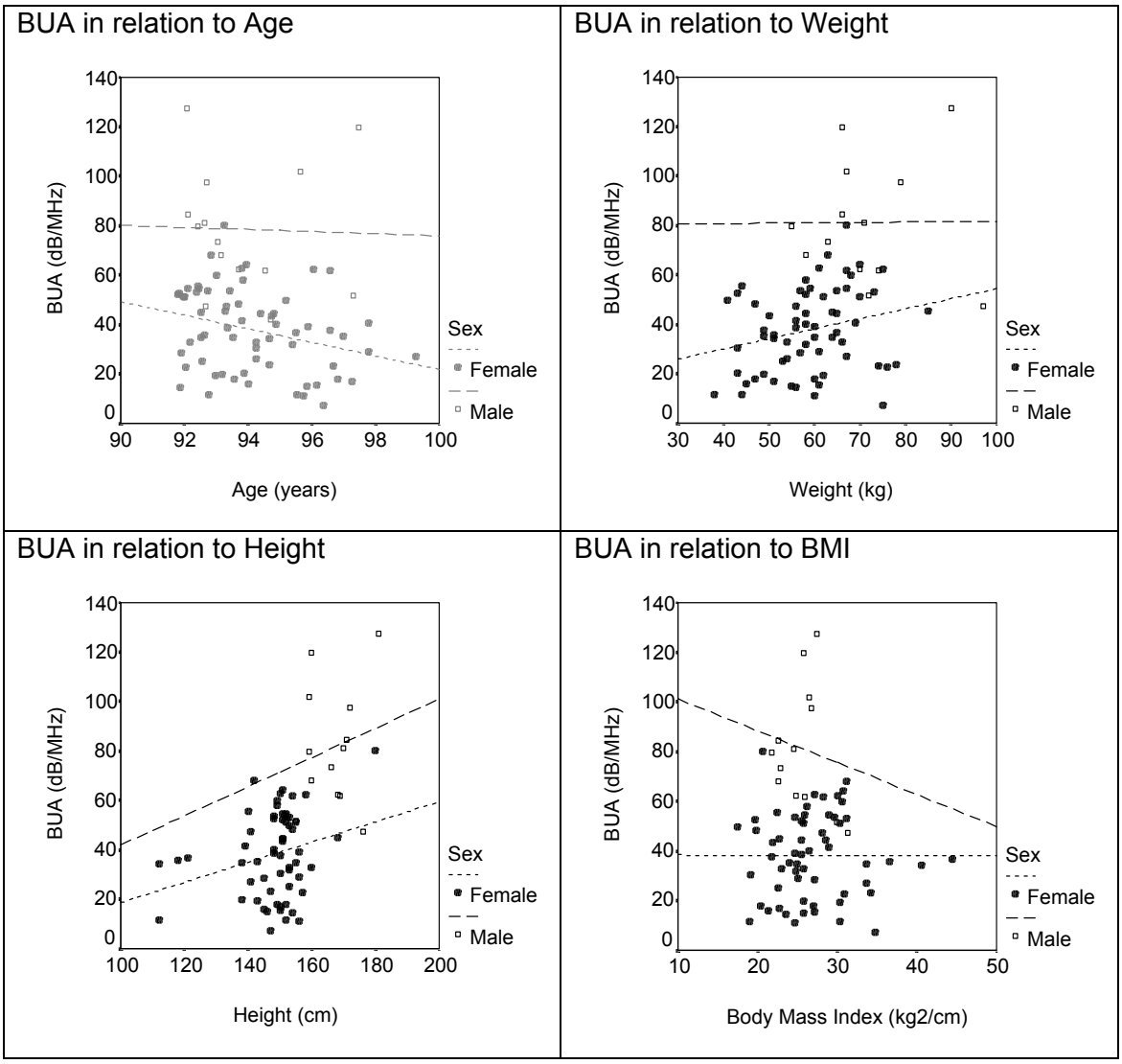


Table 10.3.3 Anthropometry of men and women aged over 90 years old who had quantitative heel ultrasound scans

	Men [n=14] Mean (SD)	Women [n=64] Mean (SD)	All [n=78] Mean (SD)
Age (years)	94.0 (1.8)	94.2 (1.8)	94.1 (1.8)
Weight (kg) *	71.4 (11.8)	58.9 (10.1)	61.0 (11.3)
Height (m) †	1.67 (0.08)	1.48 (0.11)	1.51 (0.13)
Body mass index (kg^2/cm) †	25.6 (2.9)	26.8 (5.2)	26.6 (4.9)

* Weight: n=77 excluding 1 man whose weight could not be measured
† Ht, BMI: n=72 excluding 5 women and 1 men whose height could not be measured

Table 10.3.4 Correlation coefficients for relations between anthropometric and Broadband Ultrasound Attenuation measures of os calcis scans

	Age	Weight	Height	BUA
Age	- - - -	-0.04 NS	-0.11 NS	-0.19 * p<0.05
Weight		- - - -	0.34 NS	0.28** p<0.01
Height			- - - -	0.33** p<0.01
BUA				- - - -

Significance tests derived from non-parametric testing for Kendal's tau-B rank correlation coefficient
Age and BUA measured for n=78, Weight measured for n=77, Height measured for n=72

Table 10.3.5 Correlation coefficients for relations between anthropometric and Broadband Ultrasound Attenuation measures in men

	Age	Weight	Height	BUA
Age	- - - -	-0.09 NS	-0.49 * p<0.05	-0.28 NS
Weight		- - - -	0.51 * p<0.05	-0.09 NS
Height			- - - -	0.13 NS
BUA				- - - -

Significance tests derived from non-parametric testing for Kendal's tau-B rank correlation coefficient
Age and BUA measured for n=14, Weight and height measured for n=13

Table 10.3.6 Correlation coefficients for relations between anthropometric and Broadband Ultrasound Attenuation measures in women

	Age	Weight	Height	BUA
Age	- - - -	-0.03 NS	-0.07 NS	-0.19 * p<0.05
Weight		- - - -	0.20 * p<0.05	0.19 * p<0.05
Height			- - - -	0.11 NS
BUA				- - - -

Significance tests derived from non-parametric testing for Kendal's tau-B rank correlation coefficient
Age, weight and BUA measured for n=64, Height measured for n=59

covariates for which it was necessary to adjust subsequent estimates of the effects of other factors on the skeletal measurements.

The mean age of those scanned was no different from the full sample, and there were only minimal age differences between the men and women scanned (range 92.1-97.5 for men, 91.8-99.3 for women) which are unlikely to account for the slight but significant negative correlation found between age and BUA (Kendal's tau-B -0.19, $p<0.05$ in the full sample and the women, non-significant in the small sample of men scanned).

The men's significantly greater height and weight is clearly driving the significant correlation between these factors and ultrasound parameters. Height and weight correlate with each other in men and women separately but, contrary to the graphic impression given by Figure 10.3.2, when these data are analysed separately for men and women their correlations with BUA only reach significance with weight, and only in women. The relationship matches the strength of association with age in women but with the opposite direction of effect (Kendal's tau-B 0.19, $p<0.05$).

Since the interaction of these factors is complex, regression modelling tested the effects of age, sex and all anthropometric variables (see Chapter 2 *Study Methodology*'s section 2.4.3.5). Other variables relating to the quantitative ultrasound quality assurance protocol were also included in the modelling – any degree of ankle oedema (n=13 had more than slight oedema of either or both ankles but not sufficient to prevent correct positioning of transducers), stockings not removed (n=6 scanned despite this protocol breach for inclusion in within person asymmetry analyses - see section 10.2 *Methods*) and room temperature (median 23º C, IQR 20-24º C). The model developed that provides adjusted risk estimates presented subsequently in this chapter includes these three QA factors, although their effects were slight, along with age, sex and weight.

10.4 Factors associated with skeletal fragility

10.4.1 Socio-demographics
10.4.2 Cognitive function
10.4.3 History of falls and fractures
10.4.4 Health and disability
10.4.5 Reported mobility
10.4.6 Reported past mobility
10.4.7 Functional performance tests
10.4.8 Fracture risk indices

The ultrasound parameter Broadband Ultrasound Attenuation (BUA) is a recognised predictor of fracture risk in populations with a younger age range than those in this latest CC75C survey. The current small sample of cohort survivors and limitations on length of follow-up precluded any attempt to validate the use of BUA for predicting fractures in extreme old age. However, if quantitative ultrasound is still a useful fracture risk indicator in this advanced age-range, it can be hypothesised that other fracture risk factors would be related to bone measurements. Therefore, BUA readings from the 78 men and women scanned in this study were examined in relation to factors that could potentially indicate fracture risk.

Figures in this section illustrate key findings from these analyses with bar charts of broadband ultrasound attenuation (BUA) means by categories of different factors potentially associated with bone fragility and fracture risk. Error bars represent 95% confidence intervals, numbers in each category are shown at the foot of each bar and, where p-values are shown above dichotomous comparisons, these are taken from Wilcoxon's non-parametric rank sum test of equality of means (Mann-Whitney U). Linear regression modelling to adjust for the covariates identified in section 10.3 - age, sex, weight and ultrasound QA variables - was used to provide the crude and adjusted regression coefficients tabulated below each graph. Significance included in the tabulations of linear regression results are from Wald tests, hence p-values that do not exactly match the Mann-Whitney U values shown in some of the graphs.

10.4.1 Socio-demographics

As section 10.3 and Figure 10.4.1.1 show, there were marked gender differences in skeletal measurements, with mean BUA amongst the women approximately half that recorded amongst the men. By contrast, age showed no striking pattern of association with bone fragility over the relatively narrow age-range of the participants scanned in this study (91-99 years), although dichotomising the sample at age 95 showed the mean BUA was lower in the older age-band.

There were stark differences in recorded BUA amongst community-dwelling men and women compared both with those living in care institutions and with those in sheltered accommodation, but the regression coefficients shown in Table 10.4.1.2 show that adjusting reduced this effect by a factor of nearly three.

10.4.2 Cognitive function

The clear trend of worsening skeletal fragility with decreasing cognitive function showed BUA lower amongst those with severe cognitive impairment to a similar extent as the differences found between people in different residential settings. Again adjusting for confounding reduced the strength of association, with the regression coefficient in this case halved (see Figure 10.4.1.1 and Table 10.4.1.2).

Figure 10.4.1.1 Skeletal fragility measured as broadband ultrasound attenuation in relation to age, sex, place of residence and cognitive function

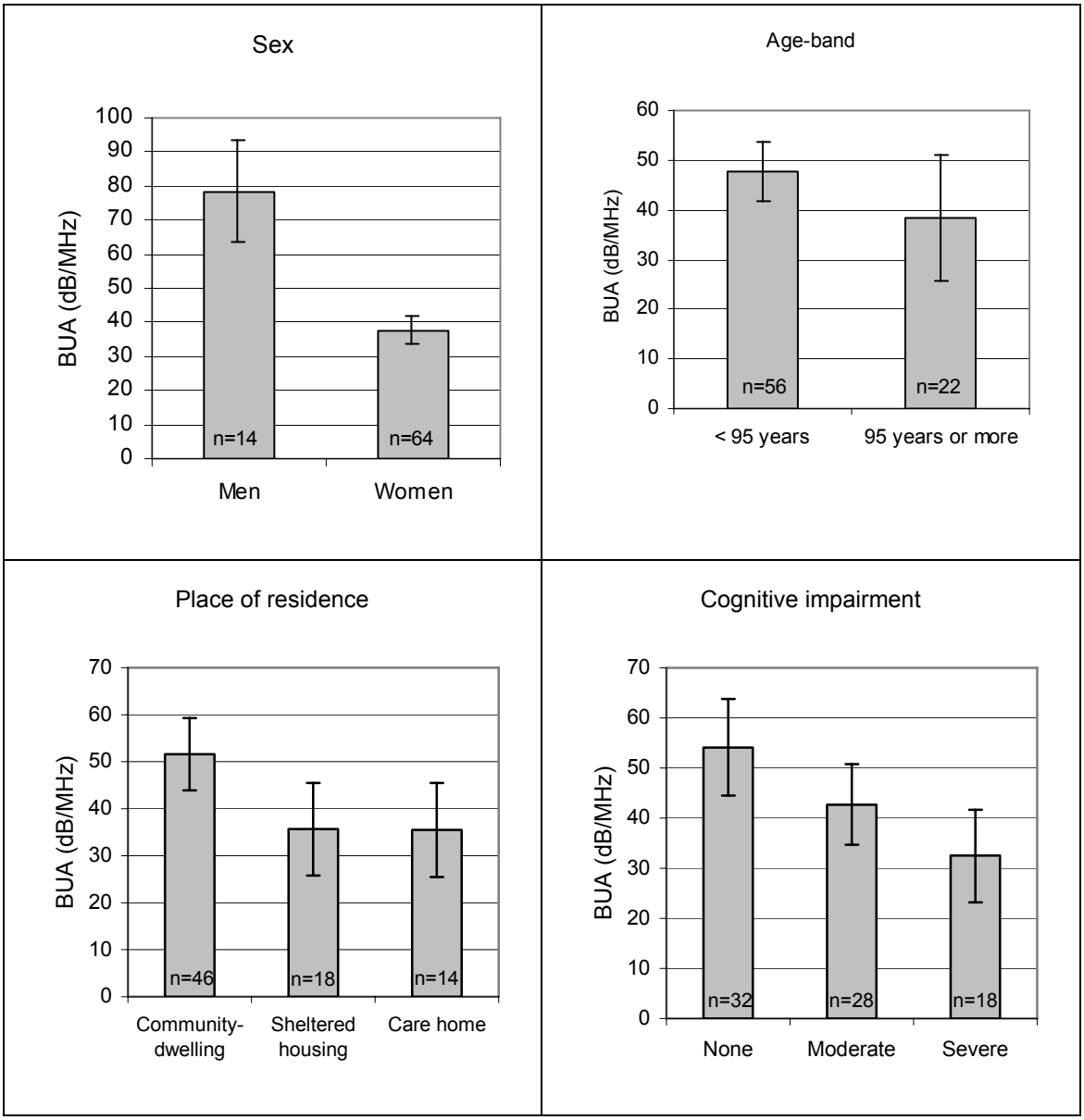


Table 10.4.1.2 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with demographic factors and cognitive function

	Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Women v. men	**-40.7 (-51.7 – -29.8)**	**p<0.001**	**-34.8 (-36.2 – -23.4)**	**p<0.001**
Aged 95 or more v. <95 years	-9.4 (-21.5 – 2.7)	p=0.1	5.0 (-11.6 – 21.6)	p=0.6
Any supported care setting v. community-dwelling	**-16.0 (-26.6 – -5.4)**	**p=0.004**	-5.7 (-13.9 – 2.6)	p=0.2
Severe cognitive impairment v. moderate or no impairment	**-16.3 (-28.9 – -3.8)**	**p=0.01**	-8.5 (-17.9 – 0.9)	p=0.08

10.4.3 History of falls and fractures

Perceived instability
Falls
Fracture history

A previous fracture is one of the strongest risk factors for future fracture[280;836-839], and falls have been shown to be better predictors of fracture risk than bone mineral density measurements[165;166;287] for men and women aged 50-79 in the European Prospective Osteoporosis Study. Thus this analysis examined the relationships of quantitative ultrasound measurements from the nonagenarian men and women scanned in the latest CC75C survey to both fracture history and variables relating to falling.

Perceived instability

The subjective measure reporting whether being "unsteady on your feet" affected a respondent day-to-day showed a clear association with BUA, lower in people who reported this as a problem compared with those who didn't, and even lower amongst those who described their unsteadiness as "disabling". Reporting any "tendency to fall", whether disabling or not, was also associated with reduced ultrasound attenuation, but to a lesser degree. The relationship between BUA and these perceptions of falls risk are graphed in Figure 10.4.3.1 and Table 10.4.3.3 shows that their corresponding regression coefficients are only partially reduced by adjusting for confounding factors.

Falls

By contrast, none of the measures of recalled and prospectively reported falling were found to bear any relation to ultrasound readings of skeletal fragility, as Figure 10.4.3.2 and the regression coefficient in Table 10.4.3.3 show.

Fracture history

Lower quantitative ultrasound scan results distinguished those who reported having suffered any fracture since the age of 50 from those reporting none, particularly when estimates were adjusted for confounders including age and sex (see again Figure 10.4.3.2 and Table 10.4.3.3). The importance of this risk indicator is examined further as one of the Fracture Risk Index factors in section 10.4.8 below.

Figure 10.4.3.1 Skeletal fragility measured as broadband ultrasound attenuation in relation to perceived problems with balance

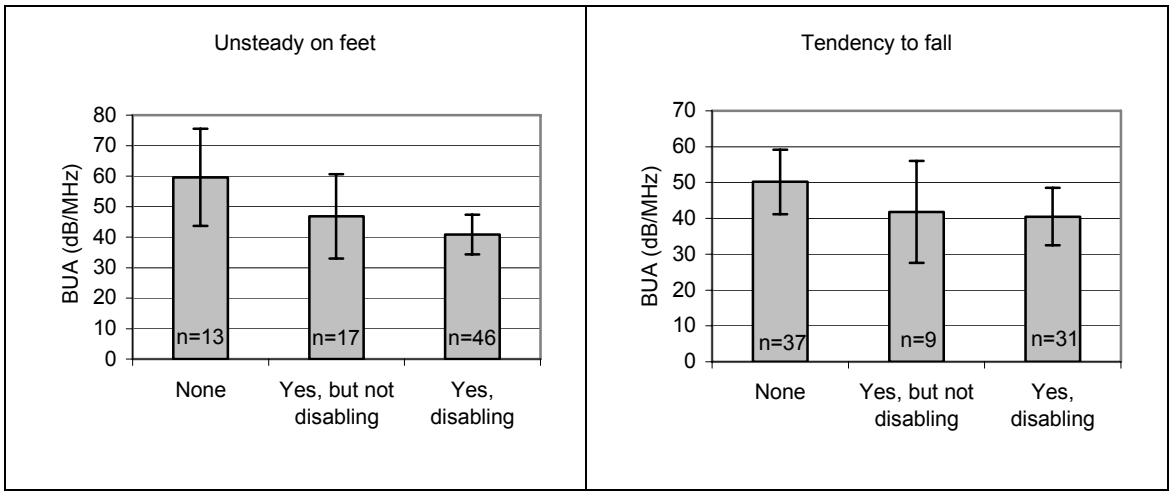


Figure 10.4.3.2 Skeletal fragility measured as broadband ultrasound attenuation in relation to falls and fractures

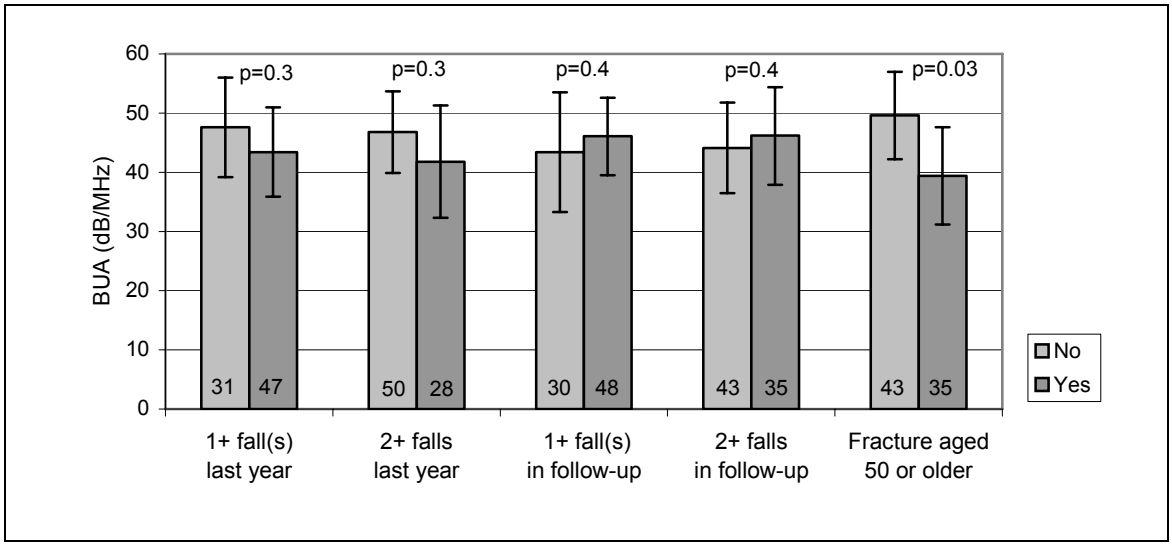


Table 10.4.3.3 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with perceived balance, falls and fracture history

	Regression coefficients - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Any v. no unsteadiness on feet	**-17.2 (-31.6 – -2.7)**	**p=0.02**	**-10.4 (-20.7 – -0.1)**	**p=0.05**
Any v. no tendency to fall	-9.4 (-20.3 – 1.5)	p=0.09	-5.8 (-13.7 – 2.0)	p=0.1
1+ v. no falls in the past year	-4.2 (-15.4 – 7.0)	p=0.5	-3.2 (-5.1 – 1.5)	p=0.5
2+ falls v. 0 / 1 in the past year	-5.0 (-16.5 – 6.4)	p=0.4	3.9 (-5.3 –13.0)	p=0.4
1+ v. no falls during follow-up	2.7 (-8.7 –14.0)	p=0.6	4.0 (-3.9 –11.8)	p=0.3
2+ v.0/1 falls during follow-up	2.0 (-9.0 –13.1)	p=0.7	-4.2 (-3.6 –12.1)	p=0.2
Any v. no fracture aged 50+yrs	-10.2 (-21.0 – 0.7)	p=0.07	**-9.3 (-16.9 – -1.7)**	**p=0.02**

10.4.4 Health and disability

Arthritis
Muscle weakness
Self-rated health
Activities of daily living

Interview measures of health and disability included a number of items that it was hypothesised could be related to skeletal measures.

Arthritis

The list of conditions about which participants were asked included "arthritis / rheumatism" but no further details were requested, such as whether any problems were due to osteo-arthritis or rheumatoid arthritis, since it was beyond the scope of the study to confirm such diagnoses. The relationships between both these diseases and osteoporosis are complex (see Chapter 1, section 1.2.5.5 *Health-related risk factors*) but the CC75C data cannot distinguish even these broad diagnostic groups. Nonetheless, examination of responses to this question in relation to ultrasound measurements shows a clear trend of lower BUA, that is increased skeletal fragility, across increasing levels of arthritis-related disability (see Figure 10.4.4.1). As the accompanying regression coefficients show, the difference in BUA between those reporting any degree of arthritis compared with none remains significant regardless of adjustment for confounders that include age, sex and weight - factors highly pertinent to arthritis. If the data are dichotomised to compare arthritis reported as "disabling" with the remainder (arthritis reported as "not disabling" plus no arthritis reported), the contrast is even more marked, as shown by the crude and adjusted regression coefficients in Table 10.4.4.2

Muscle weakness

Bone modelling is in part stimulated by forces, including muscular forces, acting on bone. The question asking to what extent participants were affected day-to-day by any "marked weakness in the arms or legs" (see Appendix C qn 68g) was therefore of interest as an indicator of muscle weakness.

Figure 10.4.4.3 illustrates the clear distinction in bone ultrasound measurements of those reporting no such muscle weakness and those reporting any limb weakness whether disabling or not. As Table 10.4.4.4 shows, the confidence intervals of the regression coefficients cross zero when adjusted for confounding co-variates.

Figure 10.4.4.1 Skeletal fragility measured as broadband ultrasound attenuation in relation to arthritis

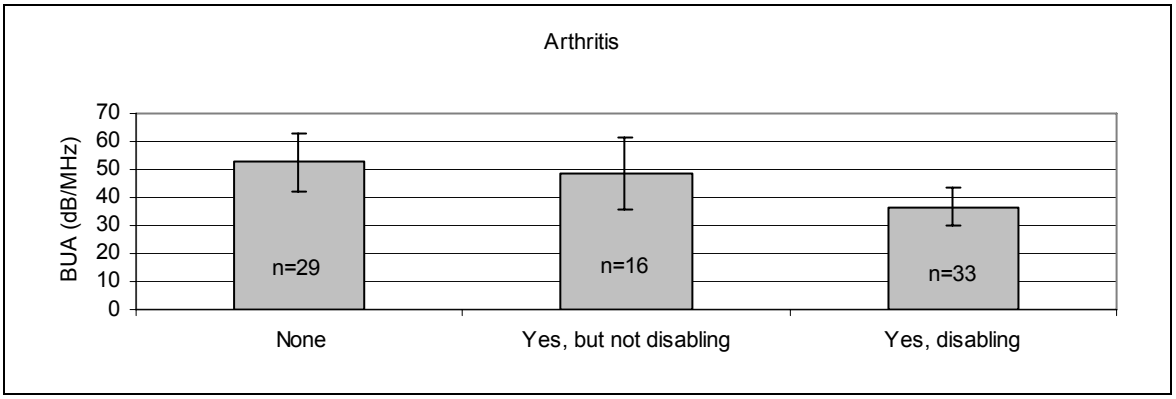


Table 10.4.4.2 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with reported arthritis

	Regression coefficients - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Arthritis				
Any v. none	**-12.0 (-23.1 – -0.9)**	**p=0.03**	**-8.5 (-16.4 – -0.6)**	**p=0.05**
Disabling v. not disabling/none	**-14.4 (-25.1 – -3.8)**	**p=0.009**	**-11.9 (-19.2 – -4.6)**	**p=0.002**

Figure 10.4.4.3 Skeletal fragility measured as broadband ultrasound attenuation in relation to marked weakness in arms and legs

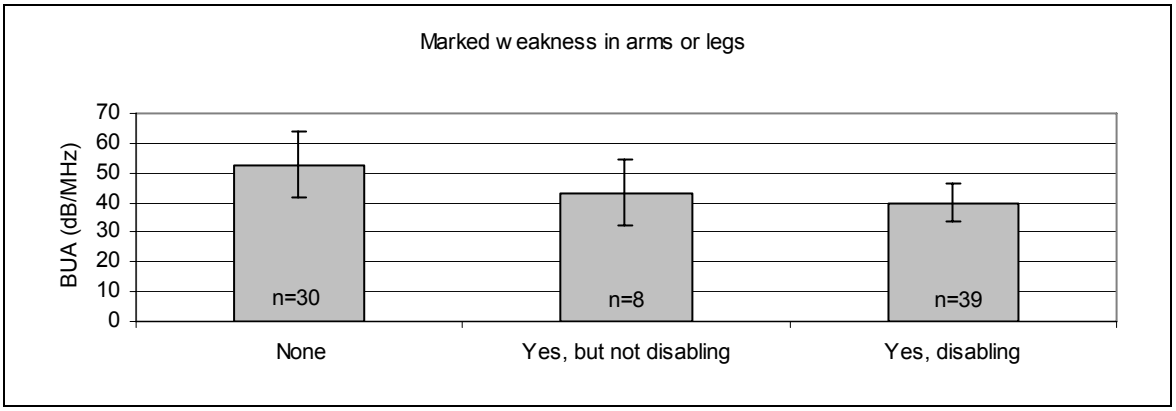


Table 10.4.4.4 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with reported muscle weakness

	Regression coefficients - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Weakness in arms or legs				
Any v. none	**-12.4 (-23.4 – -1.3)**	**p=0.03**	-4.7 (-12.8 – 3.3)	p=0.2
Disabling v. not disabling/none	**-11.0 (-21.8 – -0.1)**	**p=0.05**	-5.5 (-13.3 – 2.2)	p=0.2

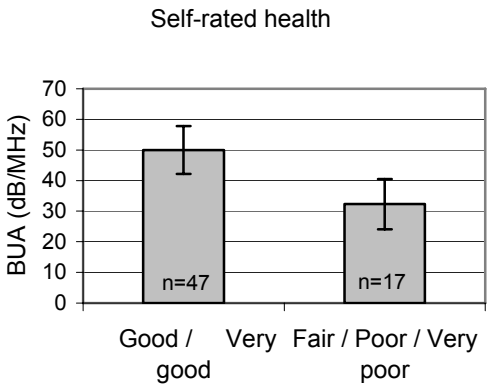
Self-rated health

Self-rated health has been reported as associated with osteoporosis[840] and is such a powerful predictor of so many outcomes, including fracture[836], that it also merited examination in relation to quantitative ultrasound results. Despite the lower numbers that could be included in this analysis, with relatively high missing data levels, there was a strong association between higher heel ultrasound results and better health as self-assessed by the participants themselves (see Figure 10.4.4.5). Whether crude or unadjusted, the regression coefficients shown are equivalent to a drop of approximately a third from the mean BUA levels recorded from those rating their health as good or very good to those found in people who assessed their own health as fair, poor or very poor compared with others of the same age.

Activities of daily living

Skeletal frailty was anticipated to be worse amongst those with poor ADL function. Scores from the interview questions about activities of daily living (ADL) were taken as markers of frailty and disability. As Figure 10.4.4.6 and Table 10.4.4.7 show, lower BUA readings were taken from people who needed help with more than two activities from both the basic ADLs and instrumental ADLs list of questions. Such a small minority managed without help in instrumental activities of daily living that the confidence intervals are very wide for this category. Taking all the ADL questions together and dichotomising the responses to compare individuals who were limited in more than half of all these ADLs with the people who had fewer difficulties, showed starkly contrasting levels of bone fragility with the largest of any of the regression coefficients related to health and disability presented in this section.

Figure 10.4.4.5 Skeletal fragility measured as broadband ultrasound attenuation in relation to self-rated health



Fair / poor / very poor v. Good / very good	
Regression coefficients (95% C.I.)	Significance (Wald test)
Unadjusted **-17.7 (-31.4 – -3.9)**	**p=0.01**
Adjusted **-15.6 (-24.8 – -6.5)**	**p=0.001**

Figure 10.4.4.6 Skeletal fragility measured as broadband ultrasound attenuation in relation to activities of daily living

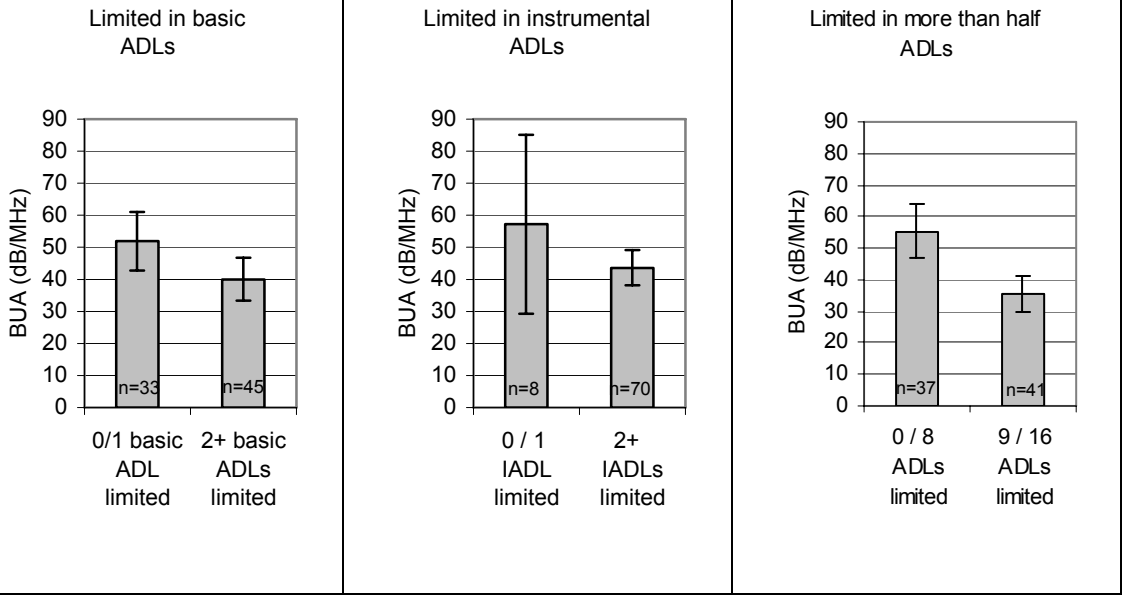


Table 10.4.4.7 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with disability in activities of daily living

	Regression coefficients - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
2+ basic ADLs limited v. 0 / 1	**-11.8 (-22.7 – -1.0)**	**p=0.03**	**-10.2 (-18.0 – -2.5)**	**p=0.01**
2+ instrumental ADLs v. 0 / 1	-13.5 (-31.5 – -4.4)	p=0.1	0.3 (-12.7 – 13.2)	p=1.0
9/16 ADLs limited v. 0 / 8	**-19.8 (-29.9 – -9.7)**	**p<0.001**	**-12.1 (-19.6 – -4.7)**	**p=0.002**

10.4.5 Reported mobility

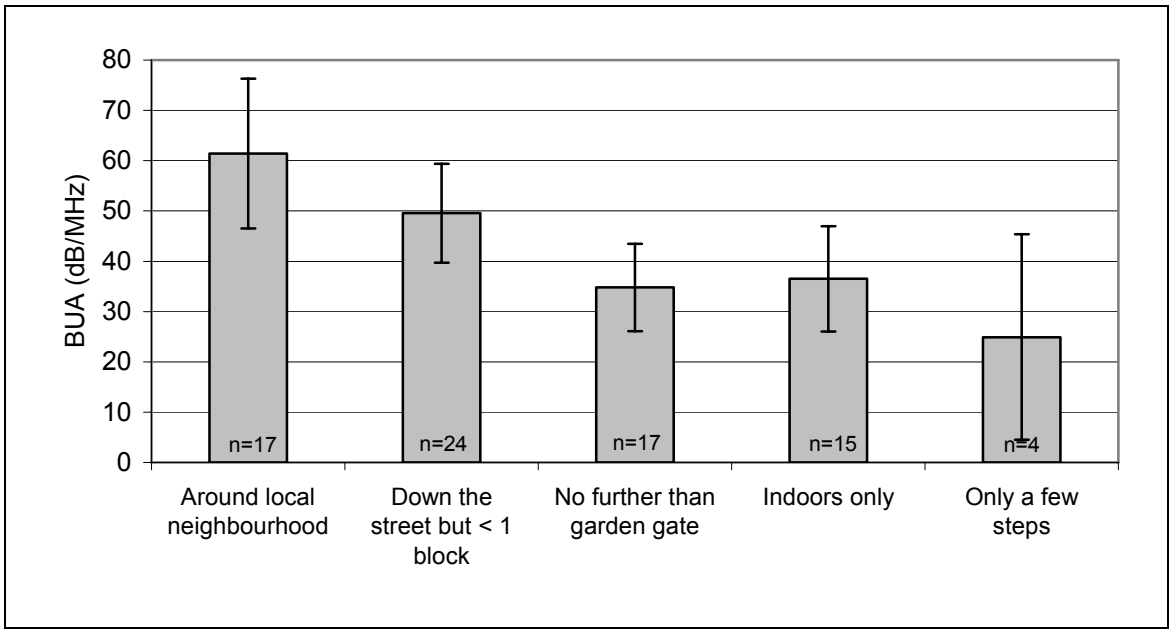
Maximum walking distance
Use of walking aids
Stair climbing, gardening, walking for exercise and other forms of physical activity

All the mobility measures were of interest in relation to heel ultrasound measures because of the established links between physical activity and skeletal strength (see Chapter 1, section 1.2.5.1). Walking and stair climbing are two common bone-loading forms of activity on which the CC75C study includes data, and the walking aid measures were also analysed to explore the effects of reduced walking ability on bone.

Maximum walking distance

Figure 10.4.5.1 shows graphically how heel bone ultrasound measures decreased with almost every reduction in maximum walking distance across the response categories for the question "How do you manage with walking?" (see Appendix C Question 78h). The only exception was that those who could walk outdoors no further than the garden gate had bone strength no better than those who could walk about indoors. However, as shown in the following graph (Figure 10.4.5.2) that illustrates dichotomous distinctions in walking distance, being able to walk any distance outdoors was associated with higher BUA than being unable to walk outside at all. Cut-points at higher levels of walking – being able to walk down the street and around the local neighbourhood – were much stronger independent indicators of skeletal fragility (see Table 10.4.5.3).

Figure 10.4.5.1 Skeletal fragility measured as broadband ultrasound attenuation in relation to reported maximum walking distance



Excluding n=1 of those scanned who was unable walk at all

Figure 10.4.5.2 Skeletal fragility measured as broadband ultrasound attenuation in relation to different levels of walking disability

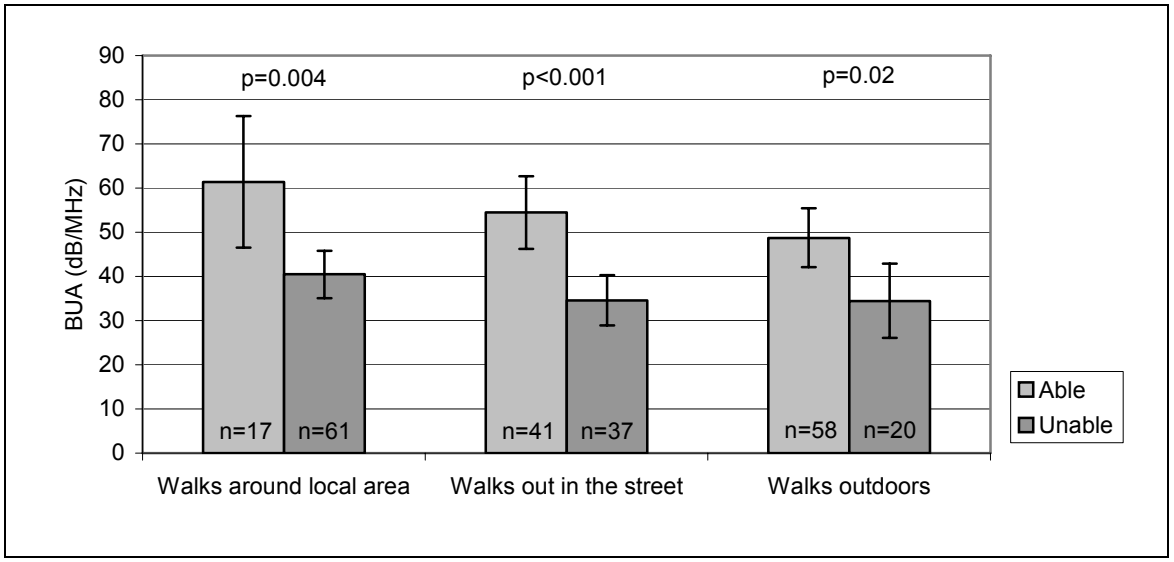


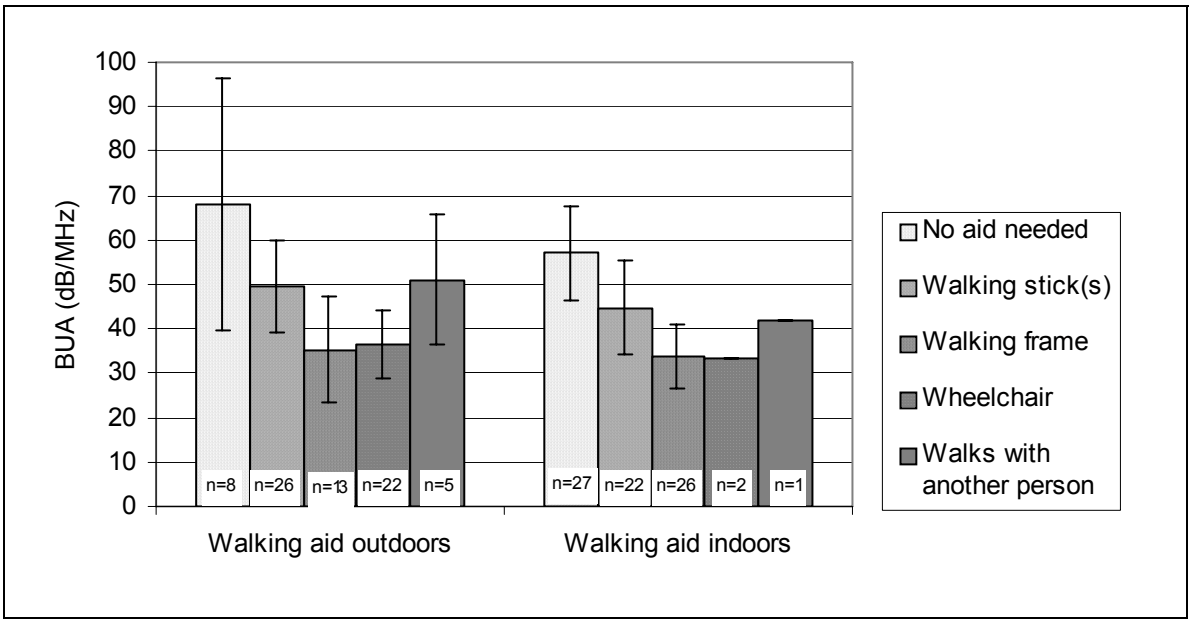
Table 10.4.5.3 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with different levels of walking disability

Unable v. able to…	***Regression coefficients*** - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Walk around local area	**-20.9 (-33.4 – -8.4)**	**p=0.001**	**-12.0 (-21.3 – -2.8)**	**p=0.01**
Walk out in the street	**-19.9 (-30.0 – -9.8)**	**p<0.001**	**-11.8 (-19.5 – -4.1)**	**p=0.003**
Walk outdoors	**-14.3 (-26.5 – -2.1)**	**p=0.02**	-4.6 (-13.9 – 4.7)	p=0.3

Use of walking aids

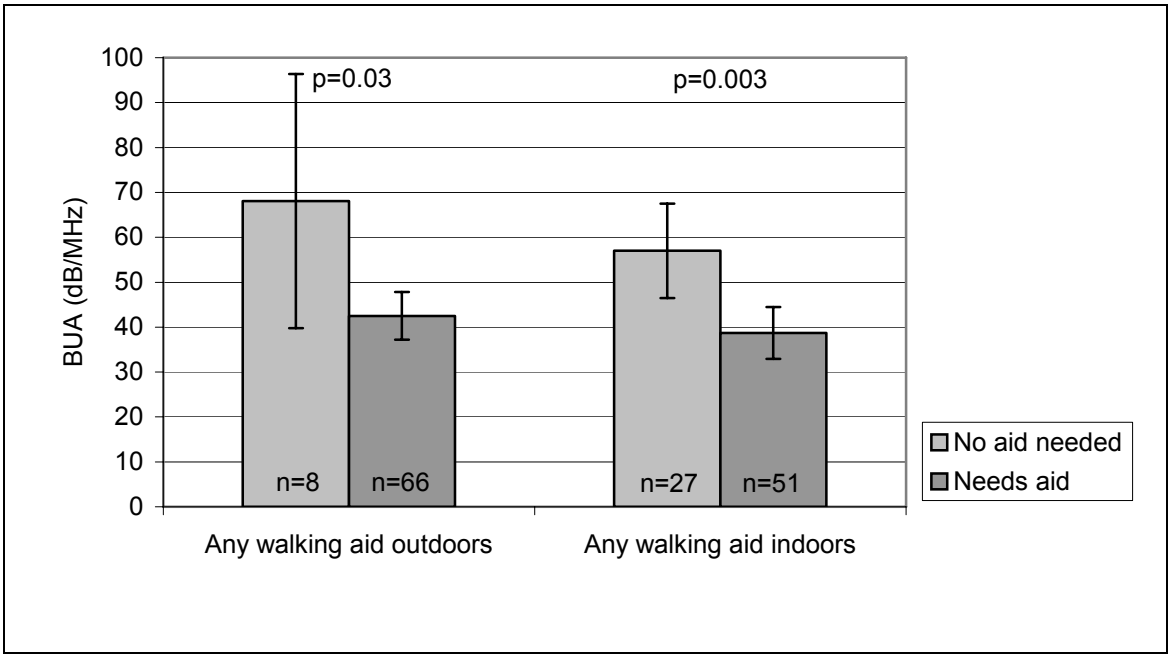
Figure 10.4.5.4 shows the drops in mean bone ultrasound readings recorded from people who required no aid to walk to those using walking sticks to those who needed the support of a walking frame. The same pattern was found whether analysing data on use of assistive devices only outdoors or also indoors. There was no difference found between the skeletal measures of those who used walking frames and those who could only get about by wheelchair, again whether indoors or out. Walking only with the support of another person in any location was associated with slightly higher BUA levels than needing a frame or wheelchair, comparable with walking stick use in outdoor walking analysis. Confidence intervals have been omitted from the bars representing only one or two people needing another person's help or a wheelchair indoors. Figure 10.4.5.5 and Table 10.4.5.6 clarify the markedly worse skeletal fragility found if any form of aid to walk was required compared with not needing any.

Figure 10.4.5.4 Skeletal fragility measured as broadband ultrasound attenuation in relation to type of aid needed to walk outdoors and indoors



Excluding n=4 and n=1 of those scanned who were unable walk outdoors and indoors respectively

Figure 10.4.5.5 Skeletal fragility measured as broadband ultrasound attenuation in relation to need for any aid to walk outdoors and indoors



Excluding n=4 and n=1 of those scanned who were unable walk outdoors and indoors respectively

Table 10.4.5.6 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with inability to walk without any aid

Unable v. able to…	Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Walk outdoors without any aid	**-25.6 (-42.9 – -8.3)**	**p=0.004**	**-16.9 (-30.0 – -3.8)**	**p=0.01**

Walk indoors without any aid	**-18.3 (-29.1 – -7.4)**	**p=0.001**	**-11.6 (-19.8 – -3.4)**	**p=0.006**

Stair climbing, gardening, walking for exercise and other forms of physical activity
All the other mobility measures reported at interview were found to identify people with higher ultrasound readings in the higher activity level categories (see Figure 10.4.5.7), though the responses to the "other physical activity or exercise" question showed only minimal differences in BUA.

Most striking was the apparent effect of climbing a flight of stairs at least once a day. Similar scale differences were also found between those who reported gardening and those who did not, though with wider confidence intervals reflecting fewer people who managed to garden than managed to climb stairs regularly. Only one in seven people said they took walks for exercise and the different levels of significance attached to the between groups variation in BUA reflects the impact of the small numbers on the different statistical approaches to testing. As Table 10.4.5.8 shows, adjusting for the confounding effects of age, sex, weight and ultrasound QA covariates approximately halved the effects on BUA of each of these three mobility measures.

Figure 10.4.5.7 Skeletal fragility measured as broadband ultrasound attenuation in relation to physical activity

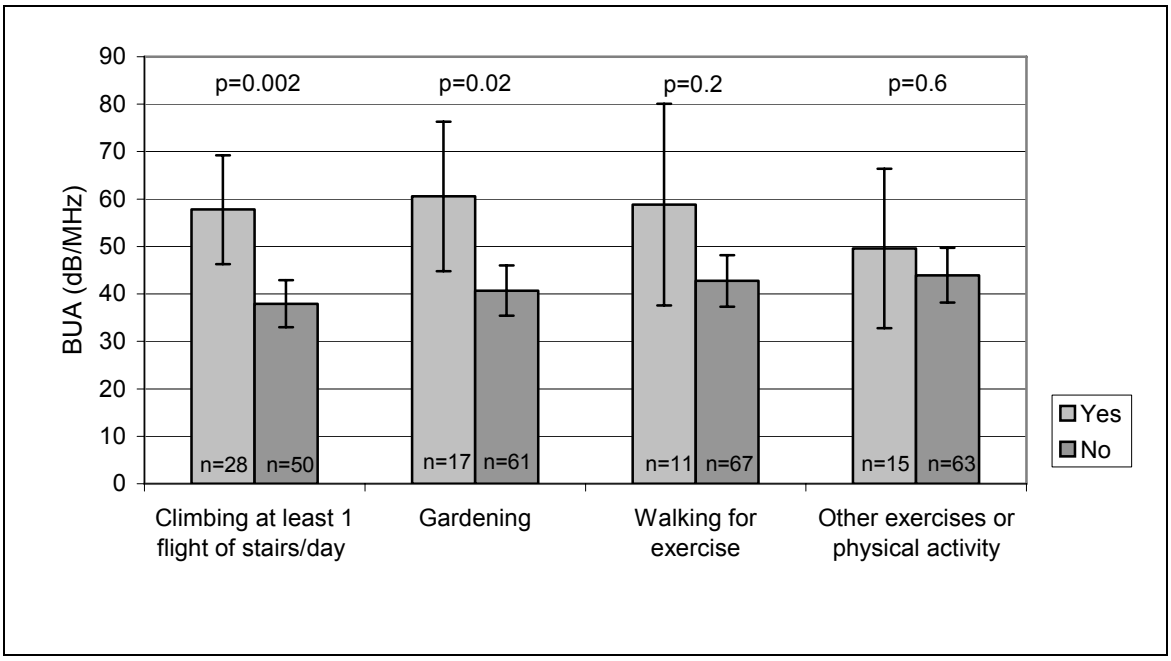


Table 10.4.5.8 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with different types of physical activity

	Regression coefficients - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Climbs flight of stairs <1x/day v. at least once/day	**-19.8 (-30.4 – -9.3)**	**p<0.001**	-8.2 (-16.9 – 0.4)	p=0.06
No gardening v. manages some gardening	**-19.9 (-32.4 – -7.3)**	**p=0.002**	-9.1 (-18.5 – 0.2)	p=0.06
No walks for exercise v. walks for exercise	**-16.1 (-31.5 – -0.7)**	**p=0.04**	-8.7 (-19.9 – 2.5)	p=0.1
No other physical activity v. some other exercises/P.A.	-5.6 (-19.6 – 8.3)	p=0.4	-1.3 (-11.4 – 8.8)	p=0.8

10.4.6 Reported past mobility

Reported walking limitation in earlier interviews
Longitudinal analyses of past maximum walking distance in relation to present BUA

Reported walking limitation in earlier interviews

Of the 78 people scanned in the current study 22% reported they still walked around their local neighbourhood, but the proportion of people who were still so physically active was higher in earlier surveys. Not everyone scanned was in each previous interview wave but, amongst those who were, the percentage who reported walking around their local area decreased as the cohort grew older from over 90% in the baseline interviews and the first follow-up (17 and 15 years before the current survey) to 86%, 81% and 52% reported 10, 7 and 4 years before respectively.

Longitudinal analyses of past maximum walking distance in relation to present BUA

The relationship between past reported walking ability and current heel bone measurements was examined with Wilcoxon's non-parametric rank sum test to compare BUA means and with linear regression to assess the impact of confounding covariates.

As Figure 10.4.6.1 illustrates those who reported a lower maximum walking distance (less than a block compared with walking around the local neighbourhood) at any past interview had lower ultrasound scan results in the current survey. Numbers in each group at each interview, from those scanned in the latest survey, are shown at the foot of each column. Confidence intervals widen with the dwindling numbers of people in the more mobile category over the years, and likewise are wider in earlier years for the limited walking category. Nonetheless the pattern is consistent and, despite the small sample sizes, the Mann-Whitney U estimates indicate that for four of these six analyses the differences are unlikely to be due to just chance. However, regression modelling to adjust for confounding reduced the effect size and significance of associations with reported walking in these previous interviews (see Table 10.4.6.2).

Figure 10.4.6.1 Skeletal fragility measured by quantitative ultrasound in current survey by reported ability to walk around the local neighbourhood in the past

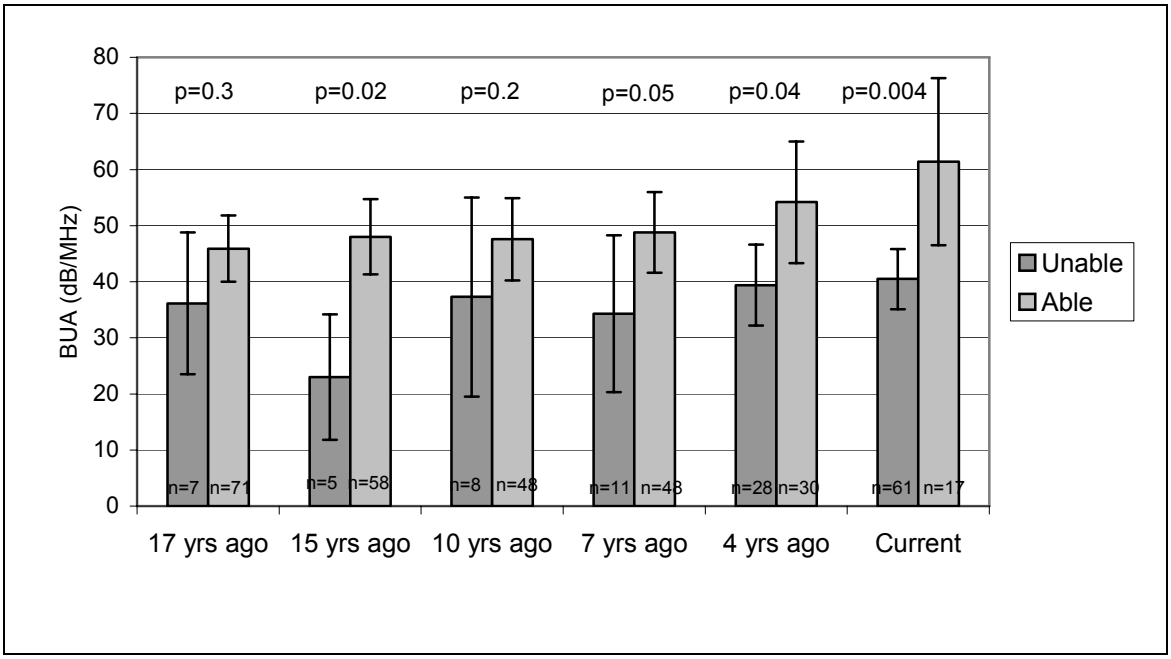


Table 10.4.6.2 Broadband ultrasound attenuation decrease (95% C.I.s) associated with walking disability reported in the latest and previous CC75C interviews

Able v. unable to walk around the local neighbourhood as reported at interview…	Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
…in the current survey	**20.9 (8.4 – 33.4)**	**p=0.001**	**12.1 (2.9 – 21.3)**	**p=0.01**
…4 years before	**14.8 (1.8 – 27.7)**	**p=0.03**	1.5 (-8.3 – 11.4)	p=0.8
…7 years before	14.5 (-1.6 – 30.6)	p=0.08	5.9 (-5.7 – 17.5)	p=0.3
…10 years before	10.3 (-8.7 – 29.4)	p=0.3	-1.2 (-14.2 – 11.9)	p=0.9
…15 years before	**25.0 (2.0 – 47.9)**	**p=0.03**	14.3 (-1.4 – 30.0)	p=0.07
…17 years before	9.8 (-9.4 – 30.0)	p=0.3	5.7 (-8.7 – 20.2)	p=0.4

10.4.7 Functional performance tests

Static and dynamic balance
Gait speed
Hand grip strength

All performance tests of physical function that involved any weight-bearing – static and dynamic balance tests, including chair rises, and gait speed – were found to be strongly associated with the quantitative ultrasound scan results.

Static and dynamic balance

Figures 10.4.7.1 and 10.4.7.3 graph the consistently higher ultrasound measures recorded from the men and women over 90 years old who completed each of the set of static and dynamic balance measurements, compared with those who could not manage these tests. It might be anticipated that gender and weight could account for some of the differences found. However, as the accompanying Tables 10.4.7.2 and 10.4.7.4 show, full adjustment for confounders including both these factors only reduced regression coefficients to insignificance in two of these analyses and the direction of effects remained constant.

Achieving the more challenging levels of performance in the tests was associated with even larger differences in BUA than the already significant distinctions found between those who were able and unable to perform the initial level of each test: for example, regression coefficients were largest for the tandem stance of all the standing balance tests, were greater for repeated chair rising than a single chair stand, and increased with greater functional reach. The most challenging measures – holding the tandem stand for 10 seconds and functional reach over 25cm – have been omitted from the graphs because the very small numbers achieving these cut-points produced extremely wide confidence intervals.

Figure 10.4.7.1 Skeletal fragility measured as broadband ultrasound attenuation in relation to performance in static balance tests

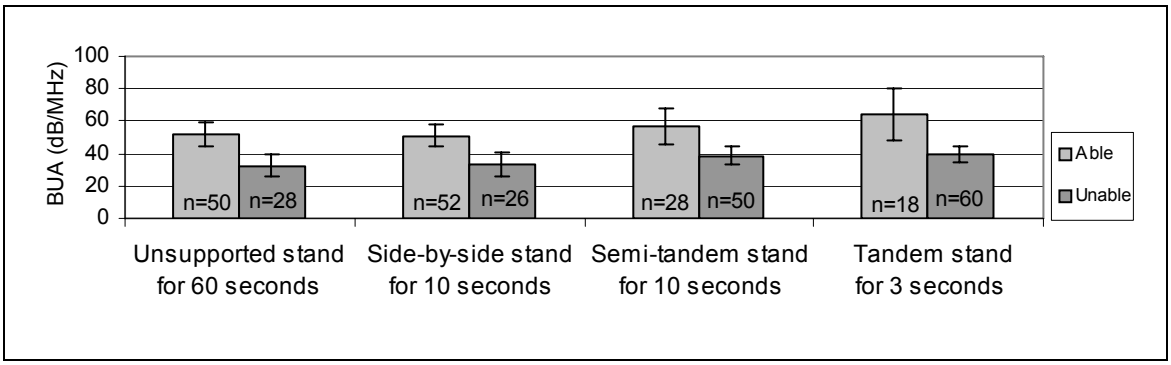


Table 10.4.7.2 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with inability to complete static balance tests

Unable v. able to complete…	***Regression coefficients*** - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
TUSS (timed unsupported) 60 secs	**-19.5 (-30.1 – -8.9)**	**p<0.001**	**-11.5 (-19.4 – -3.6)**	**p=0.005**
Side-by-side stand 10 seconds	**-18.1 (-29.1 – -7.1)**	**p=0.002**	**-9.6 (-17.8 – -1.4)**	**p=0.02**
Semi-tandem stand 10 seconds	**-18.1 (-28.9 – -7.4)**	**p=0.001**	-5.1 (-13.7 – 3.6)	p=0.2
Tandem stand 3 seconds	**-25.1 (-36.9 – -13.3)**	**p<0.001**	**-9.9 (-19.7 – -0.2)**	**p=0.05**

Figure 10.4.7.3 Skeletal fragility measured as broadband ultrasound attenuation in relation to performance in dynamic balance tests

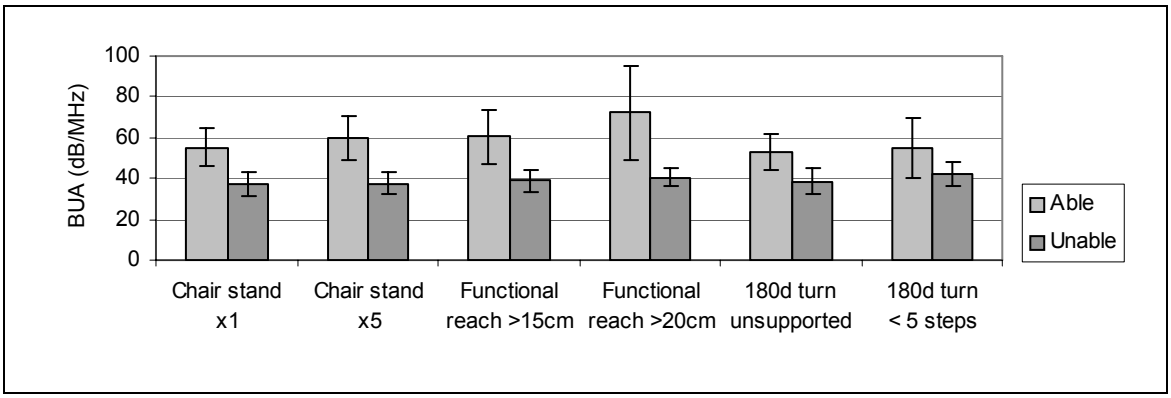


Table 10.4.7.4 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with inability to complete dynamic balance tests

Unable v. able to complete…	Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Single chair stand	**-17.5 (-27.9 – -7.0)**	**p=0.001**	**-12.2 (-19.5 – -4.8)**	**p=0.002**
5 repeated chair stands	**-22.2 (-32.7 – -11.6)**	**p<0.001**	**-15.2 (-22.7 – -7.6)**	**p<0.001**
Functional reach test > 15 cm	**-22.4 (-32.9 – -9.9)**	**p<0.001**	**-9.0 (-18.1 – 0)**	**p=0.05**
Functional reach test > 20 cm	**-36.7 (-46.0 – -17.4)**	**p<0.001**	**-12.3 (-24.3 – -0.3)**	**p=0.05**
180º turn without support	**-14.7 (-25.3 – -4.1)**	**p=0.007**	**-9.6 (-17.1 – -2.2)**	**p=0.01**
180º turn taking under 5 steps	**-13.0 (-26.0 – 0)**	**p=0.05**	-7.3 (-16.8 – 2.3)	p=0.1

Gait speed

Gait speed measurements, recorded from the faster of two timed 8 foot walks at normal pace, were dichotomised at the means for men and women separately and for the full sample. Comparisons of mean BUA by each of these binary variables showed clear differences in all three sets of analyses, as illustrated in Figure 10.4.7.5, and gait speed still distinguished different levels of skeletal fragility with fully adjusted regression modelling (see Table 10.4.7.6). The gait speed cut-point 0.6m/sec that other researchers found predicted falls and fractures in a younger old population (over 65-year-olds in the Study of Osteoporotic Fractures) did not reveal any differences in heel ultrasound recordings (see the same figure and table).

Hand grip strength

By contrast, the apparent association of hand grip strength with BUA appears to be due to gender differences in both measures. Figure 10.4.7.7 plots the ultrasound readings for men and women separately as well as both together, comparing those with above and below mean grip strength – gender-specific means for the single sex analyses and over-all mean for the full-sample comparison. Despite clear separation of the confidence intervals in the sample as a whole, suggesting grip strength relates strongly to skeletal fragility, no BUA differences were found between either men or women with higher and lower muscle strength relative to others of the same sex. The regression co-efficients in Table 10.4.7.8 show that the seemingly powerful effect is lost altogether when adjusted for confounding covariates including sex.

Figure 10.4.7.5 Skeletal fragility measured as broadband ultrasound attenuation in relation to gait speed

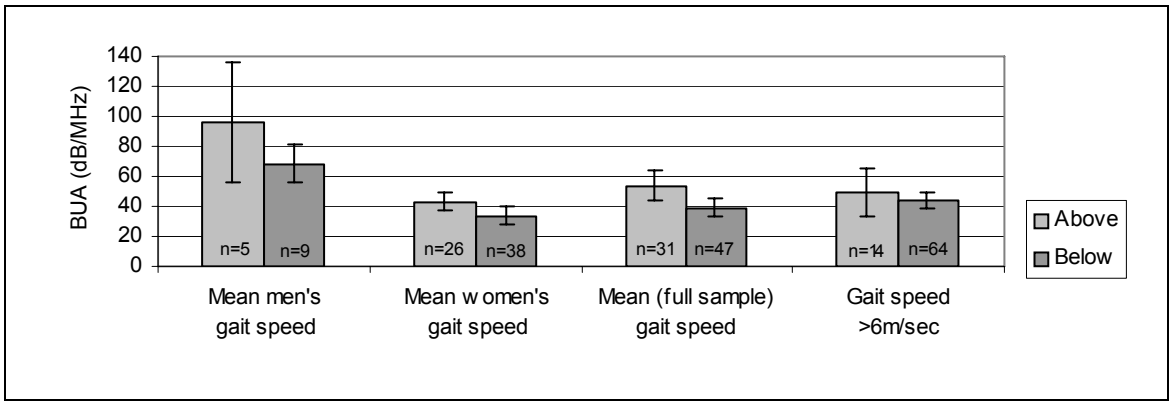


Table 10.4.7.6 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with slower gait speed

Gait speed …	Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Below v. above mean: Men	**-27.5 (-55.4 – 0.3)**	**p=0.05**	**-40.5 (-69.1 – -11.1)**	**p=0.01**
Below v. above mean: Women	**-9.1 (-17.4 – -0.9)**	**p=0.03**	**-7.7 (-15.2 – -0.1)**	**p=0.05**
Below v. above mean: All	**-14.7 (-25.4 – -4.0)**	**p=0.008**	**-9.9 (-17.7 – -2.0)**	**p=0.01**
Below v. above 0.6 m/second	-5.5 (-19.8 – 8.9)	p=0.4	-4.1 (-14.2 – 6.1)	p=0.4

Figure 10.4.7.7 Skeletal fragility measured as broadband ultrasound attenuation in relation to hand grip strength

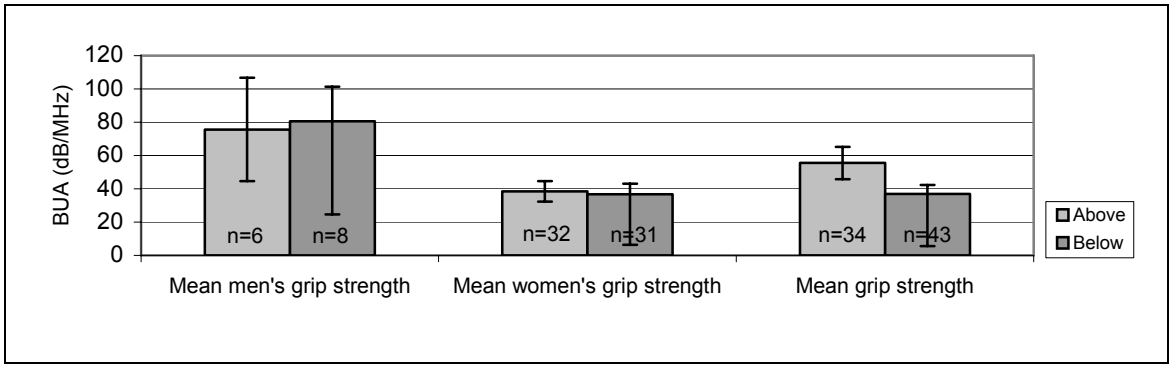


Table 10.4.7.8 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with weaker hand grip strength

Hand grip strength …	***Regression coefficients*** - unadjusted (95% C.I.)	Wald test	***Regression coefficients*** - adjusted (95% C.I.)	Wald test
Below v. above mean: Men	5.0 (-26.6 – 36.6)	p=0.7	27.2 (-22.3 – 76.6)	p=0.2
Below v. above mean: Women	-1.7 (-10.3 – 6.8)	p=0.7	0.0 (-7.7 – -7.6)	p=1.0
Below v. above mean: All	**-18.6 (-29.0 – -8.2)**	**p=0.001**	-2.0 (-11.5 – 7.4)	p=0.7

10.4.8 Fracture risk indices

There is increasing interest in using risk factor indices to target scarce resources on investigating and treating those most at risk of fracture. Older age is a factor in most risk assessment scoring systems (e.g. NORA[927], ORACLE[928], EPIDOS[929], ORAI[930], FRAT[873]). In the Black Fracture Index[597] being aged 85 or older is the highest scoring component in the index. Whether other items in the scale confer additional risk in extreme old age is unclear.

To assess the relevance of such measures to the very old, risk factors measured in the CC75C study were examined in relation to skeletal fragility. As discussed in Chapter 1, section 1.2.7, quantitative ultrasound scan parameters has been shown to predict fracture risk in younger old age cohorts[709;714] and in residents of care institutions[693]. Therefore, as the current study was too small to take fractures as an outcome, heel ultrasound measurements are used as a surrogate for fracture risk.

Of the five items besides age in the Black Fracture Index, two could not be explored in our study population: none of the women smoked and only one reported a maternal hip fracture, not one of those scanned (see Table 10.4.8.1). The remaining three risk factors were extremely prevalent, and equally so amongst the women who had heel scans as amongst all women in the full sample. 59% could not stand up from a chair without using their arms, but low weight (<57kg) and fractures since the age of 50 were also very common, each affecting over 40% of the women scanned.

Differences in mean BUA (dB/MHz) between women with or without these three Black Fracture Index risk factors were marked, as Figure 10.4.8.2 illustrates. The crude and adjusted regression coefficients associated with each of these factors are shown in Table 10.4.8.3, for the full sample scanned as well as for the women only. It is worth noting that, although the Black Fracture Index was developed using data from American women aged at least 65 years and validated with data from French women aged 75 or more, these same risk factors are strongly associated with lower scan readings in the CC75C ultrasound study as a whole, including men as well as women aged over 90

Table 10.4.8.1 Black Fracture Index: risk factor scoring and prevalence amongst women aged over 90-years-old in CC75C study

Fracture Index risk factor	Score	Prevalence in women aged over 90 years seen in the last CC75C survey	Prevalence in women aged over 90 years scanned in last CC75C survey
What is your current age?	85+ = 5	90/90 (100)	64/64 (100)
Have you broken any bones after age 50?	Yes = 1	40/88 (46)	28/64 (44)
Has your mother had a hip fracture after age 50?	Yes = 1	1/75 (<1)	0/64 (0)
Do you weigh 125 lb / 57kg or less?	Yes = 1	25/64 (39)	27/64 (42)
Are you currently a smoker?	Yes = 1	0/88 (0)	0/64 (0)
Do you usually need to use your arms to assist yourself in standing up from a chair?	Yes = 2	47/73 (64)	38/64 (59)

Figure 10.4.8.2 Differences in skeletal fragility in women aged over 90-years-old with or without Black Fracture Index risk factors

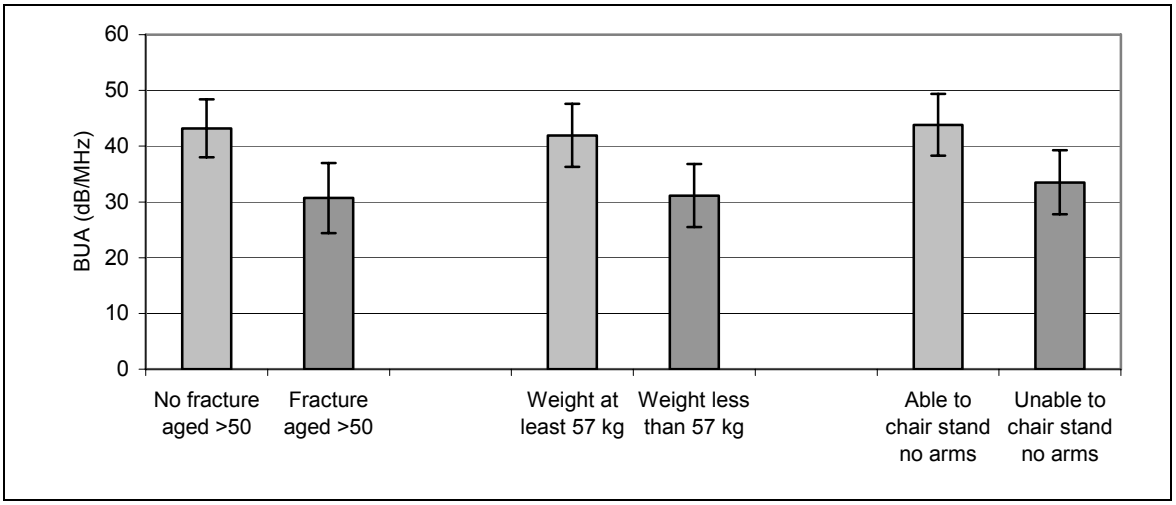


Table 10.4.8.3 Increase in skeletal fragility measured by decrease in BUA (dB/MHz) associated with Fracture Index risk factors

		Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Fracture aged ≥ 50	Women	**-12.5 (-20.4 – -4.6)**	**p=0.003**	-6.9 (-14.5 – 0.7)	p=0.08
	All	-10.2 (-21.0 – 0.7)	p=0.07	**-9.3 (-16.9 – -1.7)**	**p=0.02**
Weight < 57 kg	Women	**-10.8 (-19.0 – -2.6)**	**p=0.01**	**-12.3 (-19.6 – -5.0)**	**p=0.001**
	All	**-18.2 (-29.3 – -7.2)**	**p=0.002**	**-19.4 (-29.5 – -5.2)**	**p<0.001**
Unable to rise from a chair without arms	Women	**-10.3 (-18.5 – -2.1)**	**p=0.02**	-6.8 (-14.2 – 0.6)	p=0.07
	All	**-17.5 (-27.9 – -7.0)**	**p=0.001**	**-12.2 (-19.5 – -4.8)**	**p=0.002**

10.5 Asymmetry in quantitative ultrasound measurements

Differences between ultrasound parameters measured from opposite heels of the same person were noted from the outset. At the same time information from the first few study participants themselves regarding one leg having been weaker ever since an old injury prompted a subsidiary analysis that was not planned a priori. Any past reported fractures, sprains, joint replacements, arthritis or other lower limb injuries were recorded in the scanning log.

Thirty people reported such problems and were able to identify whether the difficulty affected the left or right side more than the other (n=17 left, n=13 right). Table 10.5.1 shows the extent of these problems reported. For some people there could be more than one problem and participants were asked to rate which problem was most serious and which side was worst affected.

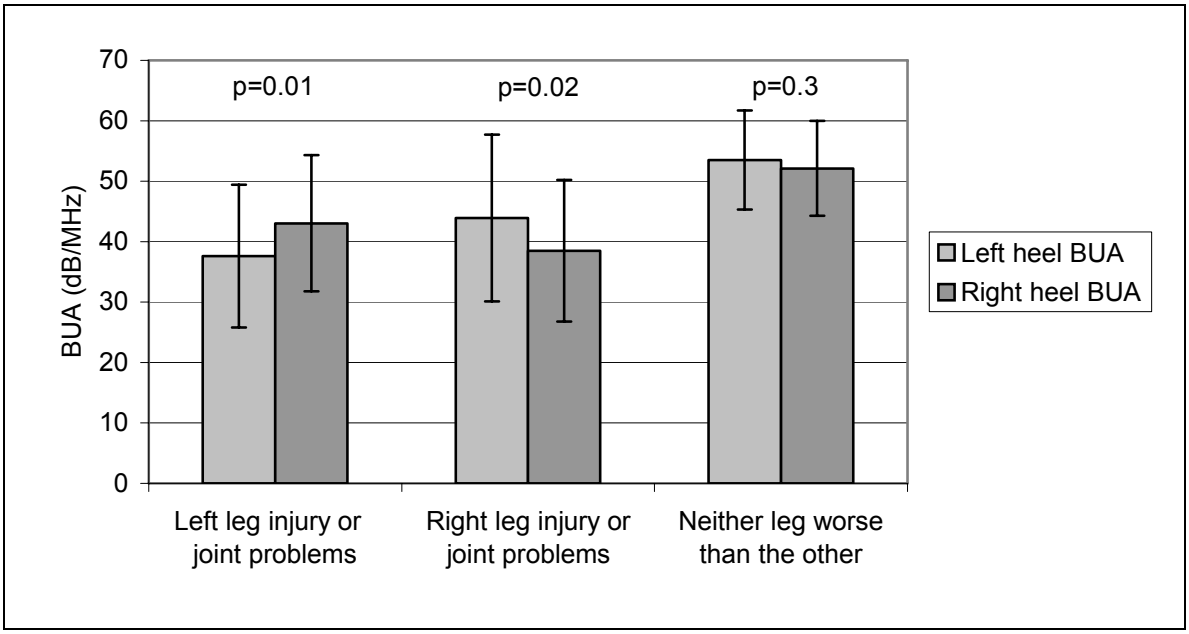
Despite the small numbers that could be included in this analysis there were striking differences between measurements of the left and right heels. Figure 10.5.2 shows how readings taken from the side reportedly affected by a previous lower limb problem were consistently lower. These differences were not significant for the very few men affected, although differences followed the same pattern as the significant distinction found in women and in this sub-sample as a whole.

Linear regression on the differences between left and right heel measurements associated with a reported history of left or right lower limb problems showed these differences persisted even when adjusted for age, sex, ultrasound QA protocol parameters and weight. Table 10.5.3 tabulates the regression coefficients for each gender separately as well, showing the differences were marked even in just the women (n=24), but not for the very few men (n=6).

Table 10.5.1 Reported problems affecting lower limbs (n=30 of n=78 scanned)

	Problem affecting left side	Problem affecting right side	Most serious problem worst affected side
Arthritis	9	7	9
Hip replacement	0	1	0
Sprain/strain	1	1	2
Fracture	11	18	19
Other	4	2	4
	No problem left side 5	No problem right side 1	-
	Most serious problem affects left side 17	Most serious problem affects right side 13	-

Figure 10.5.2 Differences in skeletal fragility between left and right heel measures by reported problems affecting lower limbs



p-values are the significance of the difference between medians using the non-parametric sign test

Table 10.5.3 Increase in skeletal fragility associated with unilateral lower limb injury or joint problems: difference between BUA (dB/MHz) measurements of affected and unaffected heels

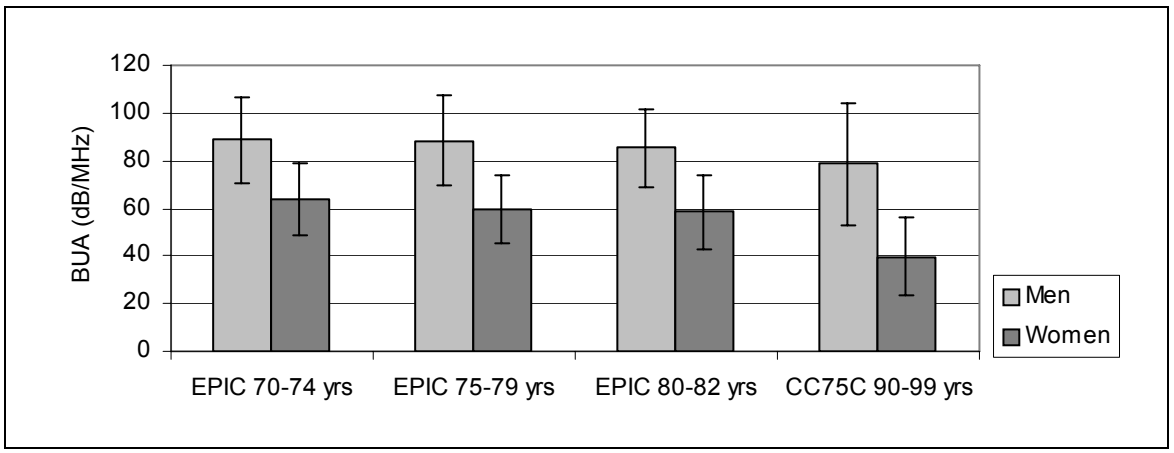
Unaffected v. affected heel		Regression coefficients - unadjusted (95% C.I.)	Wald test	Regression coefficients - adjusted (95% C.I.)	Wald test
Men	n=6	6.6 (-29.8 – 43.0)	p=0.6	-2.8 (-79.5 – 74.0)	p=0.7
Women	n=24	**11.7 (6.0 – 17.5)**	**p<0.001**	**13.1 (6.9 – 19.3)**	**p<0.001**
All	n=30	**10.8 (4.3 – 17.4)**	**p=0.002**	**12.5 (5.7 – 19.2)**	**p=0.001**

10.6 Discussion and summary

This is the first population-based study of over-90-year-olds to report calcaneal ultrasonography. The findings reveal measurements of the physical properties of the skeleton that are markedly more adverse in advanced old age than in younger old people. Interview data and functional tests reported in Chapters 4 and 5 show very high prevalence of other fracture and fall risk factors besides advanced old age but a low rate of prescribing calcium, vitamin D or any other bone-protective therapy.

This chapter reports quantitative ultrasound scan (QUS) data collected from a population more than a decade older than the manufacturer's reference range, providing important normative heel ultrasound data for extreme old age. Previous studies that gathered QUS scan data on older people in the community have not reported separately on the very small numbers of nonagenarians their oldest age band may have included. Only a few studies to date[690;693;716] have included reasonable numbers of participants aged over 90, all these being concerned with institutional residents only. One of these reported persisting gender differences in ultrasound bone assessment, but concluded calcaneal bone loss was only minor with very old age in either sex[716]. In the current study, **c**omparison with 70 – 82-year-olds in EPIC-Norfolk[741], a neighbouring population-based study that used the same scan technique, shows skeletal frailty is substantially worse in the CC75C sample (see Figure 10.6.1). The implied rapid deterioration between the 8th and 10th decade poses a major challenge for the future.

Figure 10.6.1 Broadband Ultrasound Attenuation of men and women aged over 90 yrs in comparison with younger old age-bands in the EPIC-Norfolk cohort



Error bars represent standard deviations

Given the impossibility of taking fracture as an endpoint in this small sample, no attempt has been made to assess whether quantitative ultrasound is as good a predictor of fracture in advanced old age as it has been shown to be in community studies with younger old age-groups[708;709;711;714], and in one study of elderly institutionalised women[693].

However, the CC75C study findings confirm that the ability of ultrasound parameters to distinguish people with a history of fracture from those without, as reported so far only in younger age-groups (post-menopausal women or men no older that 80)[426;690;700;702-705], persists even into the 10th decade. Other key indicators used in fracture risk assessment were also found to be associated with the CC75C ultrasound results. These findings lend support to the analyses examining the QUS measure broadband ultrasound attenuation (BUA) in relation to established fracture risk factors, but there are clearly limitations in using ultrasound results as a surrogate measure.

Notwithstanding these limitations, there were striking associations found between BUA and a range of factors important to consider in relation to skeletal fragility. The marked gender differences that persist in advanced old age and the greater fragility measured amongst people living in supported care settings are not unexpected. Fracture rates are higher in institution-dwelling than community-dwelling older people[841] and bone density by DEXA has also been reported to be lower[249]. It is interesting that health related factors that relate to bone strength in younger age groups, such as arthritis and general self-rated health, appear to still have a bearing on bone health in very old age. In the light of the CC75C findings on co-morbidity, the newly published Tromsø Study results are interesting: in this very large-scale population-based study (age range 25 – 98) increased burden of disease predicted fractures[842].

Of particular importance are the current study's findings that skeletal fragility is still, even in the tenth decade of life, strongly related to levels of physical activity. BUA was found to have strong associations with all the functional performance measures except for grip strength, interestingly the only test that involved no weight bearing. The links were also clear in relation to reported measures: self-reported muscle weakness, difficulty with activities of daily living and particularly reported walking disability – the use of a walking aid and maximum walking distance. Studies from Canada[666],

Scandinavia[417], Japan[843] and China[844] have also reported lower bone mineral density in people with lower functional test scores in healthy post-menopausal women and adults aged over 40 and over 70 years, so the CC75C data extend this findings into older old age. There is a wealth of previously published reports linking physical activity with fracture risk and bone density and an emerging literature on these links with ultrasound measures as well (see section 1.2.5.2 *Muscle weakness, balance, mobility and functional limitation* and section 1.2.7.2 *Quantitative ultrasound measures distinguish risk factors*) but again this study provides new insight into this relationship in advanced old age. Other researchers have explored the inter-relation of bone strength, muscle strength and activity levels in younger age-groups[417;845-847] and suggested that the associations found between bone and muscle function is largely mediated by physical activity[847].

Mobility and weight-bearing also may be part of the explanation why, in participants who reported joint problems, past fractures or other old injuries affecting a particular leg, the scan results recorded on the side of the affected lower limb were lower. These findings have implications for rehabilitation, say, after a lower limb fracture, especially given the established increase in subsequent fracture risk. Differences between left and right heel measurements were reported in a study of men and women aged 70 years and over in the Netherlands[426]. These differences were related to indicators of poor functional status, including past fractures, but the study did not have the data to examine links with injuries to specific limbs. This was also an acknowledged limitation in a study that reported asymmetry in leg muscle power was related to mobility limitation[848]. Also important, given the links shown between bone fragility and muscle function, are the findings that greater asymmetry in leg muscle explosive power and function was found in women who fell frequently than in those who reported no falls[401].

A longitudinal analysis taking reported maximum walking distance measured in repeated surveys of the same people over the previous 17 years showed a pattern of lower current BUA in the people who had lower past mobility. Past physical activity is known to relate to bone strength, but the suggestion from these data that skeletal fragility of people in their 90s may be influenced by levels of walking maintained in their 80s or late-70s carries an important public health message.

Summary findings

- Bone quality continues to decline with age even across the 10th decade.
- Gender differences in skeletal fragility persist into advanced old age.
- Ultrasound measurements of residents in institutional or sheltered care are lower than was found amongst community-dwelling men and women.

Associations with health and disability

- Cognitive impairment was strongly associated with skeletal frailty
- Skeletal fragility was found to be worst amongst people who reported:
    - arthritis
    - muscle weakness
    - poorer self-rated health
    - limitations in activities of daily living.

Associations with mobility and function

- Skeletal fragility is related to reported mobility, especially to reported walking disability – maximum walking distance and walking aid use.
- Walking distances reported many years before the latest survey's ultrasound scans also show associations with these bone measurements.
- Observed mobility in all weight-bearing functional tests – static and dynamic balance tests, including chair rises, and gait speed – were found to be strongly associated with the quantitative ultrasound scan results.
- Hand grip-strength is not a useful predictor of skeletal ultrasound parameters in either men or women although the two measures appeared to be related in the sample overall.

Fracture risk factors identify skeletal fragility

- Risk factors for fracture valid for a younger age-range of elderly women – previous fracture since the age of 50, low weight and inability to stand up from a chair without using arms – are associated with lower broadband ultrasound attenuation amongst nonagenarian men and women in this study.

CHAPTER 11

CONTEXT, IMPLICATIONS AND CONCLUSIONS

11.1 Brief resumé of findings

11.2 Strengths and limitations of the study
- 11.2.1 Strengths of the study
- 11.2.2 Limitations of the study

11.3 Current context
- 11.3.1 Ageing, disability and healthy life expectancy
- 11.3.2 Moving forward

11.4 Reflections on implications for policy, practice and further research
- 11.4.1 Approaches to falls prevention
- 11.4.2 Findings in relation to current recommendations
  - 11.4.2.1 Mobility and maintaining function
  - 11.4.2.2 Bone health
  - 11.4.2.3 Targeting high risk or all the “oldest old”?
- 11.4.3 Risk reduction, independence and quality of life
- 11.4.4 Possible further research directions

11.5 Conclusions

11.1 Brief resumé of findings

This study was based on the 2002 – 2003 follow-up survey of 110 men and women aged over 90 years old from the Cambridge City over-75s Cohort, a population-based longitudinal study of ageing. Data collection comprised a standardised nurse-administered questionnaire with cognitive assessment, functional performance testing, quantitative heel ultrasound scans and a year's prospective monitoring of falls. As the project nurse and administrator for this wave of the study, I conducted all the interviews (99 participants in their usual place of residence + 35 proxy informants, 84% response rate), assessments, scans and the phone-calls or visits for the falls follow-up phase.

The findings presented in this thesis characterise a representative sample of very old people. The survey revealed high levels of mobility disability, cognitive and sensory impairment, previous fractures, recent falls and the use of multiple medications including psychotropic drugs. It also found high levels of social support, self-rated health and measures of well-being.

The data provide population norms for a range of measures of physical function in extreme old age, and analyses presented show the close inter-relation of these objective tests of mobility to reported levels of walking disability and physical activity. This is the first population-based study of over-90-year-olds to report calcaneal ultrasound results, providing important normative heel ultrasound data for a population more than a decade older than the manufacturer's reference range, and revealing skeletal fragility is markedly more severe than reported from studies of younger old people.

The detailed, intensive, prospective collection of fall reports for a year after interview is a unique data source, not previously reported in a population-based sample of this age. It revealed even higher prevalence of falling – 60% – amongst people over 90 years old than the 50% of people over 80 reported in previous studies, with an incidence rate of 277 falls per 100 person-years. Three-quarters of the study participants who fell, or 45% of the full sample, had more than one fall during follow-up. Findings also showed high levels of falling alone (80%), being unable to get up from the floor on at least one occasion (80%, of whom a third were on the floor for at least an hour), minor injuries (3/4 of injuries were bruises or swellings), injuries requiring treatment (more than half

of the people who fell needed some form of treatment for at least one fall, but more than half of all the falls never presented to health service attention), fractures (one in ten of the women who fell during follow-up sustained a fracture, mainly hip fractures), hospitalisation (two-thirds of all hospital admissions during follow-up were due at least in part to falling, of which two-thirds were specifically due to falling) and transfers to long term care (1 in 7 of those not already in care moved into a home during follow-up and falling played a part in the majority of these moves).

Falls, adverse consequences of falling such as being unable to get up, and skeletal fragility were found to share in common a pattern of strong associations with a number of key risk factors, particularly impaired mobility (reported walking disability and observed poor functional performance, especially in dynamic balance tests) and characteristics typical of frailty (cognitive impairment, incontinence, multiple co-morbid conditions and poor self-rated health). In univariate analyses additional factors that appeared to be highly predictive included reported balance problems, fear of falling and recalled falls in the previous year, and many other factors – including arthritis, reported muscle weakness, difficulty with activities of daily living – were also linked. However, these were not predictive of falls when adjusted for the effects of the key mobility and frailty indicators.

11.2 Strengths and limitations of the study

11.2.1 Strengths of the study
11.2.2 Limitations of the study

11.2.1 Strengths of the study

This unique cohort is still a truly population-based sample that remains highly representative, in part due to systematic tracing of surviving study participants despite more than half having moved since last interviewed. Moreover, careful attention to recruitment into the current survey ensured that a low refusals rate was achieved: for only 16% of living survivors was it not possible to obtain even proxy informant data.

The study has collected population norms for a wide range of measures to characterise the health, well-being and function of older people who have reached an advanced old age, over 90 years old. The robust methodology using multiple sources of information minimized the anticipated difficulties of inconsistent or missing data. Objective measures were found to lend support to self-reported measures. The vast majority of participants who were interviewed in person agreed to additional measurements of physical function and most of them also had quantitative heel ultrasound scans. All these provide valuable descriptive epidemiological data on a rapidly growing section of the population. Furthermore, these data allow for extensive exploration of a variety of factors that have been previously identified as predicting fall or fracture risk, re-examining them in relation to falls reported in extreme old age.

No other study to date has gathered prospective falls data specifically from old people of such advanced age representative of their population base. Intensive 12 months' follow-up covered the full sample, with methods that proved to be feasible and well accepted. Indeed there was great willingness on the part of the old people in the study, as well as both formal and informal carers, to help with fall reporting – an indication of the high importance attached to the problem of falling amongst older people.

In addition to these advantages in the study design and implementation of the current study itself, it gains added value by being the latest in a series of data collections from the same cohort. It was therefore possible to add a longitudinal perspective to some

analyses, although it is beyond the scope of this thesis to develop this additional angle further because of the wealth of findings to report from the cross-sectional survey measures and the year's follow-up data. However, the contribution of this latest wave of interviews, physical measures and prospective data on falls, injuries and hospital or care home admissions to the CC75C data archive represents a considerable addition to this rare resource with enormous potential for future research exploring longitudinal falls risk predictors.

11.2.2 Limitations of the study

This project builds on a long-standing study with the methodology already in place which clearly imposes some limitations. No fracture data, ultrasound or functional measures were collected in earlier interviews so this aspect cannot be approached longitudinally. There was also no funding for blood samples to examine serum vitamin D associations with housebound status, bone, muscle, balance and fall measures. In order to keep the functional testing within a reasonable time limit for these very old study participants it was not possible to assess all the domains that would ideally have been examined including reaction time, co-ordination, proprioception, muscle power and specific muscle groups such as the ankle flexors. The CC75C interview included extensive assessment of cognition, but no 'dual-task' measurements were made of the effects on functional performance of a simultaneous cognitive task. A decision also had to be made to take each functional measurement only once, despite evidence that better estimates may be obtained with more than one repetition; repeatability is reported to be best for the simplest tests[849] and it is hoped that the selection of measures, particularly those already assessed as having high repeatability[619;629], may minimise the effects of this protocol drawback.

As in any falls research, there is always the possibility that recall bias or other factors may have contributed to under-reporting of falls, even in the prospective follow-up period. As discussed in Chapter 9, this would not weaken the study findings, indeed would most likely imply even higher rates of falling and subsequent complications, and could mean the study has under-estimated the strength of associations found with cognitive impairment.

The sample size in this survey was pre-determined by the survival of the cohort and no longer has the power to determine the significance of findings for relatively rare endpoints such as fracture, though hip fracture incidence was noted to be far higher than previous estimates from slightly younger populations. Whilst recognising this is a limitation to a study of fall consequences, participation still exceeded numbers in the "90 plus" age range included in many larger population studies. For any future larger scale study concentrating on this age-group sample size calculations would need to be based on age-specific mean values, ranges and standard deviations of functional and physical measures, and on accurate estimates of fall and injury rates. Thus the data gathered in this study are not only valuable in terms of descriptive epidemiology, but may also be viewed as pilot work for future research.

11.3 Current context

11.3.1 Ageing, disability and healthy life expectancy
11.3.2 Moving forward

11.3.1 Ageing, disability and healthy life expectancy

There were already almost 400,000 people aged 90 or older in 2003 in the UK, 0.7% of the total population. Projections put the figure for 2031 as more than double that, amounting to 1.6% of the UK population[2]. The largest single cause of the rising population of nonagenarians and even centenarians has been identified as the trend of falling death rates amongst octagenarians[11]. Different scenarios have been proposed for the future size of the "oldest old" population that extrapolate from different possible levels to which old age mortality might decrease[850], and the implications of these wide-ranging projections for future health and social care provision are a major source of uncertainty. Government projections have to gauge which of Kannisto's hypothetical trends will provide the most realistic scenarios on which to base future budgetary estimates.

Increased longevity and the compression of morbidity is leading the concentration of mortality into the later years of later life. Dying over the age of 85 used to be uncommon, but by 2003 the proportion of deaths over this age out of all deaths was 20% for men and 40% for women, 2.5 times the fraction these older old age deaths had been in 1960.[2]. This in part accounts for the growing proportion of care budgets spent on the very elderly, as health costs for people of all ages are higher immediately preceding death, though some researchers have pointed to lower spending on older people than on younger people dying from equivalent conditions[851].

Older people are already "the core business of the NHS"[852] but the extent to which health and social care resources will need to be increased to provide for older people's needs will be determined not just by life expectancy but crucially by healthy life expectancy. Just as population projections vary, so too do projections of the burden of disease and disability, heavily influenced by changes in current chronic disease and injury prevalence and incidence[51;853]. There are some encouraging trends: functional disability has been declining such that the number of people in the UK currently unable

to perform four activities of daily living is less than a third of the number that had been predicted 30 years ago, and more recent forecasts estimate that even in 60 years time this number will not have reached half the earlier projection for current levels[51;854]. The prevention and management of long term conditions are now receiving considerable attention from policy-makers[855], deservedly so given that the prevalence of major chronic disease groups affecting older people – musculoskeletal, circulatory, sensory and respiratory illnesses – is set to increase by 50% over the next quarter century at which point levels are forecast to plateau out[51;856].

By contrast, hip fracture rates are already 50% higher than was forecast 50 years ago that they would be by now and are expected to continue rising steeply for the next half century to at least double the current incidence[51;857]. Fall-induced deaths are rising steeply amongst older Scandinavian men but have declined there for women until 30 years ago when they levelled off[213]. In the UK hip fracture mortality is lower than 40 years ago but has seen little change in the past 20 years[295]. Improved survival after serious fall injuries such as hip fracture has implications for the prevalence of resultant disability and dependence. There is a growing body of evidence that there are modifiable determinants of old age disability[858], not only disability arising from the most common long term illnesses, but also that due to accidental falls[350;570;610;859;860]. Indeed there is considerable overlap between the risk factors for falls and those for disability as a whole, particularly the risk factors for which evidence is strongest – low levels of physical activity, lower extremity functional limitation, visual impairment, cognitive impairment, depression, poor self-rated health and burden of co-morbid chronic disease[12]. In public health terms, the imperative is to apply this evidence to prevention so that even modest individual level risk reductions, or the postponement of disability onset by even a few years, may contribute to significant population level gains in healthy life expectancy[14;861].

11.3.2 Moving forward

Increasing professional and policy awareness
Evidence into action

Increasing professional and policy awareness

Since the turn of the millennium, when accidents were highlighted as a national priority in the UK government White Paper 'Saving Lives: Our Healthier Nation'[862] there has been an increasing awareness of older people's falls as an issue of high importance. Injury prevention used to focus on road traffic and young children's accidents, ignoring the 'hidden injury' associated with falls by older people, as more than three-quarters of deaths due to falling occurred at home[304]. Clinicians, service-providers and politicians are beginning to move on from the attitude that falling was an inevitable part of ageing, one of the 'geriatric giants' that medical students were traditionally taught there was not much could be done to avoid. There has been a series of new policy initiatives and guideline developments in recent years pushing falls prevention up the agenda. The National Service Framework for Older People[863] moved on from the earlier Green and White Papers' listing of accidents in general to the specific inclusion of falls and, by setting national targets and milestone dates, sought to accelerate the development of falls services nationwide. This and other government moves, including the National Falls Collaborative and Healthy Communities Collaborative on Falls through the National Primary Care Development Team, have in many areas prompted new or existing health improvement plans to specify service needs, set up local assessment procedures and produce care pathways, but progress has been uneven. At the same time other important strategy documents and guidelines from a range of specialist and professional bodies, notably the recent guidelines from the National Institute for Clinical Excellence[617] on the assessment and prevention of falls, are also helping to raise professional awareness of this important issue (see Appendix A *Guidelines relevant to the prevention and management of falls and fall injuries*). Fall prevention is on the international agenda as well[350], specifically mentioned in the World Health Organisation's key targets for their policy framework on ageing[864;865], as rising hip fracture rates look set to threaten the developing as well as developed world.

Evidence into action

Supporting such policy developments, there has also been an explosion of falls research, arguably emerging faster than can be assimilated by the growing body of expert

reviewers[866], such as the Cochrane Collaboration and the Prevention of Falls Network Europe, who are making important contributions in synthesising the evidence on fall assessment, management and prevention for practitioners and policy-makers (see Appendix B *Reviews of the epidemiology and prevention of falls, fall injuries and subsequent consequences*).

There have been calls for action to implement existing evidence[867-870], but with the caveat that limited resources need to be concentrated where evidence suggests they can be effective[870;871]. Developments aiming to identify high risk groups, including through primary care based falls registers, are focusing attention on the need for evidence-based assessment tools[258;872;873] and appropriate monitoring systems[874]. Experts have been careful to stress the importance of "rigorously select[ing] the right actions for those people most likely to benefit"[610] and pertinent questions have been raised that relate closely to the current study: "Are all falls of equal impact …? Should the aim of intervention strategies be to prevent all falls or prevent ones which impact on the function of the older individual? Can we extrapolate data from one population and apply it to another – will the effect of the intervention be the same?"[870].

11.4 Reflections on implications for policy, practice and further research

11.4.1 Approaches to falls prevention
11.4.2 Findings in relation to current recommendations
11.4.3 Risk reduction, independence and quality of life

This study was purely observational but it is important to consider the potential implications for prevention of falls and injuries amongst the oldest old.

11.4.1 Approaches to falls prevention

It has long been known that fall rates are higher amongst the frailer elderly than the more active[181;233], and trial results have been interpreted as suggesting that interventions tend to be more effective with frailer older old people who have more risk factors. Given that intrinsic risk factors account for an increasing proportion of falls amongst over-80-year-olds[172], one approach has been to consider what factors may be amenable to intervention and target preventive strategies towards individuals identified as at high risk[616]. Another approach, as yet not well evaluated for falls prevention, is to consider population-wide interventions that aim to shift the distribution of risk factors, achieving perhaps only minimal individual-level changes but maximising the reduction in population attributable risk[858;860;861;875;876].

For both individual risk factor modification and population-wide intervention the approaches to fall and injury prevention that are most consistently found to be effective are multi-factorial ones[350;570;610;859-861;877]. This is hardly surprising: it is well established, and the current study confirms, that the aetiology of falls is multi-factorial, and that there is a further complexity of factors that affects whether a fall results in a fracture or other injury, then also whether a fall with or without any injury leads to subsequent increased health and other care needs. Of the range of components in successful preventive interventions to date, there are a number that relate to some of the key findings from this study, as the following sections highlight.

11.4.2 Findings in relation to current recommendations

11.4.2.1 Mobility and maintaining function
Benefits maintained into very old age
Non-linear relation of mobility, function and falls
11.4.2.2 Bone health
Screening with quantitative ultrasound
Walking
Prescribing
11.4.2.3 Targeting high risk or all the "oldest old"?
Which "oldest old" people are most at risk?
Older people with cognitive impairment

11.4.2.1 Mobility and maintaining function

Benefits maintained into very old age
Non-linear relations between mobility, function and falls

Benefits maintained into very old age

One of the most important findings of the current study is its demonstration that even modest levels of physical activity are strongly associated with higher functional performance and lower risks for falling and the serious consequences of falling, even in the tenth decade of life. Still managing to walk around the local area, better still taking occasional walks for the sake of walking, that is not just to the shop, and keeping up a little gardening significantly affected fall rates amongst nonagenarians and greatly improved the likelihood of being able to get up in the event of a fall. However, non-specific "other exercise" – in this sample generally reported by some of the less mobile (though not the least mobile) who nonetheless tried to carry on with some unsupervised exercises, mainly flexibility and range of motion moves – was not protective against falling, indeed it slightly increased risk. An urgent challenge for future research and practice is to ensure that such well-motivated individuals have access to appropriate guidance: evidence that muscle function and balance can be improved by training even beyond 90-years-old is not new[389;878] but is rarely applied[610;879]. There was great willingness amongst many of the nonagenarians in the survey to do all they could to keep mobile and thereby maintain as much independence as possible: they endorsed the "use it or lose it" ethos and the group who took inadequate "other exercise" would clearly stand to benefit from individually targeted, progressive training of strength and balance that has been shown to effectively reduce falls risk in at least over-80-year-old women[880] at home and in tailored group exercise[932]. Training in strategies for getting

up from the floor is also rarely used despite growing evidence for its effectiveness[299;881;882; 932].

Non-linear relations between mobility, function and falls

Both approaches to fall prevention – complementary strategies seeking to target high-risk individuals and population-based interventions – need to be aware of the potential risks as well as benefits. The curvi-linear relation between strength and function[878;883] implies that the most frail could gain more than relatively high-functioning older people: function can be improved markedly by small increases in muscle strength from very low levels whereas functional improvements are minimal when an equivalent strength gain is achieved by an already stronger person[369;884].

However, there is also a non-linear relations found between physical activity and fall risk. Falls rates have been reported as lowest amongst the least mobile, intermediate for the most mobile and highest amongst older people who are not immobile but who have only limited mobility. Such findings are common from studies in institutional settings[191;432;438-440], but also come from community studies of more disabled groups[437]. Likewise injury rates have also been reported as least amongst those with most limited function but highest amongst those who could manage some activities without help[438;440]. Thus strategies aiming to shift the population distribution of physical activity even slightly, though they may produce the benefits of improved function and hence quality of life, may also have implications, especially for the most impaired.

11.4.2.2 Bone health

Screening with quantitative ultrasound
Walking
Prescribing

Screening with quantitative ultrasound

New NICE guidelines on osteoporosis treatments[885] recommended that bisphosphonate treatments can be prescribed on the basis of fracture risk factors for women aged over 75, as well as younger women, for the secondary prevention of osteoporotic fracture. This endorsed findings that bisphosphonates reduced fracture rates for even the very old, although clinical trials only found evidence for this effect in women aged over 80-

years-old if their bone density was lower than the WHO definition of osteoporosis[886]. This raises again the question of whether quantitative ultrasound (QUS) might have a role to play in identifying those at risk, particularly as prospective studies have shown it to predict fracture as well as DEXA at this age[691]. However, although no studies have examined its predictive validity for fractures in the over-90s, it has been reported that QUS measures do not add to the ability of clinical risk factors to predict hip fractures in a sizable primary care study with 5½ years' follow-up of almost 1300 women aged 70 or older[698]. In the current study the ultrasound parameter broadband ultrasound attenuation (BUA) distinguished over-90-year-olds with and without a history of fracture over the age of 50 years, men as well as women, but fracture was not a prospective end-point. However, the BUA range indicated skeletal fragility was severe for all the women and most of the men, suggesting that in advanced old age ultrasound measures are even less likely to add to fracture prediction based on clinical risk factors.

Walking

Observational evidence already abounds for the benefit of walking to the skeleton in younger ages, and the current study's findings now extend this into old old age. As discussed above, walking mobility links with many inter-related factors and the direction of causation cannot be assumed from observational data. The longitudinal analysis may add to the cross-sectional data illustrating associations between walking disability and bone fragility but cannot exclude the effects of confounding factors such as illness and disability predating and contributing to both the past mobility levels and current skeletal measures. Caution is also called for in interpreting the current study's findings, from only a small sub-sample, that unilateral lower limb injury or disability related to worse side-specific ultrasound measures, perhaps mediated through decreased weight-bearing and bone-loading on the affected side. However, these results suggest interesting avenues for further research to confirm the findings, and the implications for prevention also need careful consideration in the light of the non-linear relation between activity levels and fall risk discussed above (see section 1.2.5.2 Muscle weakness, balance, mobility and functional limitation and 11.4.2.1 Mobility and maintaining function). A previous trial of brisk walking[887] as an intervention to increase bone density in postmenopausal women after a recent upper limb fracture led to increased fall rates, even in this predominantly younger old age-group.

Non-pharmacological interventions to reduce fracture have been tested in miniscule numbers compared with the scale of drug trials for osteoporosis[611;888], despite the established role of non-bone health factors in fracture aetiology[165;166;238;290]. A new review[889] identified only six randomised-controlled trials of lifestyle interventions specifically to prevent osteoporotic fractures with a mere 1,656 participants in total. Three exercise trials showed a reduction in spinal fractures, two multi-factorial interventions and a study of the effects of sunlight exposure reduced hip fractures but none of these findings reached statistical significance, not surprising given the much larger numbers needed to prove fracture prevention. As the review authors and others[888] point out, this is an area in urgent need of further research with larger-scale, higher-quality trials of the effect of falls prevention interventions on fractures.

Prescribing

The extent of prescribing to protect against fracture found in the current study was limited, consistent with findings from other studies. Previously reported rates vary across locations and patient groups studied, from between 2% and 27% in north American patients with hip[890;891], wrist[892] and other low trauma fractures [893-895]. In the UK a case-control study using the General Practice Research Database[896] found fewer than 10% of hip and wrist fracture cases took any bone drugs either before or after fracture, rates no different from their controls, though prescribing rose to 39% after vertebral fracture. A postal survey of GP patients aged 65 and over in Bristol, UK, found even lower rates: only 1% of their respondents who had fallen or nearly fallen in the previous year, and only 2% of those who had presented to their GP or casualty because of a fall, had started on any medication to protect against osteoporosis[897]. Only 18% of CC75C participants were on prescribed bone-protective medications – just one on an anti-resorptive, the remainder on calcium or calcium+vitamin D preparations – slightly higher prescription rates than reported elsewhere in the UK. However, given their high prevalence of previous fractures (half had suffered at least one fracture since they were 50 and a fifth had had a hip fracture) and the long-standing evidence for fracture prevention by supplementing the institutionalised and housebound[574;575] (see Chapter 1 section 1.2.5.8) this is still alarmingly low. It has been suggested that such fracture-preventive prescribing declines with increasing age[892], and in UK residential care settings the lowest rates were found in 'elderly mentally infirm' nursing homes[249;898].

The slow up-take in this oldest age group may be due to complex factors. In the current survey there were high rates of medication for multiple co-morbidity, as with the majority of older people, a possible disincentive to adding combined calcium with vitamin D preparations that must be taken daily. There may be a perception, on the part of these older people themselves and health professionals, that there is little point in initiating treatment when "too old". Side effects, especially from calcium formulations, may be more common amongst frailer older people and thereby discourage both prescription and adherence. Intermittent dosing regimes may provide one way forward but findings to date are contradictory: annual[583] and 4-monthly[578] oral doses are reported to reduce fractures but annual bolus injection was not found to be effective for primary fracture prevention in community-dwelling older people[586;899]. Recent trials that found no effect of calcium or vitamin D on secondary fracture prevention[587;588] are not in line with recent meta-analyses that confirm vitamin D's association with fall and fracture reduction[584;585], and are not inconsistent with a role for preventive prescribing for vitamin D deficient older people, given the unknown vitamin D status of those trial participants[900]. Failure to take any preventive action is not an acceptable option[901;902]: a Spanish study found only 6% of hip fracture patients were prescribed fracture-preventive drugs on discharge and 22% sustained a further hip fracture within five years[903]. One in ten of the CC75C women who fell during one year's follow-up sustained a fracture. These findings highlight the need for further research to provide clinicians and policy-makers with the evidence base for informed and effective prescribing in this age group.

11.4.2.3 Targeting high risk or all the "oldest old"?

Which "oldest old" people are most at risk of falls?
Older people with cognitive impairment and dementia

Which "oldest old" people are most at risk of falls?

The CC75C survey measured a broad range of characteristics descriptive of a representative nonagenarian population, many of them factors previously reported to be linked with falling. In univariate analyses examining these potential fall risk factors, many easily ascertained clinical characteristics or reported measures were both associated with and often also predictive of falls and repeated falls.

The study findings particularly confirm the value of self report: many older people themselves are well aware of the risk of falling and their assessments of their own risk ratings are often accurate. Self-reported balance problems and lack of confidence in carrying out daily tasks not only predicted falling but were also all strongly linked to increased risks of moving into institutional care during follow-up, likewise worry about falling which also predicted hospital admissions for falls, sadly suggestive that these concerns were well-founded. Although in this age group with widespread functional disabilities few performance tests identified which people had either fallen the previous year or who would fall in the subsequent year, reported mobility limitations were far more strongly and consistently associated with falls and other follow-up outcomes – being unable to get up after falling, moving into care and mortality. Low self-rated health showed the highest risk estimate for falls of any single covariate, and was the health factor most consistently predictive of admission to hospital or long-term care. Current guidelines[616] advise clinicians to ask older people themselves whether they have had any falls in the previous year, as routine practice to identify those at risk.

Modelling the study data to identify which of so many predictors are the key risk factors initially indicated that a history of falling in the previous year, and particularly falling more than once, indeed appeared to outweigh many other factors. This finding is in line with the majority of earlier studies but, as some other researchers have also noted[219;630], including previous falls in a model to predict further falls obscures the ability to examine other causal factors that may also have contributed to the previous falls. Subsequent modelling showed that the factors identified from the current study as independently predicting falls, regardless of previous fall status, included several which could be viewed as markers of generally poor health and functional status – multiple co-morbidity, incontinence, limited mobility and low self-rated health. Other frailty indicators, including impaired cognition and function in activities of daily living, were also found predictive of falling in univariate analyses, adding to a picture of a 'high risk' individual.

One interpretation might be that any very old person affected by these signs and symptoms of declining function can be regarded as having an increased risk for falling. Asking older people about whether they have fallen recently to identify those most at

risk, as current guidelines advise, would thus overlook many of the oldest old for whom the risks appear to be as great. This is not to suggest that older people who present to health services after a fall, or who report falling on questioning, should not receive full assessment and preventive intervention as appropriate. Recurrent fallers may run higher risks of injury including fracture[832], but there is also evidence suggesting that isolated falls tend to result in more major injuries while multiple falling leads to more minor injuries[353], while other research has found no difference in the severity of fall sequelae resulting from single or recurrent falls[224]. The difference is that people who may suffer a "one-off" fall with serious consequences are more difficult to identify. In the current study no health-related risk factor could be found to independently predict increased risk for the people who recalled no recent falls or only one fall in the past year.

A further important question arising from the study's modelling of independent risk predictors is what the practice implications may be. Identifying modifiable risk factors has been validated as a useful approach to the prevention of general functional decline[904] and, as mentioned above, is the crucial issue in falls prevention amongst the very old. Incontinence appears to strongly predict falls in the current study, but to date only one study has specifically included toileting and continence care as part of a fall prevention intervention[931], so there is insufficient evidence on the extent to which this may be a modifiable factor. Socio-demographic influences cannot be altered at the later end of life, and medical factors – multiple pathology including dementia – are arguably not easily amenable. There is, however, a wealth of existing evidence to suggest that mobility can be improved even in very old age (see Chapter 1 section 1.2.5.2 Muscle weakness, balance, mobility and functional limitation) and this may be the factor identified in the CC75C study that could be most amenable to modification (see also above, section 11.4.2.1 Mobility and maintaining function).

Older people with cognitive impairment and dementia

An area in which there is still a singular lack of evidence to support the way forward is fall and fracture prevention for the cognitively impaired. Despite the encouraging efforts being addressed to fall prevention in institutional settings over recent years, there have been negative[244;905-907] (perhaps under-powered) as well as positive[908-910] results reported from a range of interventions. The majority of these studies include cognitively impaired participants but many do not report what proportion of residents

had dementia[244;910], and most do not offer sub-group analyses of intervention effects on the cognitively impaired participants[244;906-908;910]. Caution in extrapolating from findings is therefore important: one Swedish trial in residential care and sheltered housing reduced the proportion of residents who fell as well as the fall and fracture rates overall, but had no effect amongst those with cognitive impairment[909].

Although in the UK the vast majority of the most cognitively impaired or demented live in care homes, it has been reported from a study in Newcastle of older people attending accident and emergency as a result of a fall that a third of those with MMSE scores in the range 12 – 23 were living in the community[744]. To date there have been no trials to prevent falls amongst community-dwelling cognitively impaired older people[911], and the only evidence comes from this same Newcastle study – a randomised trial of a multi-factorial intervention for cognitively impaired fallers presenting to A&E that showed no effect overall nor in sub-group analysis of the small number of participants who were not living in care (only 60 out of 274). The contributory role of severe cognitive impairment to falls risk in advanced old age found in the current study adds weight to argument for more work in this challenging area[912].

11.4.3 Risk reduction, independence and quality of life

Lay awareness of falls and risk
Uptake or refusal of falls prevention interventions
Not all risk can be eliminated
Maintaining independence
Successful ageing into advanced old age

Lay awareness of falls and risk

Just as professional and political awareness about falling amongst older people is improving, so too is awareness amongst the general public, but especially amongst older people themselves and lay carers. As the special theme of the latest survey in the long-running CC75C study, falling was readily acknowledged by study participants and their relatives as an important topic for research. However, although concerns clearly run high, awareness of falls prevention strategies appears to be quite low. Surveys of older people have reported some awareness that falls might be preventable but also a general perception, amongst community-dwelling older people, that they were not susceptible to the risks[913]. Between two-thirds and three-quarters of older people who had fallen

recently did not consider themselves at risk of falling again[138;171]. In one study, falls were reported to have prompted a plan to change behaviour or environment[171], but the literature on behaviour or lifestyle changes in advanced old age is sparse[323;914;933;934].

Uptake or refusal of falls prevention interventions

Recent work has highlighted the need to understand older people's attitudes towards falls prevention, the reasons for uptake of or resistance to professionals' offers of preventive interventions, and perceptions of risk[323]. A report on a series of focus groups and a survey of over 700 people aged 60-95 for the charity Help the Aged pinpointed a widespread reluctance to be labelled as a "faller", considerable negative views on what could be taken as patronising approaches to risk reduction, yet an equally widespread enthusiasm for doing as much as possible to help oneself remain active and independent, suggesting an "accentuate the positive" approach may be most acceptable and therefore most effective. These are important conclusions, taking forward earlier work that concluded "Not all falls are preventable and not all old people who fall are bothered enough about doing so to attend a 'falls group'. Many consider that they have more interesting things to do."[915]

Not all risk can be eliminated

Caution has been voiced about official guidelines that may foster practices aimed at minimising falls, perhaps to the overall detriment of older people[916;917]. The current study has shown that immobility is clearly associated with minimal falls risk, thus a focus on encouraging more activity could run the risk of increasing falls. One of the editorials that appeared when the National Institute for Clinical Excellence falls guidelines[617] were being prepared quoted an example from a quarter century ago: "A spectacular reduction in fall rate was reported during a nurses' strike, as patients were left in bed and not mobilized [918]", concluding that "A risk free life is no life at all"[916].

Maintaining independence

The positive message on mobility from the current study is that, even in very old age, keeping active helps to maintain physical functioning and, if active enough, may lower the risk of falling and some of the adverse consequences of falls. There are implications for younger old people, that maintaining walking ability even in one's 70s or 80s may, besides all the other benefits of physical activity, also help ameliorate the severe effects

of age on the skeleton. The findings that so many people could not get up when they fell adds weight to an earlier call to focus fall prevention initiatives on reducing concerns about falling, for example teaching older people how to get up if they fall[919].

The challenge is to strike a balance between encouraging lifestyle options that increase the chances of ageing well, allowing the autonomy and choice essential for quality of life, and minimising the risk of a fall with the possible devastating consequences that also severely affect quality of life.

Successful ageing into advanced old age

Few researchers have found out from old people themselves what successful ageing means to them[920-922], but one time trade-off study has reported that 80% of the women aged over 75 years in an Australian sample 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[736]. Older people report that the impact on quality of life of functional disability resultant from long-term conditions is four times as great as the impact of the condition itself[923]. There is long-standing evidence that targeted physical training can achieve the equivalent of one to two decades "rejuvenation" in muscle strength and aerobic power[441], contributing to significant functional improvements[924], a health promotion message that may have more appeal than the negative image that goes with fall prevention[323]. Classic definitions of successful ageing, such as the rather traditional medical model proposed from the McArthur Studies, have emphasised absence of disease, avoidance of risk factors and maintenance of function as key elements; however, these do not appear to concur well with older people's self-reported views of how successfully they feel they are ageing[920]. With the exponential growth of the very old population, it is all the more important to seek their views on the relative importance of risk reduction, maintaining independence and what other aspects make for quality of life at the later end of life[922;925].

11.4.4 Possible further research directions

The methodological challenges of research in this potentially sensitive topic have been discussed; the psychosocial impacts for an older person who falls and those involved in their care include the fear of falling and its consequences, related fears of loss of independence, and help avoidance such as the reluctance to summon assistance or report falls. The contribution of epidemiological studies of risk factors to public health should ultimately be to inform the development of preventive interventions, but better understanding of the motivators of health behaviours is a pre-requisite for success in any such interventions. This thesis concentrates on quantitative research objectives, and its limitations prevent the fuller exploration of these complex issues that they merit. The application of qualitative research methods to further data that I have collected but not presented could yield new perspectives. Half of those interviewed have died since, a statistic that emphasises the extent to which this cohort represents an "end of life" population. Quality of life, autonomy and its loss, and the socio-economic aspects of the provision of care for the very aged are all potential new directions related to the impact of falls at the personal, familial and societal levels.

11.5 Conclusions

Contribution of this research

- **The description of a representative population aged over 90** is in itself of value to social and health service planners preparing for demographic change. This revealed high levels of many fall risk factors including mobility disability, cognitive and sensory impairment, previous fractures, recent falls and the use of multiple medications including psychotropic drugs.

- **Detailed characterisation of functional status in advanced old age** shows close agreement between reported levels of disability and performance tests.

- This **first population-based survey of skeletal fragility in the tenth decade** and beyond found extremely low calcaneal quantitative ultrasound measures, markedly lower than previous studies with younger old people. Skeletal fragility reflected reported mobility and physical activity, including past maximum walking distance, and also showed associations with weight-bearing functional test performance.

- The one-year follow-up data collection monitoring falls and their adverse consequences is the **first prospective study of falling amongst people aged over 90 years old in a representative population-based sample.** Findings show falls are even more common and frequent at this advanced age than previous studies have reported for "very old people" a decade younger. In the current study 60% fell at least once during follow-up, 45% more than once, and incidence was 277 falls / 100 person-years, with minimal gender difference. Most falls occurred alone, most people were unable to get up when they fall, and the vast majority did not use available alarm systems to call help. Findings also showed high levels of injuries including fractures, hospitalisation and transfers to long-term care.

- Falls, adverse consequences of falling and skeletal fragility were found to share in common a pattern of strong associations with a number of key risk factors, particularly impaired mobility and characteristics typical of frailty; fracture risk factors were also associated with skeletal ultrasound measures. Functional tests added no predictive value to reported clinical risk factors.

Implications - ***Identifying very old people at risk***

- Reported measures of function – simple clinical risk factors – were more predictive of falls risk than objective functional measures in this study sample, suggesting that there is no advantage to be gained from time-consuming resource-intensive performance testing in the over-90s age group.
- Very old people tend to be well aware of their own risk status – reported measures such as having difficulties with balance were largely self-reported (rather than reported by a proxy informant), and subjective measures such as worry about falling and self-rated health were entirely self-reported. These factors were strongly associated with falling in univariate analyses.
- Recall of falling in the past year closely matched fall prevalence reported prospectively over the following year, but recurrent falling may have been less well remembered; factors associated with recalled falling were generally also predictive of subsequent falls. Despite acknowledged difficulties with recall methods, these findings confirm the validity of asking very old people about recent falls.
- Severe cognitive impairment and recent fall history, both often strong fall risk factors, were only predictive of falls amongst this study's very old people in univariate analyses, outweighed by the importance of closely related factors indicative of general frailty – multiple co-morbid health conditions, incontinence, poor self-rated health and mobility. This could be interpreted as implying that very old people with these characteristics merit careful falls risk assessment and preventive intervention, whether or not they have fallen recently or are severely cognitively impaired.

Implications - ***Mobility and function***

- Even over the age of 90, moderate physical activity – such as maintaining the ability to walk around the local area – appears to protect against the risk of falling, reduce the likelihood of complications that can follow from not being able to get up after falling and is associated with less fragile bones. The study design cannot confirm whether this apparent slowing of age-related bone loss is sufficient to decrease fracture risk. The longitudinal relationships found between maximum walking distance and skeletal ultrasound measures suggest the contribution to bone health in extreme old age that can still be made by keeping active in earlier old age, an important health promotion message.
- Unspecified exercise appears not necessarily beneficial, in this study slightly increasing fall risk. It is important to ensure that older people, often aware of the importance of keeping mobile and keen to preserve their independence, have access to advice on appropriate targeted and progressive exercise strategies that offer them the benefits of evidence-based strength and balance training. The widespread inability to get up after falling reported in the follow-up study suggests many people of this age might also benefit from training in floor-rising techniques.
- The study confirmed findings from some earlier studies of frail older people that the most severe levels of disability confer a lower fall risk than the not quite so disabled. The implication could be that individually targeted or broader approaches that aim to improve the mobility of the most impaired may actually increase fall risk slightly, against which must be weighed the expected benefits of improved function and quality of life.

Implications - ***Bone health***

- Quantitative ultrasound distinguished between those with and without risk factors for fracture in this sample of over-90-year-olds but the very low range of broadband ultrasound attenuation readings suggest the technique is unlikely to add to fracture prediction based on clinical risk factors
- Bone protective medication had been prescribed for only a minority of study participants, despite over half having suffered fractures since the age of 50 and a fifth having already fractured at least one hip. During follow-up one in ten of the women who fell sustained fractures, most of them hip fractures. There is an urgent need to improve rates of prescribing to prevent fractures.

Implications - ***After a fall***

- More than half the falls reported during follow-up never presented to medical attention. 4/5 of falls happened when alone, 4/5 of people who fell could not get up from the floor and 4/5 of people alone and unable to get up did not use available call alarm systems to contact help. These findings, illustrating understandable reluctance to be identified as a "faller" for fear of losing independence, pose major questions for care providers on how to approach this sensitive issue.
- Falls accounted for the majority of hospitalisations and moves into long-term care during follow-up, with higher mortality if falling was the cause of admission to either. These data on subsequent outcomes reveal the major impact of falling in advanced old age on health service use and social care needs.

Appendix A

Guidelines relevant to the prevention and management of falls and fall injuries

Strategy for the secondary prevention of osteoporotic fractures - hospital-based approach.
National Osteoporosis Society, Bath, UK. 2005

Falls: the assessment and prevention of falls in older people.
National Institute for Clinical Excellence. Clinical Guideline 21. London, UK 2004

What are the main risk factors for falls amongst older people and what are the most effective interventions to prevent these falls? How should interventions to prevent falls be implemented?
Skelton, D. and Todd, C. pp28. Health Evidence Network - Evidence for Decision-Makers.
World Health Organisation Regional Office for Europe. Copenhagen, 2004

The care of fragility fracture patients.
British Orthopaedic Association, London, UK. 2003

Evidence-based guidelines for the secondary prevention of falls in older adults.
Moreland J *et al*. *Gerontology* 2003;**49**:93-116

Osteoporosis prevention, diagnosis and therapy.
National Institute of Health. NIH Consensus Statement. 17. pp45. USA 2002

Primary Care Strategy for Osteoporosis and Falls.
National Osteoporosis Society, Bath, UK. 2002

Position statement on the use of quantitative ultrasound in the management of osteoporosis.
National Osteoporosis Society, Bath, UK. 2002

Guideline for the prevention of falls in older persons.
American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. *J.Am.Geriatr.Soc.* 2001;**49**:664-72

Effectiveness of falls prevention and rehabilitation strategies in older people: implications for physiotherapy: Chartered Society of Physiotherapy Evidence Briefing. Lamb, S. E. pp33. 2001

National Service Framework for Older People.
Department of Health, London, UK. 2001

Guidelines for the prevention of falls in people over 65. The Guidelines' Development Group.
Feder G, Cryer C, Donovan S, Carter Y. *BMJ* 2000;**321**:1007-11

An update on the diagnosis and assessment of osteoporosis with densitometry.
International Osteoporosis Foundation Committee of Scientific Advisors.
Kanis JA,.Gluer CC. *Osteoporos.Int.* 2000;**11**:192-202

Physiotherapy Guidelines for the management of osteoporosis.
Chartered Society of Physiotherapists Mitchell, S.,*et al* pp49. London, UK 1999

Osteoporosis: clinical guidelines for prevention and treatment.
Royal College of Physicians, London, UK. 1999

Appendix B Reviews of the epidemiology and prevention of falls, fall injuries and subsequent consequences

	Epidemiological reviews	Reviews of falls prevention interventions
Falls, fall injuries, including fractures and osteoporosis risk factors - overviews	Close JCT, Lord SL, Menz HB, Sherrington C. What is the role of falls? *Best Practice & Research Clinical Rheumatology* 2005;**19**:913-35. Skelton, Dawn and Todd, Chris. What are the main risk factors for falls amongst older people and what are the most effective interventions to prevent these falls? How should interventions to prevent falls be implemented? Copenhagen, World Health Organisation Regional Office for Europe. Health Evidence Network - Evidence for Decision-Makers. pp28. 2004. Cummings SR,.Melton LJ. Epidemiology and outcomes of osteoporotic fractures. *Lancet* 2002;**359**:1761-7. Cryer, Colin and Patel, Sanjeev. Falls, fragility and fractures - National Service Framework for older people: the case for strategies to implement a joint Health Improvement and Modernisation Plan for Falls and Osteoporosis. pp58. 2001. Centre for Health Service Studies, University of Kent; St George's Hospital, London; Alliance for Better Bone Health. Perell KL,Nelson A,Goldman RL,Luther SL,Prieto-Lewis N,RubensteinLZ Fall risk assessment measures: an analytic review. *J Gerontol.A Biol.Sci.Med Sci.* 2001;**56**:M761-M766. Lambert M, Arblaster L. Factors associated with acute use of hospital beds by older people: a systematic review of the literature. *Shaping the Future NHS: Long Term Planning for Hospitals and Related Services. Consulation on the Findings of the National Beds Inquiry - Supporting Analysis*, pp 105-8. London: Department of Health, 2000.	McClure R, Turner C, Peel N, Spinks A, Eakin E, Hughes K. Population-based interventions for the prevention of fall-related injuries in older people. *Cochrane.Database.Syst Rev.* 2005; CD004441. Kannus P, Sievanen H, Palvanen M, Jarvinen T, Parkkari J. Prevention of falls and consequent injuries in elderly people. *The Lancet* 2005;**366**:1885-93. Skelton DA,.Todd CJ. Thoughts on effective falls prevention intervention on a population basis. *Journal of Public Health* 2005;**13**:196-202. Chang JT, Morton SC, Rubenstein LZ, Mojica WA, Maglione M, Suttorp MJ *et al*. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *BMJ* 2004;**328**:680. Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in elderly people. *Cochrane Database.Syst.Rev.* 2003; CD000340. Cumming RG. Intervention strategies and risk-factor modification for falls prevention. A review of recent intervention studies. *Clin.Geriatr.Med.* 2002;**18**:175-89. Hill-Westmoreland EE, Soeken K, Spellbring AM. A meta-analysis of fall prevention programs for the elderly: how effective are they? *Nurs.Res.* 2002;**51**:1-8.
…/continued below		

Appendix B cont.	**Epidemiological reviews**	**Reviews of falls prevention interventions**
…/continued **Falls, fall injuries, including fractures and osteoporosis risk factors - overviews**	Lord SR, Sherrington C, Menz HB. Falls in older people: risk factors and strategies for prevention. Cambridge University Press, 2000. Dowsell, T., Towner, E., Cryer, C., Jarvis, S., Edwards, P., and Lowe, P. Accidental Falls: Fatalities and Injuries - an examination of the data sources and review of the literature on preventative strategies. 1-81. 1999. University of Newcastle -a report for the Department of Trade and Industry Lilley JM, Arie T, Chilvers CE. Accidents involving older people: a review of the literature. *Age Ageing* 1995;**24**:346-65.	Tideiksaar R. Falls in Older people: Prevention & Management. Health Professions Press, 2002. Easterbrook, L., Horton, K., Arber, S., and Davidson, K. International review of interventions in falls among older people. London, Health Development Agency. pp86. 2001 Nuffield Institute for Health, University of Leeds and the Centre for Reviews and Dissemination, University of York. Preventing falls and subsequent injury in older people. *Effective Healthcare Bulletin* 1996;**2**:1-16.
Falls and injury - specific risks or populations **…/continued below**	*Muscle function and the role vitamin D* Venning G. Recent developments in vitamin D deficiency and muscle weakness among elderly people. *BMJ* 2005;**330**:524-6. Bischoff-Ferrari HA, Willett WC, Wong JB, Giovannucci E, Dietrich T, Dawson-Hughes B. Fracture prevention with vitamin D supplementation: a meta-analysis of randomized controlled trials. *JAMA* 2005;**293**:2257-64. Bischoff-Ferrari HA, Dawson-Hughes B, Willett WC, Staehelin HB, Bazemore MG, Zee RY *et al*. Effect of Vitamin D on falls: a meta-analysis. *JAMA* 2004;**291**:1999-2006. Moreland JD, Richardson JA, Goldsmith CH, Clase CM. Muscle weakness and falls in older adults: a systematic review and meta-analysis. *J Am Geriatr.Soc* 2004;**52**:1121-9.	*In the community* Weatherall M. Prevention of falls and fall-related fractures in community-dwelling older adults: a meta-analysis of estimates of effectiveness based on recent guidelines. *Intern.Med J* 2004;**34**:102-8. van Haastregt JCM, Diederiks JPM, van Rossum E, de Witte LP, Crebolder HFJM. Effects of preventive home visits to elderly people living in the community: systematic review. *BMJ* 2000;**320**:754-8. Lange M. The challenge of fall prevention in home care: a review of the literature. *Home.Healthc.Nurse* 1996;**14**:198-206. *In institutional care* Help the Aged Preventing Falls Programme. Preventing falls - Managing the risk and effect of falls among older people in care homes. pp1-20. 2004.

Appendix B cont.	**Epidemiological reviews**	**Reviews of falls prevention interventions**
…/continued **Falls and injury - specific risks or populations** **…/continued below**	*Muscle function and the role vitamin D* *…/continued* Latham NK, Anderson CS, Reid IR. Effects of vitamin D supplementation on strength, physical performance, and falls in older persons: a systematic review. *J.Am.Geriatr.Soc.* 2003;**51**:1219-26. Janssen HC, Samson MM, Verhaar HJ. Vitamin D deficiency, muscle function, and falls in elderly people. *Am J Clin.Nutr.* 2002;**75**:611-5. *Medication* Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: I. Psychotropic drugs. *J.Am.Geriatr.Soc.* 1999;**47**:30-9. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: II. Cardiac and analgesic drugs. *J.Am.Geriatr.Soc.* 1999;**47**:40-50. *Mental health factors* Shaw FE. Falls in cognitive impairment and dementia. *Clin Geriatr.Med* 2002;**18**:159-73. Cwikel J, Fried AV, Galinsky D. Falls and psychosocial factors among community-dwelling elderly persons: a review and integration of findings from Israel. *Public Health Rev.* 1989;**17**:39-50.	*In hospital* Oliver D, Daly F, Martin FC, McMurdo ME. Risk factors and risk assessment tools for falls in hospital in-patients: a systematic review. *Age Ageing* 2004;**33**:122-30. Oliver D, Hopper A, Seed P. Do hospital fall prevention programs work? A systematic review. *J.Am.Geriatr.Soc.* 2000;**48**:1679-89. NHS Centre for Reviews and Dissemination and Joanna Briggs Institute for Evidence Based Nursing. Falls in hospital. *Best Practice - Evidence Based Practice Information Sheets for Health Professionals.* 2(2), 1-6. 1998.

Appendix B cont.	**Epidemiological reviews**	**Reviews of falls prevention interventions**
Physical activity/ mobility/disability in relation to balance/falls/injury **…/continued below**	Heikkinen, Eino. What are the main risk factors for disability in old age and how can disability be prevented? 1-16. 2003. Copenhagen, World Health Organisation Regional Office for Europe. Health Evidence Network - Evidence for Decision-Makers. Jarnlo G-B. Functional balance tests related to falls among elderly people living in the community. *European Journal of Geriatrics* 2003;**5**:7-14. Skelton DA. Effects of physical activity on postural stability. *Age Ageing* 2001;30 Suppl 4:33-9. Gregg EW, Pereira MA, Caspersen CJ. Physical activity, falls, and fractures among older adults: a review of the epidemiologic evidence. *J.Am.Geriatr.Soc.* 2000;**48**:883-93. Startzell JK, Owens DA, Mulfinger LM, Cavanagh PR. Stair negotiation in older people: a review. *J.Am.Geriatr.Soc.* 2000;**48**:567-80. Stuck AE, Walthert JM, Nikolaus T, Bula CJ, Hohmann C, Beck JC. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc Sci Med* 1999;**48**:445-69. Joakimsen RM, Magnus JH, Fonnebo V. Physical activity and predisposition for hip fractures: a review. *Osteoporos.Int* 1997;**7**:503-13. Thornby MA. Balance and falls in the frail older person: a review. *Topics in Geriatric Rehabilitation* 1995;**11**:35-43.	Sherrington C, Lord SR, Finch CF. Physical activity interventions to prevent falls among older people: update of the evidence. *J Sci Med Sport* 2004;**7**:43-51. Borst SE. Interventions for sarcopenia and muscle weakness in older people. *Age and Ageing* 2004; **33**:548-55. Bonaiuti D, Shea B, Iovine R, Negrini S, Robinson V, Kemper HC *et al*. Exercise for preventing and treating osteoporosis in postmenopausal women. *Cochrane.Database.Syst Rev.* 2002;CD000333. Carter ND, Kannus P, Khan KM. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. *Sports Med.* 2001;**31**:427-38. Gardner MM, Robertson MC, Campbell AJ. Exercise in preventing falls and fall related injuries in older people: a review of randomised controlled trials. *Br.J.Sports Med.* 2000;**34**:7-17.

Appendix B cont.	**Epidemiological reviews**	**Reviews of falls prevention interventions**
Osteoporosis and fracture risk assessment	Laugier P. An overview of bone sonometry. *International Congress Series* 2004;**1274**:23-32. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. *Lancet* 2002;**359** :1929-36. Prins SH, Jorgensen HL, Jorgensen LV, Hassager C. The role of quantitative ultrasound in the assessment of bone: a review. *Clin.Physiol* 1998;**18**:3-17. Njeh CF, Boivin CM, Langton CM. The role of ultrasound in the assessment of osteoporosis: a review. *Osteoporos.Int.* 1997;**7**:7-22.	Lock C, Lecouturier J, Mason J, Dickinson H. Lifestyle interventions to prevent osteoporotic fractures: a systematic review. *Osteoporosis International* 2006;**17**:20-8. Kannus P, Sievanen H, Palvanen M, Jarvinen T, Parkkari J. Prevention of falls and consequent injuries in elderly people. *The Lancet* 2005;**366**:1885-93. Kannus P, Uusi-Rasi K, Palvanen M, Parkkari J. Non-pharmacological means to prevent fractures among older adults. *Ann Med* 2005;**37**:303-10.
Falls and function research methods	Jorstad EC, Hauer K, Becker C, Lamb SE. Measuring the psychological outcomes of falling: a systematic review. *J Am Geriatr Soc* 2005;**53**:501-10. MacKnight C,.Rockwood K. Assessing mobility in elderly people. A review of performance-based measures of balance, gait and mobility for bedside use. *Reviews in Clinical Gerontology* 1995;**5**:464-86. Guralnik JM, Branch LG, Cummings SR, Curb JD. Physical performance measures in aging research. *J.Gerontol.* 1989;**44**:M141-M146.	Hauer K, Lamb SE, Jorstad EC, Todd C, Becker C (on behalf of the ProFaNE-group). Systematic review of definitions and methods of measuring falls in randomised controlled fall prevention trials. *Age and Ageing* 2006;**35**:5-10. Jorstad-Stein EC, Hauer K, Becker C, Bonnefoy M, Nakash RA, Skelton DA *et al*. Suitability of physical activity questionnaires for older adults in fall-prevention trials: a systematic review. *J Aging Phys.Act.* 2005;**13**:461-81. Lamb SE, Jorstad-Stein EC, Hauer K, Becker C. Development of a Common Outcome Data Set for Fall Injury Prevention Trials: The Prevention of Falls Network Europe Consensus. *Journal of the American Geriatrics Society* 2005;**53**:1618-22.

Appendix C

Cambridge Project for Later Life (CC75C) interview schedule

The current study reported in this thesis is the latest in a series of surveys of the same population-based sample that has become a prospective cohort study known as the Cambridge City over-75s Cohort (CC75C) study. To avoid confusion all paperwork used with the study participants (letters, information sheets, consent forms, interview schedules) has continued to use the earlier name Cambridge Project for Later Life.

CONFIDENTIAL

This booklet is the property of

The Cambridge Project for Later Life
(Cambridge City Over 75 Cohort)
Department of Public Health and Primary Care
Institute of Public Health, Robinson Way, Cambridge CB2 2SR

FOR COMPLETION BY INTERVIEWER

Project number [ID]

Respondent

Subject 1
Proxy .....2 [resp]

Interview type

Face-to-face 1
Telephone .....2 [inttype]

GP Practice [cover1]

Subject initials _____

Date of interview [cover4]

Date interview completed (if > 1 visit needed) [cover4a]

Accepted falls calendar

No 0
Yes 1
Not asked .....2 [cover5a]

Date falls calendar accepted [cover5aa]

Consent for calcaneal quantitative ultrasound scan

No 0
Yes 1
Not asked .....2 [cover5b]

Date ultrasound scan performed [cover5bb]

Consent for functional performance measures

No 0
Yes 1
Not asked .....2 [cover5c]

Date measurements taken [cover5cc]

Consent for bone density scan and muscle dynamometry

No 0
Yes 1
Not asked .....2 [cover5d]

Date visited Addenbrooke's [cover5dd]

Number of approaches made:

in total

cover5

before interview

cover5i

for interviews and measures

cover5ii

Was interview complete?

Complete 1
Incomplete 2

cover6

Reason interview incomplete (code 9 for complete)

cover7

Family refusal 1
Refusal 2
Frailty 3
Abandoned 4
Ill 5
Disturbed 6
Other (specify) 7

If Other, specify .....

If Proxy interview for non-cognitive section code as follows: (not applicable 9)

cover8

Spouse 1
Child 2
Other relative 3
Friend 4
Care assistant, warden or Matron 5
Other 6

INTRODUCTION AND EXPLANATION OF VISIT

Thank you very much for seeing me.

I would just like to explain what this study is about. I am in the team from the Cambridge Project for Later Life. You may remember seeing an interviewer some time ago who asked about your health and how you were getting along. We would like to ask you some of these questions again to see how things have been since the last time.

The reason for asking these questions is that it will give us a better understanding of the ageing process and it will help in planning better services for the future.
At the end there is a section of questions about memory, concentration and the like. Some people find they do have problems with memory as they get older although this may not apply to you. We ask everyone the same questions and we would be very grateful if you felt able to answer them.

Everything you tell us is confidential, and I would like to stress that this study does not affect your medical care at all.

First of all, I'd like to ask you to remind me of some personal details.

•• 1. **What is your full name?**
(not proxy)

Error 0
Right 1

v1

•• 2(a) **Age?**
(not proxy)

Record age given

v2a

•• 2(b)

Error 0
Right 1

v2b

•• 3(a) **Date of Birth?**
(not proxy)

Record date of birth given

- -

v3

•• 3(b)

Error 0
Right 1

v3b

4. **Marital Status?**

Married 1
Widowed 2
Separated/Divorced 3
Single 4
Other 5

v4

IF MARRIED/NEVER MARRIED THEN CODE QUESTION 5 WITH 99

5. **How long have you been widowed, separated/divorced?** In years

v5

6. **Could you tell me how things have been for you in the past year?**
Note any important comments

_____

_____

_____

_____

RESIDENCY

7. **Have you moved house in the last 4 years?**

No 0
Yes 1

v7

IF "No" MOVE THEN CODE QUESTION 8 (EIGHT) WITH 9's

8. **Why did you move to this address?**
Code reason(s)

To be near relative(s)

No 0
Yes 1

v8a

Bereavement

No 0
Yes 1

v8b

Ill health/disability

No 0
Yes 1

v8c

Smaller/more convenient house

No 0
Yes 1

v8d

Other reason (specify)

No 0
Yes 1

v8e

Specify _____

9. Record what type of house. Only ask if uncertain.

v9

House/flat/granny flat 1
Warden controlled 2
Council residential home 3
Private residential home 4
Long stay hospital 5
Other (specify) 6

Specify _____

IF LIVING IN RESIDENTIAL HOME OR HOSPITAL
THEN CODE QUESTIONS 10, 11, 12, 13, 14 WITH 9's

10. Is this house/flat owned or rented?

v10

Owned 1
Council rented 2
Private rented 3
Other (specify) 4

Specify _____

11. Who is head of the household?

v11

Respondent or spouse 1
Sibling 2
Child 3
Other (specify) 4

Specify _____

12. Does anyone else live here?

v12

No 0
Yes 1

IF "No" THEN CODE REMAINDER OF QUESTION 12 WITH 9's

Ask and record numbers of people in each category.

Spouse v12a

Siblings v12b

Children v12c

In laws v12d

Grandchildren v12e

Others (specify) v12f

Specify _____

IF LIVES ON OWN THEN CODE QUESTIONS 13 AND 14 WITH 9's

13. **Is there anyone who lives with you who is frail and unwell and needs your help with day-to-day tasks?**

No 0
Yes 1

v13

IF "No" THEN CODE QUESTION 14 WITH 9.

14. Establish whether due to

Physical frailty 1
Mental frailty 2
Both 3

v14

FAMILY CONTACT

15. **Do you have any children of your own?**

No 0
Yes 1

v15

IF "No" THEN CODE QUESTION 16 WITH 99

16. **How many children?**
Omit children who have died, but do not probe

Number

v16

17. **Do any of your (children or other) relatives live in the area or within easy reach of the area?**
(Cambridge City or nearby villages up to 7 miles).

No relatives 0
None in area 1
Yes 2

v17

IF "Yes" THEN record number of people in each category living in the area.

Number of children

v17a

Number of grandchildren

v17b

Number of brothers/ sisters

v17c

Number of parents

v17d

Number of other relatives.

v17e

IF RESPONDENT LIVES WITH RELATIVES
THEN CODE QUESTIONS 18 AND 19 WITH 9 AND 99 RESPECTIVELY

18. **How often do you see any of your relatives to speak to?**

Never 0
Daily 1
2-3 times a week 2
At least weekly 3
At least monthly 4
Less often 5

v18

IF "Never" THEN CODE QUESTION 19 WITH 99.

19. **Of all your relatives with which one do you have the most contact?**

Daughter 1
Son 2
Daughter-in-law 3
Son-in-law 4
Parent 5
Sister/Brother 6
Other female relative 7
Other male relative 8

v19

20. **In the last year, have you been in contact with your relatives as much as usual?**

More 1
Same 2
Less 3

v20

IF "Same" THEN CODE QUESTION 21 WITH 9.

21. Establish the main reason for change.

Physical illness (subject) 1
Mood change (subject eg. says depressed) 2
Interpersonal problems 3
Moving 4
Other (specify) 5

v21

Specify _____

FRIENDS AND NEIGHBOURS

22. **Do you have any friends locally?**

No 0
Yes 1

v22

23. **In the last year, have you been in contact with your friends as much as usual?**

More 1
Same 2
Less 3

v23

IF "Same" THEN CODE QUESTION 24 WITH 9

24. Establish the main reason for change. v24

Physical illness (subject) 1
Mood change (subject e.g. says depressed) 2
Interpersonal problems 3
Moving 4
Other (Specify) 5

Specify _____

25. **In general, do you have as much contact with family and friends as you would like to?** v25

Yes, satisfied 1
No, would like more contact 2
No, would like less contact 3

IF LIVES IN INSTITUTION THEN CODE QUESTION 26 WITH 9

26. **How often do you see any of your neighbours?** v26

Daily 1
2-3 times a week 2
At least weekly 3
At least monthly 4
Less often 5
Never/no neighbours 6

I will read some comments people have made about their family and friends and I would like you to say how much each statement is true for you.

27. **There are members of my family (friends) who can be relied on no matter what happens.** v27

No 0
Yes to an extent 1
Yes, definitely 2

28. **There are members of my family (friends) who would see that I am taken care of if I needed to be.** v28

No 0
Yes to an extent 1
Yes, definitely 2

29. **Is there someone in whom you can confide about anything that might be worrying you?** v29

No 0
Yes to an extent 1
Yes, definitely 2

SOCIAL CONTACTS

30. Have you had any contact with any clubs or organisations in the past week?

Ask each item

Over 60's Club	No .....0 Yes 1	v30a
Other social club	No .....0 Yes 1	v30b
Church	No .....0 Yes 1	v30c
Church group	No .....0 Yes 1	v30d
Voluntary work	No .....0 Yes 1	v30e
Other (specify)	No .....0 Yes 1	v30f
Specify _____		
Record if mentions regular events less than weekly eg. monthly W.I. (specify)	No .....0 Yes 1	v30g
Specify _____		

IF BEDRIDDEN THEN CODE QUESTION 31 WITH 9

31. In general, do you get out and about as much as you would like to?	No .....0 Yes 1	v31
(a) **When the weather is sunny, in an average week do you spend half an hour or more outdoors?**	No .....0 Yes 1	v31a

IF NO, SKIP TO 32

(b) **When you go out during sunny weather do you wear a hat?**	No .....0 Yes 1	v31b

(c) **When you go out during sunny weather are your arms usually covered?**

No 0
Yes 1

v31c

(d) **When you go out during sunny weather do you use sunscreen?**

No 0
Yes 1

v31d

32. **Do you manage to do any physical activity or exercise?**
If yes then ask each item (do not ask if inappropriate)

Keep fit

No 0
Yes 1

v32a

Walking

No 0
Yes 1

v32b

Gardening

No 0
Yes 1

v32c

DIY

No 0
Yes 1

v32d

Cycling

No 0
Yes 1

v32e

Stair climbing:
How many times do you climb up a flight of stairs (approx 10 steps) each day?
Code average over the past year

None 0
1 to 5 times a day 1
6 to 10 times a day 2
More than 10 times a day 3

v32g

Other (specify)

No 0
Yes 1

v32f

Specify _____

33. Have you been involved in any other activities in the last fortnight?

IF HOUSEBOUND THEN CODE (a), (b), (c) and (d) WITH 9's.

(a) **Visited places of interest**
No 0
Yes 1
v33a

(b) **Amateur Music, Acting, Singing**
No 0
Yes 1
v33b

(c) **Been to a pub/restaurant**
No 0
Yes 1
v33c

(d) **Class or lecture**
No 0
Yes 1
v33d

NOW ASK (e) TO (j)

(e) **Knitting or sewing**
No 0
Yes 1
v33e

(f) **Hobbies such as painting, crafts or collecting things**
No 0
Yes 1
v33f

(g) **Games such as cards, board games or bingo**
No 0
Yes 1
v33g

(h) **Reading**
Code 1 if reads magazines thoroughly and include talking books
No 0
Yes 1
v33h

(i) **Other (specify)**
No 0
Yes 1
v33i

Specify _____

(j) **How many hours a day do you watch TV or videos?**
Code average over the past year

None 0
Less than 1 hour a day 1
1 to 2 hours a day 2
2 to 3 hours a day 3
3 to 4 hours a day 4
More than 4 hours a day 5
v33j

34. **Have you attended any kind of educational or training course in recent years?**

No 0
Yes (specify) 1

v34

Specify _____

35. **Would you say that you enjoy your life?**

No 0
Some of the time 1
Most of the time 2

v35

36. **Do you feel lonely?**

Very lonely 1
Lonely 2
Slightly lonely 3
Not at all lonely 4

v36

I am going to read some statements about the way some people feel as they get older. Please tell me if they apply to you.

37. **As I grow older, things seem better than I thought they would be.**

No 0
Yes 1

v37

38. **I am just as happy as when I was younger.**

No 0
Yes 1

v38

39. **The things I do are as interesting to me as they ever were.**

No 0
Yes 1

v39

SERVICE CONTACT

40. **Did you have any contact with any of these services in the past week?**

IF MORE THAN FIVE CONTACTS THEN CODE 6

(a) **Care assistants** No. of contacts

v40a

IF RESPONDENT HAS CONTACT WITH CARE ASSISTANT THEN CODE QUESTION (b) WITH 9.

(b) **Home help** No. of contacts

v40b

(c) **Community nurse** No. of contacts

v40c

(d) **Private domestic help** No. of contacts

IF RESPONDENT DOES NOT LIVE IN WARDEN CONTROLLED HOUSING THEN CODE QUESTION (e) WITH 9.

(e) **Warden** No. of contacts [ ] v40e

(f) **Meals on wheels** No. of contacts [ ] v40g

(g) **Cook chill delivery** No. of contacts [ ] v40h

(h) **Chiropodist** No. of contacts [ ] v40i

(i) **Day centre** No. of contacts [ ] v40j

(j) **Day hospital** No. of contacts [ ] v40k

(k) **Voluntary agencies (specify)** No. of contacts [ ] v40f

Specify _____

(l) **Other (specify)** No. of contacts [ ] v40l

Specify _____

IF NO CONTACTS TO EACH PART OF QUESTION 40 THEN CODE QUESTION 41 WITH 9.

41. **Do you think you are receiving enough of these services?** No (specify) ..... 0 Yes ..... 1 [ ] v41

Specify _____

42. **Are there any services which you are not receiving which would be valuable to you?** No ..... 0 Yes (specify) ..... 1 [ ] v42

Specify _____

_____

_____

ONLY ASK QUESTION 43 IF RELEVANT - OTHERWISE CODE QUESTION 43 WITH 9

43. **Have you ever received respite care/gone into a home or hospital to have a short break away from the family?** No ..... 0 Yes ..... 1 [ ] v43

If "YES" then ask where? _____

44. **Do you receive any allowances such as invalidity or attendance allowance?** No ..... 0 Yes (specify) ..... 1 [ ] v44

MOOD AND RECENT EVENTS

The next questions are about recent events that may have happened to you and about how you feel.

46. Have you lost anyone close to you in the last year - such as someone close to you dying or moving away, or losing a cherished pet?

Bereavement	No .....0 Yes 1	v46a
Close friend or relative moving away or becoming ill	No .....0 Yes 1	v46b
Loss of pet	No .....0 Yes 1	v46c

47. Have you been very worried about anything in the last year, for example, money worries?

No 0
Worried 1
Very worried 2

v47

Specify _____

_____

_____

48. Do you feel more tense and worry more than usual about little things?

No 0
Yes 1

v48

49. Have you felt more irritable lately (eg. intolerant of noise)?

No 0
Yes 1

v49

50. Do you consider yourself a nervous person?

No 0
Yes 1

v50

51. Do you often feel like crying?

No 0
Sometimes 1
Often 2

v51

52. Have you lost or gained a lot of weight in the last six months?

No 0
Some loss 1
Considerable loss 2
Some gain 3
Considerable gain 4

v52

53. **Do you find it more difficult to make decisions than you used to?**

No 0
Yes 1

v53

54. **Have you lost pleasure or interest in doing things you usually cared about or enjoyed?**

No 0
Sometimes 1
Most of the time 2

v54

55. **Have you preferred to be more on your own recently?**

No 0
Yes 1

v55

56. **Do you find it more difficult to concentrate than is normal for you?**

No 0
Yes 1

v56

57. **Are there times when your thoughts come much more slowly than usual?**

No 0
Yes 1

v57

58. **Do you feel sad or depressed or miserable?**

No 0
Occasionally 1
Most of the time 2

v58

59. **How do you feel about the future? How do you think things will work out for you?**

Neutral/Positive/Optimistic 0
Pessimistic/Negative 1

v59

60. **Do you sometimes feel that life isn't worth living?**

No 0
Yes 1

v60

61(a) **Have you ever had an emotional or nervous illness requiring treatment?**

No 0
Yes 1

v61a

IF "No" THEN CODE REMAINDER OF QUESTION 61 WITH 9's

61(b) Establish how many episodes requiring treatment by psychiatrist.

Record number of episodes. IF MORE THAN 5 CODE 6

v61b

61(c) Establish how many episodes requiring treatment by general practitioner.

Record number of episodes. IF MORE THAN 5 CODE 6

v61c

PHYSICAL HEALTH

I would like to move on to some questions about your health now.

62. **Would you say you have more or less energy than most people your age?**
More 1
Same 2
Less 3
v62

63. **Would you say you have more or less energy at the moment than you did a year ago?**
More 1
Same 2
Less 3
v63

64. **Have you had more trouble sleeping recently than is normal for you?**
No 0
Yes 1
v64

65. **How would you rate your physical health at present compared to others of the same age?**
Very good 1
Good 2
Fair 3
Poor 4
Very poor 5
v65

66. **How would you rate your physical health compared to a year ago?**
Better 1
Same 2
Worse 3
v66

I would like to ask you about some special conditions you may have had.

67. **Have you ever had or has a doctor ever told you that you have had:**

(a) **Angina?**
No 0
Yes 1
v67a

(b) **Heart attack?**
No 0
Yes 1
v67b

(c) **Problems with circulation in your legs?**
No 0
Yes 1
v67c

(d) **High blood pressure?**
No 0
Yes 1
v67d

(e) **Chronic bronchitis?**
No 0
Yes 1
v67e

(f) **Sugar diabetes?**
No 0
Yes 1
v67f

(g) **Thyroid problems?**
No 0
Yes 1
v67g

(h) **Severe headaches or migraine?**
No 0
Yes 1
v67h

(i) **A stroke?**
No 0
Yes 1
v67i

(j) **A mini-stroke?**
No 0
Yes 1
v67j

(k) **A Transient Ischaemic Attack (TIA)?**
No 0
Yes 1
v67k

IF "Yes" FOR (k) THEN CODE (l) WITH 9.

(l) **Have you ever had sudden weakness, or difficulty with speech, memory or vision which got better after a short time?**
No 0
Yes 1
v67l

(m) **Anything else?**
No 0
Yes (specify) 1
v67m

Specify _____

68. **I'd like to ask you about some specific conditions which may have affected your day-to-day routine in the last month.**
For each conditions reported, establish whether it prevented respondent carrying out day-to-day activities

DEFINITIONS OF RESPONSE CODES
NO = Condition not present
YES, DISABLING = Condition present AND interferes with day to day activities
NOT DISABLING = Condition present BUT DOES NOT interferes with day to day activities

(a) **Poor vision (with spectacles)**
No 0
Yes, disabling 1
Yes, not disabling 2
v68a

(b) **Poor hearing (with hearing aid)**
No 0
Yes, disabling 1
Yes, not disabling 2
v68b

(c) **Arthritis or rheumatism**
No 0
Yes, disabling 1
Yes, not disabling 2
v68c

(d) **Back pain**
No 0
Yes, disabling 1
Yes, not disabling 2
v68d

(e) **Chest pain**
No 0
Yes, disabling 1
Yes, not disabling 2
v68e

(f) **Shortness of breath**
No 0
Yes, disabling 1
Yes, not disabling 2
v68f

(g) **Marked weakness in arm or leg**
No 0
Yes, disabling 1
Yes, not disabling 2
v68g

(h) **Unsteady on feet**
No 0
Yes, disabling 1
Yes, not disabling 2
v68h

(i) **Tendency to fall**
No 0
Yes, disabling 1
v68i

(j) **Trouble with nerves**

No 0
Yes, disabling 1
Yes, not disabling 2

v68j

(k) **Other not specified above**

No 0
Yes, disabling (specify) 1
Yes, not disabling (specify) 2

v68k

Specify _____

Record any important conditions mentioned but which remain uncoded _

_____

_____

_____

IF NO CONDITIONS CODED IN QUESTION 68 (a) TO (k)
THEN CODE QUESTIONS 69, 70, 71 AND 72 WITH 9s.

69. **How much do these problems interfere with your life?**

Not at all 0
Slightly 1
Moderately 2
Very much 3

v69

IF "Not at all" THEN CODE QUESTION 70 WITH 99

70. **Which of the things mentioned is most important?**
Use numbers as follows.

1. Vision
2. Hearing
3. Arthritis
4. Back pain
5. Chest pain
6. Shortness of breath
7. Weakness in limbs
8. Unsteady on feet
9. Falls
10. Nerves
11. Other

v70

71. **Have you had to go into hospital to stay because of any of these difficulties in the last year?**

No 0
Yes 1

v71

72. **If so, for which ailment(s)?**
Use response numbers as in question 70.

v72

73. **How many times have you been in hospital in the last year?**

None 0
Once 1
Two or more 2

v73

IF RESPONDENT HAS BEEN IN HOSPITAL
THEN CODE QUESTION 74 WITH 99

74. **How long is it since you were last admitted to any hospital?**
(In years)

Years

v74

75. **Have you had a general anaesthetic in the last year?**

No 0
Yes 1

v75

IF NO THEN CODE QUESTION 76 WITH 99.

76. **How long ago was that/or the most recent?**
(i.e. 1-12 months)

Months

v76

77. **How long is it since you last saw a GP?**
(in months, round up).

Months

v77

ACTIVITIES OF DAILY LIVING

78. **Now I'd like to ask you some questions about how you cope with day-to-day tasks.**
Note all helpers using list below. If more than one helper given then code highest professional level.

(rr) **How confident are you that you can get in and out of a chair without falling?**

0. Not confident at all
1. Fairly confident
2. Completely confident

v78rr

(ss) **How confident are you that you can get into and out of bed without falling?**

0. Not confident at all
1. Fairly confident
2. Completely confident

v78ss

(a) **How do you manage with using a telephone i.e. looking up numbers, dialing etc?**

0. Telephones independently - looks up numbers, dialling etc?
1. Dials a few well-known numbers only
2. Answers telephone but does not dial
3. Cannot use telephone at all
9. No telephone within easy access

v78a

(aa) **How confident are you that you can answer the door or telephone?**

0. Not confident at all
1. Fairly confident
2. Completely

v78aa

(b) **How do you manage with shopping?**

0. Takes care of all or nearly all shopping independently
1. Shops independently for small purchases only
2. Needs to be accompanied on any shopping trip
3. Does not shop at all

v78b

Who helps? Note helpers using codes below _____

Code main helper

v78bhelp

If Other then Specify _____

CODE							
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18
	Other relative	06				

(bb) **How confident are you that you can do simple shopping?**

0. Not confident at all
1. Fairly confident
2. Completely

v78bb

(c) **How do you manage with finance/money matters?**

0. Manages financial matters independently
1. Manages day to day purchases but needs help with banking
2. Incapable of handling money

v78c

Who helps? Note helpers using codes below _____

Code main helper

v78chelp

If Other then Specify _____

(d) **How do you manage with preparing meals?**

0. Prepares all or nearly all meals independently
1. Prepares snacks only or heats up meals prepared by others
2. All meals and snacks must be prepared by others
9. Meals have always been prepared by spouse or others

v78d

Who helps? Note helpers using codes below _____

Code main helper

v78dhelp

If Other then Specify _____

(dd) **How confident are you that you can prepare a hot meal (not needing to carry heavy or hot objects)?**

0. Not confident at all
1. Fairly confident
2. Completely

v78dd

CODE							
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18
	Other relative	06				

(e) **How do you manage with housework?**

v78e

0. Independent apart from occasionally help with heavy work
1. Performs only light daily tasks eg.dish washing, dusting. (Cleanliness adequate)
2. Performs light daily tasks but cannot maintain acceptable level cleanliness
3. All housework must be done by others
9. Housework has always been done by spouse or other

Who helps? Note helpers using codes below _____

Code main helper

v78ehelp

If Other then Specify _____

(ee) **How confident are you that you can do light housework?**

v78ee

0. Not confident at all
1. Fairly confident
2. Completely

(f) **How do you manage with transport?**

v78f

0. Travels independently on public transport or drives own car or cycle
1. Arranges own travel via taxi only
2. Travels on public transport with others
3. Travel limited to taxi, or with assistance of others
4. Does not travel at all

(g) **How do you manage with laundry?**

v78g

0. Independent apart from occasional help with heavy work
1. Launders only small items e.g. stockings, underwear
2. All laundry must be done by others
9. Laundry has always been done by spouse or other

Who helps? Note helpers using codes below _____

Code main helper

v78ghelp

If Other then Specify _____

CODE						
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18
	Other relative	06				

(h) How do you manage with walking?

v78h

0. Walks around town, suburb or village
1. Walks no further than one block away
2. Walks no further than gate
3. Walks only within house
4. Takes no more than a few steps
5. Bedridden

(hh) How confident are you that you can walk around the house without falling?

v78hh

0. Not confident at all
1. Fairly confident
2. Completely confident

(i) Do you use a walking stick or other aid?

v78i

0. Independent
1. Walking stick
2. Frame/tripod
3. Wheelchair
4. Other person

IF NOT IN A WHEELCHAIR THEN CODE QUESTION (j) WITH 9.

(j) How do you manage with your wheelchair?

v78j

1. Gets in and out and can propel self without help
2. Gets in and out without help, can't propel self
3. Needs help to get in and out, can't propel

(k) How do you manage with bathing or showering?

v78k

0. Independent in bath, shower or strip-wash
1. Needs help getting in or out of bath or shower
2. Can wash face and hands only
3. Needs major assistance

Who helps? Note helpers using codes below _____

Code main helper

v78khelp

If Other then Specify _____

(kk) How confident are you that you can take a bath or shower?

v78kk

0. Not confident at all
1. Fairly confident
2. Completely

CODE						
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18
	Other relative	06				

(l) **How do you manage with reaching up to comb your hair (or shave) or down to cut your toenails?**

v78l

0. Attends to grooming independently
1. Needs minor assistance e.g. cutting toenails
2. Needs moderate assistance e.g. shaving, brushing hair
3. Needs moderate and regular assistance
4. Needs grooming care but can remain well groomed with help

Who helps? Note helpers using codes below _____

Code main helper

v78lhelp

If Other then Specify _____

(ll) **How confident are you that you can reach into a cupboard without falling?**

v78ll

0. Not confident at all
1. Fairly confident
2. Completely confident

(m) **How do you manage with dressing or undressing?**

v78m

0. Dresses and undresses independently
1. Needs minor assistance e.g. tying shoelaces, buttons
2. Needs moderate assistance e.g. shows and socks, arms in sleeves. Selection of clothes
3. Needs major assistance
4. Unable to dress

Who helps? Note helpers using codes below _____

Code main helper

v78mhelp

If Other then Specify _____

(mm) **How confident are you that you can get dressed or undressed?**

v78mm

0. Not confident at all
1. Fairly confident
2. Completely

(n) **How do you manage with getting to the toilet on time?**

v78n

0. Always gets to the toilet on time
1. Rare (weekly at most) accidents
2. Accidents more than once a week
3. No control of bladder or bowels

Who helps? Note helpers using codes below _____

Code main helper

v78nhelp

If Other then Specify _____

CODE						
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18

(o) **How do you manage with eating?**

0. Eats without assistance
1. Eats with some assistance at meal times
2. Feeds self with moderate assistance and is untidy
3. Requires extensive assistance for all meals
4. Does not feed self at all

v78o

Who helps? Note helpers using codes below _____

Code main helper

v78ohelp

If Other then Specify _____

(p) **How do you manage with taking medicines?**

0. Responsible for taking medicines
1. Medication must be put out in advance by others
2. Medication must be administered by others
9. Takes no medication at present

v78p

Who helps? Note helpers using codes below _____

Code main helper

v78phelp

If Other then Specify _____

IF NO DIFFICULTY ADMITTED IN (a) TO (p)
THEN CODE QUESTION (q) WITH 9

(q) **In any of these tasks that you have difficulty with do you think that you need more help than you are getting at the moment?**

No 0
Yes (specify) 1

v78q

Specify _____

CODE						
	Nobody/none required	00	Friend/Neighbour	07	Volunteer agencies	13
	Spouse	01	Care assistant	08	Meals on wheels	14
	Daughter	02	Home help	09	Cook chill delivery	15
0	Daughter-in-law	03	Community nurse	10	Chiropodist	16
	Son	04	Private domestic help	11	Residential home staff	17
	Son-in-law	05	Warden	12	Other (specify)	18
	Other relative	06				

79. **Do people ever do things for you that you feel you would prefer and are able to do yourself?**

No 0
Yes (specify) 1

v79

Specify _____

80. **Is there anyone whom you help with anything?**

No 0
Yes 1

v80

IF "No" THEN CODE QUESTION 81 WITH 9's

81. **Who, and what kind of help do you give?**

Write exactly what respondent says. If respondent gives several types of help to one person, code the one which is more important or most frequent.

CODING

PERSON	TYPE OF HELP
Spouse 1	Personal care 1
Child 2	Chores 2
Sibling 3	Emotional support .. 3
Other relative 4	Financial support ... 4
Friend/neighbour 5	Child Minding 5
Others 6	Other 6

Person	Type	Person	Type
_____	_____		v8111
_____	_____		v8112
_____	_____		v8113
_____	_____		v8114
_____	_____		v8115
_____	_____		v8116
_____	_____		v8117
_____	_____		v8118

COGNITIVE EXAMINATION

BEFORE COMMENCING, MAKE SURE YOU HAVE THE FOLLOWING ITEMS

Booklet
Pencil and Wristwatch
Envelope
Coins - 1p, 10p.

It is important that the interviewer speaks slowly and clearly. If person appears not to have heard or understood, repeat question (unless item specifically prohibits repetition).

DO NOT CORRECT IF WRONG ANSWER GIVEN

Make a note of any unusual responses including extra memory items recalled.

CODING: This section differs from other sections in that respondents who give a silly answer are given a score of 0 (not 8) which is equivalent to giving an incorrect answer. Where a score of 9 or 99 is given indicate why question was not asked.

•• Signifies MMSE questions

• Signifies extended MMSE question

Because we are interested in how people manage as they get older, we'd like to know something about your memory and concentration. Many people find they have a little more difficulty with these as they get older and we need to know a little more about them. Some of the questions may seem rather easy, others may be more difficult, but we need to ask everyone the same questions, so please bear with me.

ORIENTATION

Time

• **120.** **What day of the week is it?**
Incorrect 0
Correct 1
v120

• **121.** **What is the date to-day?**
Day
Incorrect 0
Correct 1
v121

• **122.** Month
Incorrect 0
Correct 1
v122

• **123.** Year
Incorrect 0
Correct 1
v123

• **124.** **What is the season?**
Incorrect 0
Correct 1
v124

Allow flexibility when season changes, i.e.
March=winter/spring
September=summer/autumn
June=spring/summer
December=autumn/winter

Place

• **125.** **Can you tell me the name of the county we are in?**
Incorrect 0
Correct 1
v125

• **126.** **What is the name of this city?**
Incorrect 0
Correct 1
v126

• **127.** **What are two main streets nearby?**
Incorrect 0
Correct 1
v127

• **128.** **What floor of the building are we on?**
Incorrect 0
Correct 1
v128

• **129.** **What is the address here?**
(or **What is this place?** if person tested in hospital.)
Incorrect 0
Correct 1
v129

LANGUAGE

Comprehension (motor response)

If the respondent does not complete the full sequence then the whole instruction may be repeated, without change in tone or tempo to ensure that it has been heard and understood. Prompting and coaching stage by stage is not allowed.

I am going to ask you to carry out some actions, so please listen carefully.

• **130.** **Please nod your head.**
Incorrect 0
Correct 1
v130

131. **Touch your right ear with your left hand.**
Incorrect 0
Correct 1
v131

• **132.** **Before you look at the ceiling look at the floor.**
Incorrect 0
Correct 1
v132

133. **Tap each shoulder twice with two fingers keeping your eyes shut.**
Incorrect 0
Correct 1
v133

Comprehension (verbal response)

I am going to ask you some questions and would like you to answer yes or no.

134. **Is this place a hotel?**
Yes/Incorrect 0
No/Correct 1
v134

135. **Are villages larger than towns?**
Yes/Incorrect 0
No/Correct 1
v135

136. **Was there wireless/radio in this country before television was invented?**
No/Incorrect 0
Yes/Correct 1
v136

Expression - Naming

In 137-138 we are looking for accurate naming; descriptions of function or approximate answers are not acceptable.

Some items may have more than one correct name, as we have indicated. Errors include description of function (eg. "used for telling the time" for watch) and approximate answers (eg. "bag" or "carrier" for suitcase; "light" for lamp). In the case of approximate answers, the examiner should say: Can you think of another word for it?

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

•• **137(a)** SHOW PENCIL

•• **What is this called?** Pencil..... v137a

•• **137(b)** SHOW WRISTWATCH

•• **What is this called?** Watch..... v137b

• **138.** **I am going to show you some objects. Please tell me the name of each one.**
SHOW PICTURES IN BOOKLET

• (a) Shoe, sandal..... v138a

• (b) Typewriter..... v138b

• (c) Scales..... v138c

• (d) Suitcase, portmanteau..... v138d

• (e) Barometer..... v138e

• (f) Table lamp, lamp..... v138f

• 139. **Could you name as many different animals as you can think of? You will have one minute to do this.**

When ready, say **starting now** and start timing.

Only if subject asks for clarification, explain that animals include birds, insects, humans, etc. If subject gets stuck, encourage them with **Can you think of any more?**

LIST ALL ITEMS

RECORD NUMBER CORRECT IN ONE MINUTES.

Repetitions not to be counted. Number correct ☐☐ v139

Expression -Definitions (Record answer)

140. What do you do with a hammer? _____

.....0
(Any correct use) 1

☐ v140

141. Where do people usually go to buy medicine?

_____

Shop (if unable to specify) 0
Chemist 1

☐ v141

Expression -Abstract Definitions (Record answer)

IN QUESTIONS 142 AND 143 a concrete definition scores 1 and an abstract definition scores 2.
Examples are given beside each score.

142. What is a bridge? _____

Incorrect 0
Cross the bridge 1
Goes across a river etc 2

☐ v142

143. What is an opinion? _____

.....0
A good opinion of someone 1
A person's ideas about something 2

☐ v143

Expression - Repetition

IN QUESTION 144 ONLY ONE PRESENTATION allowed so it is essential that you read the phrase clearly and slowly, enunciating all the "S"s.

I am going to say something and I would like you to repeat it after me.

• **144.** **No ifs, ands or buts.**

Incorrect 0
Correct 1

v144

145. Question no longer in interview

MEMORY -(Recall)

146. **Can you tell me what were the objects in the coloured pictures I showed you a little while ago?**
Indicate booklet

)EFINITIONS OF RESPONSE CODES
ıcorrect... 0
Correct... 1

(a) Shoe, sandal..... v146a

(b) Typewriter..... v146b

(c) Scales..... v146c

(d) Suitcase, portmanteau..... v146d

(e) Barometer..... v146e

(f) Table lamp, lamp..... v146f

Recognition

SHOW MULTIPLE CHOICE PICTURES IN BOOKLET

147. **Which of these did I show you before?**

)EFINITIONS OF RESPONSE CODES
ıcorrect... 0
Correct... 1

(a) Shoe, sandal..... v147a

(b) Typewriter..... v147b

(c) Scales v147c

(d) Suitcase, portmanteau v147d

(e) Barometer v147e

(f) Table lamp, lamp v147f

Retrieval of remote information

Now I am going to ask you some questions about the past.

• 148. **Can you tell me when the First World War began?**
Within 1 year
Incorrect 0
1914 ..... 1 v148

• 149. **Can you tell me when the Second World War began?**
Within 1 year
Incorrect 0
1939 ..... 1 v149

• 150. **Who was the leader of the Germans in the Second World War?**
Incorrect 0
Hitler 1 v150

• 151. **Who was the leader of the Russians at that time?**
Incorrect 0
Stalin 1 v151

• 152. **What was Mae West famous for?**
Any appropriate verbal or non-verbal answer which indicates memory
Incorrect 0
Entertainer 1 v152

• 153. **Who was the famous flyer whose son was kidnapped?**
Close approximations to the name are acceptable
Incorrect 0
Lindbergh 1 v153

Retrieval of recent information

• 154. **What is the name of the present King or Queen?**
Incorrect 0
Correct 1 v154

• 155. **Who will follow her?**
Incorrect 0
Correct 1 v155

• **156.** **What is the name of the Prime Minister?**
For 1 month after an election, if the name of the former PM is given, say **Is he/she still PM?**

Incorrect 0
Correct 1

v156

• **157.** **What has been in the news in the past week or two?**
If a general answer is given eg. "war", ask for details

Incorrect 0
Correct 1

v157

Registration

•• **158(a)** **I am going to name 3 objects. After I have finished saying all three, I would like you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes.**

Name three objects taking 1 second to say each.

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

•• (i) Apple v158a1

•• (ii) Table v158a2

•• (iii) Penny v158a3

IF EACH PART OF QUESTION 158(a) IS CORRECT
ON THE FIRST ATTEMPT
THEN CODE QUESTION 158(b) WITH 0.

158(b) If any errors or omissions are made on the first attempt, repeat all the names until respondent learns all three (maximum of five repeats). Record number of repeats.

Record 6 if unable to remember after 5 repeats.

Number of repeats

v158b

ATTENTION/CONCENTRATION

159. **Now I would like you to count backwards from 20.**
Cross out as you go along.

20, 19, 18, 17, 16, 15, 14, 13, 12, 11,

10, 9, 8, 7, 6, 5, 4, 3, 2, 1.

Two or more errors 0
One error 1
Correct 2

v159

•• **160.** **Now I would like you to take 7 away from 100. Now take 7 away from the number you get. Now keep subtracting 7 until I tell you to stop.**

Subject's answer .....
93 .....
86 .....
79 .....
72 .....
65 .....

Record answers. Score 1 point each time the difference is 7 even if a previous answer was incorrect. Maximum score=5 points.

Total

v160

MEMORY - recall

•• **161.** **What were the three objects I asked you to repeat a little while ago?**

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

•• (i) Apple .....

v161a

•• (ii) Table .....

v161b

•• (iii) Penny .....

v161c

LANGUAGE - Reading comprehension

SHOW COMMANDS IN BOOKLET

Please, read this page and then do what it says.

•• **162.** **Close your eyes.**

Incorrect 0
Correct 1

v162

163. **If you are older than 50 put your hands behind your head.**

Incorrect 0
Correct 1

v163

It is not necessary for respondent to read aloud. Code 1 only if action is carried out correctly. If respondent reads instruction but fails to carry out action, say **Now do what it says.**

PRAXIS - Copying and Drawing

Recond responses on sheet provided.

•• **164.** **Copy this design (Pentagon)**
Each pentagon should have 5 sides and 5 clear corners and the overlap should form a diamond.

Incorrect 0
Correct 1

v164

165. **Copy this design (Spiral)**
Three connected loops are required in the correct orientation.

Incorrect 0
Correct 1

v165

•• **166.** **Copy this design (3-D house)**
Requires windows, door chimney in correct position and 3-D represented.

Incorrect 0
Correct 1

v166

•• **167.** **Draw a large clock and put the numbers in.**

•• When respondent has done this say

•• **Now set the hands to 10 past 11**

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

•• Circle v167a

•• All numbers in correct position v167b

•• Correct time v167c

Writing - Spontaneous

•• **168.** **Write a complete sentence on this sheet of paper.**

Incorrect 0
Correct 1

v168

ASK RESPONDENT WHAT HE/SHE HAS WRITTEN AND RECORD HERE

Spelling and grammar are not important. The sentence must have a subject (real or implied) and a verb. "Help!" "Go away" are acceptable.

PRAXIS - Ideational

READ FULL STATEMENT AND THEN HAND OVER THE PAPER. MAKE A POINT OF HANDING TO SUBJECT'S MIDLINE.

•• **169.** **I am going to give you a piece of paper. When I do, take the paper in your right hand. Fold the paper in half with both hands, and put the paper down on your lap.**

DO NOT REPEAT INSTRUCTIONS OR COACH

Score a move as correct only if it takes place in the correct sequence. Tick each correct move and enter number correct under Total. Maximum score = 3 points.

DEFINITIONS OF RESPONSE CODES
Incorrect... 0
Correct... 1

••		Right hand	v169a
••		Folds	v169b
••		On lap	v169c
	170. **Put the paper in the envelope and seal the envelope.**	Incorrect ..... 0 Correct 1	v170

Writing to dictation

•	**171.** **Write this name and address on the envelope Mr John Brown 42 West Street Bedford**	Incorrect ..... 0 Poor but acceptable ..... 1 Correct 2	v171

Spelling and neatness are not important. Criterion is whether letter is likely to reach exact destination, e.g. Jon Brwn is acceptable; 24, and Burford are incorrect.

THEN SAY

Please try to remember this name and address as I shall be asking you about them later on.

IF RESPONDENT IS UNABLE TO WRITE, SAY THE ADDRESS SLOWLY, TWICE AND ASK HER/HIM TO REMEMBER IT.

PRAXIS - Ideomotor

Now I am going to ask you to carry out some simple actions which check co-ordination and ease of movement.

• **172.** **Show me how you wave goodbye.**

Incorrect 0
Correct 1

v172

In 173 and 174 we are looking for a correct mime. If the subject uses finger to represent scissors or brush, say, for example, "pretend you are holding a toothbrush" Score 1 if subject makes brushing movement but not as though holding a toothbrush

173. **Show me how you would cut with scissors.**

Incorrect 0
Concrete response 1
Correct mime 2

v173

• **174.** **Show me how you would brush your teeth with a toothbrush.**

Incorrect 0
Concrete response 1
Correct mime 2

v174

PERCEPTION - Tactile

• 175. **I am going to place a coin into your hand and I want you to tell me what it is without looking at it.**

PLACE COINS (1p,10p) ONE AT A TIME IN THE SUBJECT'S HAND PALM DOWN.

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

1p..... v175a

10p (or 2 shillings or florin) v175b

CALCULATION

Mental calculation is required. Paper and pencil are not allowed.

LET THE RESPONDENT SEE THE COINS.

176. **How much money does that make?**

Incorrect 0
(11p) 1

v176

177. **If somebody gave you this amount (11p) as change from £1, how much did you spend?**

Incorrect 0
(89p) 1

v177

MEMORY - Recall

• 178. **What was the name and address you wrote on the envelope a short time ago?**

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

John..... v178a

Brown..... v178b

42..... v178c

West Street..... v178d

Bedford..... v178e

ABSTRACT THINKING

In this question we are looking for the capacity to think abstractly. Abstract answers score 2, concrete answers score 1. Examples are given beside each score.If subject says "they are not alike", say "Can you think of any way in which they are alike?"

I am going to name two things and I'd like you to tell me in what way they are alike. For example, a dog and a monkey are alike because they are both animals.

• **179.** **In what way are an apple and a banana alike?**

round, have calories 0
food, grow, have peel 1
fruit 2

v179

RECORD ANSWER...

For this question ONLY if score is less than 2 say, "They are also alike because they are both fruit."

180. **In what way are a shirt and a dress alike?**

have buttons 0
to wear, made of cloth, keep you warm 1
clothing, garments 2

v180

RECORD ANSWER...

• **181.** **In what way are a table and chair alike?**

wooden, have 4 legs 0
household objects used for meals 1
furniture 2

v181

RECORD ANSWER...

182. **In what way are a plant and an animal alike?**

useful to man, carry germs 0
grow, need feed, natural . 1
living things 2

v182

RECORD ANSWER...

VISUAL PERCEPTION - Famous People

SHOW PICTURES IN BOOKLET

Score as correct if picture is recognised. Correct name is not required, but record any answer which does not correspond exactly to the examples given. f

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

•• **183(a)** SHOW PICTURE OF QUEEN

•• **Who is this?** Queen..... v183a

•• **183(b)** SHOW PICTURE OF POPE

•• **Who is this?** Pope, Archbishop..... v183b

Object Constancy

SHOW PICTURES IN BOOKLET

• **184. These are pictures of objects taken from unusual angles. Can you tell me what they are?**

DEFINITIONS OF RESPONSE CODES
Incorrect...0
Correct...1

(a) Spectacles..... v184a

(b) Shoe..... v184b

(c) Purse, Suitcase..... v184c

(d) Cup and Saucer..... v184d

(e) Telephone..... v184e

(f) Pipe..... v184f

PASSAGE OF TIME

• **186. Without looking at your watch or the clock, could you tell me what the time is now?**
To the nearest hour

Incorrect 0
Correct 1

v186

186(a) FALLING

The next questions are about whether or not you have had any falls and, if so, what happened? When I say "FALLING" I mean "UNINTENTIONALLY COMING TO THE FLOOR OR GROUND OR SOME LOWER LEVEL, SUCH AS LANDING ON A CHAIR OR STAIR".

(i) **Have you fallen in the last three months?** No 0
Yes 1

v402a

How many times? When did the fall(s) happen? Can you say roughly which month? NOTE ANY INFORMATION GIVEN THAT CAN CODE TO (iii) Number of falls

---

(ii) **Have you fallen in the last year?** No 0
Yes 1

v404a

How many times? When did the fall(s) happen? Can you say roughly which month? NOTE ANY INFORMATION GIVEN THAT CAN CODE TO (iii) Number of falls

---

(iii) DO NOT ASK AGAIN BUT USE INFORMATION GIVEN ABOVE:

Number of falls in the last month v186iiia

Number of falls in the last 3 months..... v186iiib

Number of falls in the last 6 months..... v186iiic

Number of falls in the last year..... v186iiid

IF NO FALLS REPORTED IN THE LAST YEAR, THEN ASK

(iv) **If you have ever fallen, how long ago was the last time you fell?** Months (round up, code 60 for 60 or more) v186iv

IF ANY FALLS REPORTED AT ANY TIME, THEN ASK

(v) **How long ago was the last time you fell and hurt yourself in any way?** Months (round up, code 60 for 60 or more) v186v

IF LAST INJURIOUS FALL = LAST FALL THEN ONLY ASK THE FOLLOWING SEC-

Thinking back to that time, when you last fell and hurt yourself: →

Thinking back to just the last time you fell: →

		LAST FALL	LAST INJURIOUS FALL
(to be coded later)	**When was that?** **Can you say roughly which month?**		
(to be coded later)	**What were you doing at the time?** **Can you describe how you fell?**		
(vi)	**Did you fall from standing?**	*No 0* *Yes 1*	*No 0* *Yes 1*
(vii)	**Did you fall from higher than standing height?** (e.g. downstairs)	*No 0* *Yes 1*	*No 0* *Yes 1*
(viii)	**Where did the fall take place?**	*Indoors 0* *Outdoors 1*	*Indoors 0* *Outdoors 1*
(ix)	**When did the fall take place?**	*During the day 0* *During the night 1*	*During the day 0* *During the night 1*
(x)	**What was the cause of the fall?**	*Accident* *Dizziness* *Blackout* *Other (specify)*	*Accident* *Dizziness* *Blackout* *Other (specify)*
(xi)	**When you fell were you able to get up without help from anyone?**	*No 0* *Yes 1*	*No 0* *Yes 1*
(xii)	**How long do you think you were on the floor after you fell?**	*< 5 minutes? 0* *5 min < 1 hr? 1* *1 - 2 hours? 2* *> 2 hours? 3*	*< 5 minutes? 0* *5 min < 1 hr? 1* *1 - 2 hours? 2* *> 2 hours? 3*
(xiii)	**Did you tell anyone about that fall?**	*Accident and Emergency Dept.?* *Your doctor (GP)?* *Any other healthcarer?* *Family, friend, carer or neighbour?*	*Accident and Emergency Dept.?* *Your doctor (GP)?* *Any other healthcarer?* *Family, friend, carer or neighbour?*
(xiv)	**Did you hurt yourself in any way when you fell?**	*No 0* *Yes 1*	*No 0* *Yes 1*
(xv) (xvi)	**If so, in what way?** **What part of your body did you hurt?** *1. Hips, legs or feet* *2. Shoulders, arms or hands* *3. Trunk/back/neck* *4. Head or face* *5. Other*		*1. Bruise/bump/swelling* *2. Graze/scrape/abrasion* *3. Cut/laceration* *4. Sprain/strain* *5. Fracture* *6. Disclocation* *7. Head injury* *8. Back pain* *9. Other*
(xvii)	**Did you need treatment for any injury from the fall?**		*No 0* *Yes 1*
(xviii)	**If so, where were you treated?**		*1. A &E* *2. GP's surgery* *3. At home*
(xix)	**Did you need to stay in hospital overnight because of the fall?**		*No 0* *Yes 1*
(xx)	**If so, which hospital was it?**		

(xxi) Are you worried about falling again?

0. No
1. Yes

186(b) FRACTURES

(i) Have you ever broken any of your bones?

0. No
1. Yes

	Date of fracture (if known)				
(ii)	**If so, which bone(s) have you broken?** 1. Hip fracture 2. Other lower limb fracture 3. Wrist / Colles fracture 4. Other upper limb fracture 5. Vertebral fracture 6. Other				
(iii)	**Can you say roughly how old you were when this (these) happened?** 1. Less than 50 years old 2. 50 years old or more NOTE ACTUAL AGE IF GIVEN				
(iv)	**How did the fracture(s) happen?** 1. Trip or slip 2. Fall due to dizziness 3. Fall due to a blackout 4. Fall from higher than standing 5. Road traffic accident 6. Other trauma 7. Other				
(v)	**Where did you attend for treatment of this (these) fractures?** NOTE NAME OF HOSPITAL				

(vi) Did any of your relatives ever break any bones?
(I mean one of your parents, or a brother or sister)

0.No
1.Yes

Code as above

	If so, which relative(s)?				
	Which bone(s) have they broken?				
	Can you say roughly how old she / he / they were when this (these) happened?				
	How did their fracture(s) happen?				

(vii) (Women only) **As you maybe know, your bones are affected by the female hormones, so we are interested to know what age you were when your menopause came (when your periods stopped)?**

1. Less than 50 years old
2. 50 years old or more

NOTE ACTUAL AGE IF GIVEN

(viii) Have you ever taken any of the following medications that can affect you bones?

1. Steroids
2. Calcium supplements
3. Cod liver oil
4. Other vitamin D preparations
5. Hormone Replacement Therapy
6. Other treatments for osteoporosis (fragile bones)

0. No
1. Yes, in the past
2. Yes, currently taking

186(c) **ALCOHOL INTAKE**

(i) **Have you ever had alcoholic drinks?**

No 0
Yes 1

v421

IF "No" THEN CODE REMAINDER OF QUESTION 186(c) WITH 9s.
IF "YES" THEN PLEASE TRY TO ASCERTAIN HOW MANY DRINKS PER WEEK OF EACH KIND NOW.

Glasses of wine — v421a

Half pints of Beer — v421b

Measures of Spirits — v421c

Small glasses of Fortified Wine — v421d

IF DRANK ALCOHOL IN PAST BUT HAS STOPPED ASK

(ii) **When did you stop drinking alcohol?**

Code age at which person stopped — v422

(iii) **Why did you stop drinking alcohol?**
Rate answer given No=0, Yes=1

Social v423a

Health deterioration v433b

Awareness of health effects v433c

Medical advice..... v433d

Cost..... v433e

Other (specify) v433f

186(d) SMOKING

(i) **Have you ever smoked?**

No 0
Yes 1

v441

IF "No" THEN CODE REMAINER OF QUESTION 186(d) WITH 9s AND GOTO QUESTION 186(e) VISION

(ii) **Do you still smoke?**

No 0
Yes 1

v442

IF "Yes" THEN CODE QUESTION (iii), (iv), (v) WITH 9 AND ASK (vi)

(iii) **When did you stop smoking?** Code age when stopped

v443

(iv) **Why did you give up smoking?**
Rate answer given No=0, Yes=1

Social and/or family pressure — v444a

Health deterioration — v444b

Awareness of health effects — v444c

Medical advice — v444d

Cost — v444e

Other (specify) — v444f

.....

(v) **How many cigarettes did you smoke a day?**

v445

FOR CURRENT SMOKERS ONLY ASK:

(vi) **How many cigarettes do you smoke a day?**

v446

Establish if respondent is a pipe smoker.

(vii) **How many ounces do you smoke a day?**

v447

186(e) VISION (SIGHT TEST)

v186e

Please read the following lines:
Hand card to interviewee and point out N.10. If unable to read this line go on to the next. Only the first few words are necessary (with reading glasses). Code number of line read.

186(f) HEARING (WHISPER TEST)

I am now going to do some checks on your hearing by whispering some letters and numbers. Please keep looking forward.

Stand behind subject at a distance of 6 inches.

FOR (i) THROUGH (iv) REPEAT THE FOLLOWING SEQUENCE.
STOPPING WHEN THE RESPONDENT
HEARS THE ITEM AND RESPONDS ACCURATELY.

Take a deep breath in, breathe right out and then at the specified volume at one item per second read the bold text.

Ask the subject to repeat this.

Record whether respondent heard you and whether they repeated the item accurately

LEVEL	ACCURACY
Did not hear 0	Repeated inaccurately 0
Heard 1	Repeated accurately 1

		Level	Acc-uracy
(i)	Whisper **3, A, 2**		v186f1
(ii)	Whisper **1, F, 3**		v186f2
(iii)	Normal voice **3, A, 2**		v186f3
(iv)	Normal voice **1, F, 3**		v186f4

ONLY SHOUT IF "Whisper" AND "Normal voice" NOT HEARD

(v)	Shout **3, A, 2**		v186f5
(vi)	Shout **1, F, 3**		v186f6

That's the end of that section. Thank you for bearing with me. Finally, I would like to ask about any medicines you might be taking.

187. **What medicine are you taking now. Approximately how long is it since it was started?**

Include all medicines from doctor and self administered which respondent takes regularly.

CODE 98 FOR 8 YEARS OR MORE

	CURRENT MEDICATION Drug code	Duration in months	
.....	☐☐	☐☐	v187a
.....	☐☐	☐☐	v187b
.....	☐☐	☐☐	v187c
.....	☐☐	☐☐	v187d
.....	☐☐	☐☐	v187e
.....	☐☐	☐☐	v187f
.....	☐☐	☐☐	v187g
.....	☐☐	☐☐	v187h
.....	☐☐	☐☐	v187i
.....	☐☐	☐☐	v187j

It is very helpful for us to know about how people feel about answering all these questions. How did you feel?

v187c

Very anxious (specify) 1
Somewhat concerned 2
Unconcerned 3
Enjoying it 4
Other (specify) 5

Specify _____

As a routine part of this interview we ask if we might approach someone who knows you well to ask them a few questions if necessary. Would this be alright? Who would be the best person to ask?

Take a note of the name address, telephone number and relationship and enter it on the front sheet.

We are very grateful for your help. Thank you for giving us so much of your time.

End of interview

TO BE COMPLETED BY INTERVIEWER

DID RESPONDENT HAVE ANY OF THESE PROBLEMS?

CODES FOR QUESTIONS (a) TO (k)

No 0
To some extent 1
To a marked extent 2

(a) **Anxious or worried, more so than other respondents?** v200a

(b) **Depressed, miserable or tearful?** v200b

(c) **Distressed during interview by pain, shortness of breath or any physically ill symptom?** v200c

(d) **Subject appears tobe physically ill?** v200d

(e) **Unclear speech that interfered with responses?** v200e

(f) **Poor grasp of English that interfered with responses?** v200f

(g) **Deafness that interfered with questioning?** v200g

(h) **Poor eyesight that interfered with reading, writing or drawing?** v200h

(i) **Weakness, tremor etc. of hand that interfered with writing, drawing or folding paper?** v200i

(j) **Confusion, vagueness or forgetfulness?** v200j

(k) **Living conditions that concerned you, eg. cold, dirty?** v200k

(l) **What is your assessment of the respondent's ability to cope to solve problems and to make appropriate use of assistance?**

Very poor 1
Poor 2
Good 3
Very good 4

v200l

(m) **Do you think this person may be illiterate?**

No 0
Possibly 1
Definitely 2

v200m

(n) **Would you judge the respondent's situation to be stable or precarious?**

Precarious 1
Coping with hardships ...2
Minor difficulties 3
Stable 4

v200n

(o) **In your opinion, does the respondent feel lonely?**

Very lonely 1
Lonely 2
Slightly lonely 3
Not at all lonely 4

v200o

(p) **If you have spoken to an informant - is there any discrepancy between what is said by the informant and the subject in relation to (Code 9s if not relevant)**

() **Other Activity?**

No 0
A little 1
Yes 2

v200p0

(i) **Activities of Daily Living?**

No 0
A little 1
Yes 2

v200p1

(ii) **Physical Health?**

No 0
A little 1
Yes 2

v200p2

(iii) **Falls and Fractures?**

No 0
A little 1
Yes 2

v200p3

q) **Interviewed with someone else present?**

No 0
Yes 1

v200q

Appendix D

FUNCTIONAL PHYSICAL PERFORMANCE MEASURES – CC75C TESTING PROTOCOL

Explanation	
Static balance	- Timed Unsupported Stand (TUSS)
Static balance	- SPPB Stand tests (Side-by-side, Semi-tandem, tandem)
Gait speed	- SPPB Timed 8 foot walk
Dynamic balance	- 180 degree turn (inserted between SPPB items in order to ensure use of correct height chair)
Dynamic balance / Muscle strength	- SPPB Chair stands
Muscle strength	- Hand grip strength
Dynamic balance	- Functional reach

Before discussing the individual physical performance tests, read the general instructions (below) to the study participant. To some participants, the detailed verbal instructions may seem pedantic and unnecessary. It may help to say that you are going to explain each test in detail since this is the best way to make sure that everyone does the test in a similar manner. It is up to you to determine whether a participant understands what is required and to provide the appropriate level of instruction.

While administering these tasks, it is important to maintain the participant's motivation to continue giving their best effort on each task. Since the tasks are designed to be quite difficult, many participants will not be able, for example, to hold the balance positions for a full ten seconds. It is important, therefore, (if the participant has any trouble) that you indicate to them that <u>everyone</u> has trouble with these tasks because they are designed to be difficult. If the participant asks how they are doing, you should tell them they are doing fine.

For all balance, gait and strength tests that require standing the interviewer must be alert to the possibility that the participant may become unsteady and be in danger of falling. In all instances you should be close enough to support her/him if s/he should lose balance. You should stand within arms reach with your arms ready so that if the participant begins to lose balance you can try to steady her/him. If s/he begins to fall do not try to catch her/his whole weight, but reach under her/his shoulders and ease her/him down to the floor. This will prevent you both from becoming injured. If this happens, and the participant is not injured, help her/him up by first having her/him get on all fours, place a chair next to her/him and have her/him support herself/himself on the chair as you lift under the shoulders. Do not lift the respondent alone from the floor. If there is anyone else present, consider their risk of injury should they offer to help. Do not attempt to lift with anyone else if you judge this to be unsafe. If you are unable to get the respondent up from the floor or if suspect an injury contact the ambulance service.

Now, let's take a break from the questions and go on to a more active part of the interview.

I would like you to try and do some different movements of your body that involve your arms and legs.

First, I will show each movement to you. Then, when I've finished, I'd like you to try to do it. If you cannot do a particular movement or you feel it would be unsafe to try to do it, tell me, and we'll move on to the next one. Let me emphasise that I do not want you to try to do any exercise you feel might be unsafe.

Do you have any questions before we begin? …… OK, let's begin.

STATIC BALANCE STANDS
==========

Walking aids should not be used for these tests.
The tests should be performed in the type of shoes normally worn by the participant.
However, high-heeled shoes should not be worn for tests of balance.

TIMED UNSUPPORTED STEADY STAND (TUSS)

For the first movement I'm going to place this spare chair in front of you.
Position sturdy chair with back towards participant, far enough away to allow him/her to stand up and near enough for him/her to comfortably hold onto the chair back for support when standing.

Soon you are going to get up and stand holding onto the back of this chair.

Once you are steady I shall say "Start".

Then you are to put your hand by your sides and stand as long as you feel safe and steady.

As soon as you feel unsteady you must put your hands back onto the chair. (Demonstrate)

Are you clear about what you are going to do?

Help the participant into the standing position, with feet placed comfortably apart.
If necessary remind him/her what to do:
In a moment I am going to say "Start".

Then you are going to let go of the chair and keep standing.

As soon as you feel unsteady put your hands back on the chair.

We'll have one practice go just to get the idea.
Remember, if you start to wobble at all, just hold on to the chair again.
Are you ready? Start. …… (no need to time) **….I'll stop you there.**

Are you ready for the real go now? Start.

Start timing as you say **Start**.
Stop timing as soon as the participant places his/her hand on the chair
OR when s/he has stood steadily for 60 seconds – whichever occurs first.

Record time to the nearest tenth of a second ٱ . ٱ ٱ seconds

If no time recorded	Not attempted, interviewer felt unsafe	ٱ	Participant refused	ٱ
	Not attempted, participant felt unsafe	ٱ	Tried but unable	ٱ
	Participant could not understand test	ٱ	Other	ٱ

The participant is given only one attempt for each of the following stand positions, so it is important that you explain carefully the goal of the exercise and demonstrate the movement clearly. You may assist her/him into the starting position for each different stand.

SIDE-BY-SIDE STAND

Now I will show you the next movement (Demonstrate).

I want you to try and stand with your feet together, side-by-side, for about 10 seconds.

You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold the position until I tell you to stop.

Stand next to the participant to help her/him into the side-by-side position. Allow the participant to hold onto your arm(s) to get balance. Supply just enough support to the participant's arm to prevent loss of balance. When the participant has her/his feet together, ask if s/he is ready:

When you are ready, let go of my arm. or **Are you ready?** If yes… **Start.**

Start timing as the participant lets go.

Stand to the side and slightly behind the participant, within arms reach and with arms ready so that you could reach her/him without having to lean forward.

If the participant steps out of position or grabs onto anything for support, stop the stopwatch, say **Stop** and offer her/him arm support.

If this stance is maintained for ten seconds leave the stopwatch running and ask
Can you stand like that any longer?

If not, stop timing, say **Okay, stop** , offer the participant arm support and tell them
You managed more than 10 seconds already.

If yes, keep the stopwatch running until the participant steps out of position, grabs for support or 30 seconds has passed, then stop it, say **Stop** and offer arm support.

	Record time to the nearest tenth of a second		ٱ . ٱ ٱ seconds	
	Record whether any compensatory movements to keep balance	Arms moved	Yes ٱ	No ٱ
		Trunk swayed	Yes ٱ	No ٱ
If no time recorded	Not attempted, interviewer felt unsafe ٱ		Participant refused	ٱ
	Not attempted, participant felt unsafe ٱ		Tried but unable	ٱ
	Participant could not understand test ٱ		Other	ٱ

If participant is unable to hold side-by-side stand for 10 seconds do not attempt other static stands.

SEMI-TANDEM STAND

Now I want you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.

Please watch while I demonstrate.

You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold the position until I tell you to stop.

Stand next to the participant to help her/him into the semi-tandem position. The heel of one foot should not be placed in the arch of the other foot, but the heel of one foot may be next to the ball of the other foot. Allow the participant to hold onto your arm(s) to get balance. Supply just enough support to the participant's arm to prevent loss of balance. When the participant has her/his feet in position, ask if s/he is ready:

When you are ready, let go of my arm. or **Are you ready?** If yes… **Start.**

Start timing as the participant lets go.

Stand to the side and slightly behind the participant, within arms reach and with arms ready so that you could reach her/him without having to lean forward.

If the participant steps out of position or grabs onto anything for support, stop the stopwatch, say **Stop** and offer her/him arm support.

If this stance is maintained for ten seconds leave the stopwatch running and ask
Can you stand like that any longer?

If not, stop timing, say **Okay, stop** , offer the participant arm support and tell them
You managed more than 10 seconds already.

If yes, keep the stopwatch running until the participant steps out of position, grabs for support or 30 seconds has passed, then stop it, say **Stop** and offer arm support.

Record time to the nearest tenth of a second ☐.☐ ☐ seconds

Record whether any compensatory movements to keep balance

Arms moved Yes ☐ No ☐
Trunk swayed Yes ☐ No ☐

If no time recorded

Not attempted, interviewer felt unsafe ☐
Not attempted, participant felt unsafe ☐
Participant could not understand test ☐
Participant refused ☐
Tried but unable ☐
Other ☐

If participant is able to hold semi-tandem stand at all s/he goes on to the full tandem stands.

TANDEM STAND

Now I want you to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable.

Please watch while I demonstrate.

You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold the position until I tell you to stop.

Stand next to the participant to help her/him into the tandem position. Allow the participant to hold onto your arm(s) to get balance. Supply just enough support to the participant's arm to prevent loss of balance. When the participant has her/his feet in position, ask if s/he is ready:

When you are ready, let go of my arm. or **Are you ready?** If yes… **Start.**

Start timing as the participant lets go.

Stand to the side and slightly behind the participant, within arms reach and with arms ready so that you could reach her/him without having to lean forward.

If the participant steps out of position or grabs onto anything for support, stop the stopwatch, say **Stop** and offer her/him arm support.

If this stance is maintained for ten seconds leave the stopwatch running and ask
Can you stand like that any longer?

If not, stop timing, say **Okay, stop** , offer the participant arm support and tell them
You managed more than 10 seconds already.

If yes, keep the stopwatch running until the participant steps out of position, grabs for support or 30 seconds has passed, then stop it, say **Stop** and offer arm support.

Record time to the nearest tenth of a second ☐☐.☐ seconds

Record whether any compensatory movements to keep balance

Arms moved Yes ☐ No ☐
Trunk swayed Yes ☐ No ☐

If no time recorded

Not attempted, interviewer felt unsafe ☐
Not attempted, participant felt unsafe ☐
Participant could not understand test ☐
Participant refused ☐
Tried but unable ☐
Other ☐

GAIT SPEED
==========

TIMED WALK (Skip if participant cannot walk even with aid ☐)

Participant is seated while walking FES question asked, suitable walking course identified and marked and timed walk explained with demonstration.

Now the next thing we are interested in is how you walk.

In this next exercise, I am going to observe how you normally walk. I am going to measure out a standard length for you to walk. Do you mind if I temporarily mark a starting and finishing line with some tape on the floor ?

If you use a stick or something else to help you walk and would feel more comfortable with it, then you may use it during the test. However, if possible I would like you to walk without any walking aids.

This is our walking course. I want you to walk to the other end of the course at your usual speed. I want you to walk all the way past the other end of the tape before you stop. I will walk with you, and back again. (Demonstrate)

Do you feel this would be safe? Yes ☐
No ☐

Do not attempt if participant feels this would be unsafe.

Okay, now you try it.

Help participant if necessary to stand and get in position with both toes behind starting line.

Start here. Ready? Begin.

Start the stopwatch when the participant's foot first touches the ground beyond the start line and stop when her/his foot touches the ground beyond the finish line. Walk beside the participant.

Now we can walk back again. Remember to walk at your usual pace, and go all the way past the tape at the other end. Ready? Begin.

Time for first walk ☐☐.☐☐ seconds
Time for second walk ☐☐.☐☐ seconds

Walking aid used
- 1 stick ☐
- 2 sticks ☐
- Walking frame ☐

If no time recorded
- Not attempted, interviewer felt unsafe ☐
- Not attempted, participant felt unsafe ☐
- Participant could not understand test ☐
- Participant refused ☐
- Tried but unable ☐
- Other ☐

DYNAMIC BALANCE
==========

180 º TURN

The next exercise is about keeping your balance as you turn round. I will need to place another chair opposite you and maybe move up another chair to the side here, if that is alright with you. I have brought a spare chair with me in case there isn't one here that is a suitable height.

The participant is seated with a standard height chair facing her and tables or the back of chairs or other stable handhold to either side.
S/he is wearing her usual footwear. (Unless this is unsafe).
Her chair is high enough to allow her to stand up with minimal effort or assistance.

Soon you are going to stand up, you can hold onto the table/chairs if you want to.
Once you are steady I shall say NOW.
Then you are going to put your hands by your sides and step around on the spot until
[you are standing facing me, I shall be down there {indicate]** OR
[you are standing with your back is to that chair].
Then stop.
Remember to keep your hands by your sides.
But if you really must you can hold onto the chairs/tables
Are you clear about what you are going to do?
[***Patients with memory difficulties will understand this command best. Be sure you stand in the correct position!*]

If necessary the participant is helped to get into the starting position: standing holding onto a chair or table to the side.

When they are steady in the start position say **Ready? Now**.
If necessary add **Step around until you face me**. It is not a timed test – instructions should not be given such that a need for speed is implied, avoid saying 'Go'.

The person should be discouraged from holding on. The (friendly) commands **Hands down**, **No cheating** or **No holding** may be used. The test becomes invalid if the person holds on for support. Quickly touching a support is allowed – the number of times this is done is recorded.

Start counting with the first step. Count ALL number of steps taken to complete the 180 degrees turn EXCEPT any steps backward towards the chair or forwards toward you. A step = any attempt on the person's part to shift her body weight. Do not allow pivoting. Do not give feedback in terms of number of steps taken.

Number of steps to complete the turn ☐☐

Number of times the participant touched the chair ☐☐

If no score recorded
- Not attempted, interviewer felt unsafe ☐
- Not attempted, participant felt unsafe ☐
- Participant could not understand test ☐
- Participant refused ☐
- Tried but unable ☐
- Other ☐

MUSCLE STRENGTH / DYNAMIC BALANCE
==========

CHAIR STAND – SINGLE

Ideal chair is armless, straight-backed and approximately 18 inches / 45 cm high at the front edge. Use of a walking aid is not permitted for the chair stand tests.

We've reached the last exercises now –they measure the strength in your legs for standing up.

If participant is still in his/her own chair (i.e. because s/he did not complete the 180 degree turn), measure chair height from floor to front of seat

Chair height ☐☐ cm

If participant is in a wheelchair, ask:

Can you get up from your wheelchair by yourself?

☐ Yes
☐ No
☐ N/A

If yes, and to all other participants not in a wheelchair, ask:

Do you feel it is safe to try to stand up without using your arms?

☐ Yes
☐ No

If no, say:

Okay, then can you try to stand up using your arms to push off. Sit so that your feet are on the floor.

If yes, stand next to the participant to provide assistance if s/he loses his/her balance and say:

Okay, first please fold your arms across your chest and sit so that your feet are on the floor. (Demonstrate) **Now try to sand up without using your arms.**

If participant tries but is unable to stand, say:

Okay, now try to stand up using your arms to push off.

☐ Stood without arms

☐ Stood using arms

☐ Test not completed

If not completed

☐ Not attempted, interviewer felt unsafe
☐ Not attempted, participant felt unsafe
☐ Participant could not understand test
☐ Participant refused
☐ Tried but unable
☐ Chair or bed bound
☐ Other

CHAIR STANDS – REPEATED UP TO 5 STANDS

Do not attempt if participant could not complete single chair stand.

Do you think it is safe for you to try to stand up from the chair five times without using your arms? Yes ☐ No ☐

If yes, say:

Next, I want you to keep your arms folded across your chest.
Please stand up straight as quickly as you can five times, without stopping in between.
After standing up each time, sit down and then stand up again.
Keep your arms folded across your chest. (Demonstrate)
I'll be timing you with a stopwatch. Please begin when I say "Ready?…Stand."

When the participant is properly seated, say **Ready?….. Stand** and begin timing.

Count out loud as s/he arises each time, up to five.

Stop the stopwatch when she has straightened up completely the firth time.

Stop if participant becomes tired or short of breath during repeated chair stands.

Also stop
- if participant uses her arms
- after 1 minute, if participant has not completed rises
- at your discretion, if concerned about participant's safety

If the participant appears to be fatigued before completing five stands, confirm this by asking:

Can you continue? (This should be just a reminder, not an urging.)

If yes, continue timing.

If no, stop the stopwatch and score the number of stands completed as well as the time.

Time to complete 5 stands ☐.☐☐ seconds

If < 5 stands, number of stands completed ☐

If not completed
- Not attempted, interviewer felt unsafe ☐
- Not attempted, participant felt unsafe ☐
- Participant could not understand test ☐
- Participant refused ☐
- Tried but unable ☐
- Chair or bed bound ☐
- Other ☐

GRIP STRENGTH

If the participant has completed the 180 degree turn s/he will now be seated in a chair of standard height, facing the chair they were in. The hand grip strength testing can be done seated in this chair, allowing a short rest before attempting the chair stands from this standard height chair.

Adjust the dynamometer to an appropriate size for smaller/larger hands so that the participant can comfortably grip the handle, usually position 2 for women and 3 for men. As the dynamometer is fairly heavy, the interviewer can hold it steady for the participant resting on their knee.

In this exercise I am going to use this instrument to test the strength in your hands.

Have you had a recent worsening of pain or arthritis in your wrist, or do you have tendonitis? Yes ☐ No ☐

Have you had any surgery on your hands or arms during the last 3 months? Yes ☐ No ☐

I'd like you to take the arm that you think is stronger, bend your elbow and press your arm against your side.

Now, grab the two pieces of metal together like this (Demonstrate)**.**

When I say "Squeeze" squeeze as hard as you can. It won't feel like the bar is moving, but we are able to get a reading.

I want you to do this three times. If you feel any pain or discomfort, tell me and we will stop.

Repeat the examination 3 times on the dominant hand, then switch the grip strength dynamometer to the non-dominant hand and test again 3 times. Set dynamometer to "0" after each test.

With each test say **Squeeze as hard as you can**
and when they begin say **Squeeze, squeeze, squeeze.**

Dominant hand	Left ☐ Right ☐	
1st try	☐☐ kg	
2nd try	☐☐ kg	
3rd try	☐☐ kg	
Non- dominant hand	Left ☐ Right ☐	
1st try	☐☐ kg	
2nd try	☐☐ kg	
3rd try	☐☐ kg	

If no score recorded
- Not attempted, interviewer felt unsafe ☐
- Not attempted, participant felt unsafe ☐
- Participant could not understand test ☐
- Participant refused ☐
- Tried but unable ☐
- Other ☐

DYNAMIC BALANCE
==========

Participant is seated while walking FES question asked, suitable wall space identified and functional reach exercise explained with demonstration.

This next exercise is about balancing as you reach forward.

FUNCTIONAL REACH

If participant is unable to hold side-by-side stand for 30 seconds do not attempt standing reach test.

I am going to demonstrate what I am going to ask you to do. We need to use a bit of clear wall space, if there is any. I will ask you to stand by the wall while I attach this tape to your wall (just temporarily – would that be alright?) …This looks like the best place…(Stand in position)

Do you think it would be safe for you to reach forward as far as you can, like this (Demonstrate)**, without losing your balance?** Yes ☐
No ☐

If no: do not attempt standing functional reach – skip to seated functional reach.

If yes:
Okay, I need you to stand here with your right shoulder next to the wall.
Now, let me attach this paper tape measure to your wall.

Now I would like to explain the maoeuvre that I am going to ask you to do.
Please stand here with your shoulder next to the end of the tape (right acromion by tape end).

Your should place your feet in a normal, relaxed stance, with hands held at your side. Please try and keep your feet in this position for the rest of the task.

Now make a fist with your right hand and extend your arm forward along the tape
(approx. 90 degrees to trunk, horizontally).
Mark the position of the distal end of the right 3rd metacarpal with post-its on the tape measure.

Position of distal end of 3rd right metacarpal before reach ☐.☐☐☐ cms

When I ask you to, please reach as far forward as you can without losing your balance or taking a step. **Your arm and body should not touch the wall.**

		Position of 3rd right metacarpal	Functional reach
Okay, go ahead and reach as far as you can.	1st trial	☐.☐☐☐ cms	☐.☐☐ cms
Now, I would like you to do that again.	2nd trial	☐.☐☐☐ cms	☐.☐☐ cms
And one more time.	3rd trial	☐.☐☐☐ cms	☐.☐☐ cms

No attempt need be made to control the participant's method of reaching.
However, guard the participant, in case of loss of balance, to prevent him/her from falling.

If the participant touches, the wall or takes a step during testing, the trial should be repeated.

- if not completed:
  - Not attempted, interviewer felt unsafe ☐
  - Not attempted, participant felt unsafe ☐
  - Participant could not understand test ☐
  - Participant refused ☐
  - Tried but unable ☐
  - Other ☐

Appendix E

Simple Physical Performance Battery (SPPB)

The original protocol and score sheet that follows provide instructions for the administration of the SPPB as developed by the US National Institute of Aging for their Established Populations for Epidemiologic Studies of the Elderly (EPESE) program. This is taken from their training materials CD-ROM (OrthoBiotech):
Assessing Physical Perfomance in the Older Patient
presented by Jack M. Guralnik

Study ID _____ Date _____ Tester Initials _____

SHORT PHYSICAL PERFORMANCE BATTERY PROTOCOL AND SCORE SHEET

All of the tests should be performed in the same order as they are presented in this protocol. Instructions to the participants are shown in bold italic and should be given exactly as they are written in this script.

1. BALANCE TESTS

The participant must be able to stand unassisted without the use of a cane or walker. You may help the participant to get up.

> ***Now let's begin the evaluation. I would now like you to try to move your body in different movements. I will first describe and show each movement to you. Then I'd like you to try to do it. If you cannot do a particular movement, or if you feel it would be unsafe to try to do it, tell me and we'll move on to the next one. Let me emphasize that I do not want you to try to do any exercise that you feel might be unsafe.***
>
> ***Do you have any questions before we begin?***

A. Side-by-Side Stand

1. ***Now I will show you the first movement***.
2. (Demonstrate) ***I want you to try to stand with your feet together, side-by-side, for about 10 seconds.***
3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***
4. Stand next to the participant to help him/her into the side-by-side position.
5. Supply just enough support to the participant's arm to prevent loss of balance.
6. When the participant has his/her feet together, ask ***"Are you ready?"***
7. Then let go and begin timing as you say, ***"Ready, begin."***
8. Stop the stopwatch and say ***"Stop"*** after 10 seconds or when the participant steps out of position or grabs your arm.
9. If participant is unable to hold the position for 10 seconds, record result and go to the gait speed test.

Study ID _____ Date _____ Tester Initials _____

B. Semi-Tandem Stand

1. ***Now I will show you the second movement***.

2. (Demonstrate) ***Now I want you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.***

3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***

4. Stand next to the participant to help him/her into the semi-tandem position

5. Supply just enough support to the participant's arm to prevent loss of balance.

6. When the participant has his/her feet together, ask ***"Are you ready?"***

7. Then let go and begin timing as you say ***"Ready, begin."***

8. Stop the stopwatch and say ***"Stop"*** after 10 seconds or when the participant steps out of position or grabs your arm.

9. If participant is unable to hold the position for 10 seconds, record result and go to the gait speed test.

C. Tandem Stand

1. ***Now I will show you the third movement***.

2. (Demonstrate) ***Now I want you to try to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.***

3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***

4. Stand next to the participant to help him/her into the tandem position.

5. Supply just enough support to the participant's arm to prevent loss of balance.

6. When the participant has his/her feet together, ask ***"Are you ready?"***

7. Then let go and begin timing as you say, ***"Ready, begin."***

8. Stop the stopwatch and say ***"Stop"*** after 10 seconds or when the participant steps out of position or grabs your arm.

Study ID _____ Date _____ Tester Initials _____

SCORING:

A. Side-by-side-stand

Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points
If 0 points, end Balance Tests

Number of seconds held if less than 10 sec: ___.__ __sec

If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not hold position unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (specify) _____	6
Participant refused	7

B. Semi-Tandem Stand

Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points *(circle reason above)*
If 0 points, end Balance Tests

Number of seconds held if less than 10 sec: ___.__ __sec

C. Tandem Stand

Held for 10 sec ❒ 2 points
Held for 3 to 9.99 sec ❒ 1 point
Held for < than 3 sec ❒ 0 points
Not attempted ❒ 0 points (circle reason above)

Number of seconds held if less than 10 sec: ___.__ __sec

D. Total Balance Tests score_____(sum points)

Comments: _____

Study ID _____ Date _____ Tester Initials _____

2. GAIT SPEED TEST

Now I am going to observe how you normally walk. If you use a cane or other walking aid and you feel you need it to walk a short distance, then you may use it.

A. First Gait Speed Test

1. ***This is our walking course. I want you to walk to the other end of the course at your usual speed, just as if you were walking down the street to go to the store.***

2. Demonstrate the walk for the participant.

3. ***Walk all the way past the other end of the tape before you stop. I will walk with you. Do you feel this would be safe?***

4. Have the participant stand with both feet touching the starting line.

5. ***When I want you to start, I will say: "Ready, begin."*** When the participant acknowledges this instruction say: ***"Ready, begin."***

6. Press the start/stop button to start the stopwatch as the participant begins walking.

7. Walk behind and to the side of the participant.

8. Stop timing when one of the participant's feet is completely across the end line.

B. Second Gait Speed Test

1. ***Now I want you to repeat the walk. Remember to walk at your usual pace, and go all the way past the other end of the course.***

2. Have the participant stand with both feet touching the starting line.

3. ***When I want you to start, I will say: "Ready, begin."*** When the participant acknowledges this instruction say: ***"Ready, begin."***

4. Press the start/stop button to start the stopwatch as the participant begins walking.

5. Walk behind and to the side of the participant.

6. Stop timing when one of the participant's feet is completely across the end line.

Study ID _____ Date _____ Tester Initials _____

GAIT SPEED TEST SCORING:

Length of walk test course: Four meters ❒ Three meters ❒

A. Time for First Gait Speed Test (sec)

1. Time for 3 or 4 meters __ __.__ __sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify) _____	6
Participant refused	7

Complete score sheet and go to chair stand test

3. Aids for first walk.....None ❒ Cane ❒ Other ❒

Comments:_____

_____

_____

B. Time for Second Gait Speed Test (sec)

1. Time for 3 or 4 meters __ __.__ __ sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

3. Aids for second walk..... None ❒ Cane ❒ Other ❒

What is the time for the faster of the two walks?
Record the shorter of the two times __ __.__ __ sec
[If only 1 walk done, record that time] __ __.__ __ sec

If the participant was unable to do the walk: ❒ **0 points**

For 4-Meter Walk:		**For 3-Meter Walk:**	
If time is more than 8.70 sec:	❒ **1 point**	If time is more than 6.52 sec:	❒ **1 point**
If time is 6.21 to 8.70 sec:	❒ **2 points**	If time is 4.66 to 6.52 sec:	❒ **2 points**
If time is 4.82 to 6.20 sec:	❒ **3 points**	If time is 3.62 to 4.65 sec:	❒ **3 points**
If time is less than 4.82 sec:	❒ **4 points**	If time is less than 3.62 sec:	❒ **4 points**

Study ID _____ Date _____ Tester Initials _____

3. CHAIR STAND TEST

Single Chair Stand

1. ***Let's do the last movement test. Do you think it would be safe for you to try to stand up from a chair without using your arms?***

2. ***The next test measures the strength in your legs.***

3. (Demonstrate and explain the procedure.) ***First, fold your arms across your chest and sit so that your feet are on the floor; then stand up keeping your arms folded across your chest.***

4. ***Please stand up keeping your arms folded across your chest.*** (Record result).

5. If participant cannot rise without using arms, say ***"Okay, try to stand up using your arms."*** This is the end of their test. Record result and go to the scoring page.

Repeated Chair Stands

1. ***Do you think it would be safe for you to try to stand up from a chair five times without using your arms?***

2. (Demonstrate and explain the procedure): ***Please stand up straight as QUICKLY as you can five times, without stopping in between. After standing up each time, sit down and then stand up again. Keep your arms folded across your chest. I'll be timing you with a stopwatch.***

3. When the participant is properly seated, say: ***"Ready? Stand"*** and begin timing.

4. Count out loud as the participant arises each time, up to five times.

5. Stop if participant becomes tired or short of breath during repeated chair stands.

6. Stop the stopwatch when he/she has straightened up completely for the fifth time.

7. Also stop:
   - If participant uses his/her arms
   - After 1 minute, if participant has not completed rises
   - At your discretion, if concerned for participant's safety

8. If the participant stops and appears to be fatigued before completing the five stands, confirm this by asking ***"Can you continue?"***

9. If participant says "Yes," continue timing. If participant says "No," stop and reset the stopwatch.

Study ID _____ Date _____ Tester Initials _____

SCORING
Single Chair Stand Test

		YES	NO	
A.	Safe to stand without help	❒	❒	
B.	Results:			
	Participant stood without using arms	❒		→ Go to Repeated Chair Stand Test
	Participant used arms to stand	❒		→ End test; score as 0 points
	Test not completed	❒		→ End test; score as 0 points

C. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not stand unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify) _____	6
Participant refused	7

Repeated Chair Stand Test

		YES	NO
A.	Safe to stand five times	❒	❒

B. If five stands done successfully, record time in seconds.

Time to complete five stands __ __.__ __ sec

C. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not stand unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

Scoring the Repeated Chair Test

Participant unable to complete 5 chair stands or completes stands in >60 sec:	❒ 0 points
If chair stand time is 16.70 sec or more:	❒ 1 points
If chair stand time is 13.70 to 16.69 sec:	❒ 2 points
If chair stand time is 11.20 to 13.69 sec:	❒ 3 points
If chair stand time is 11.19 sec or less:	❒ 4 points

Study ID _____ Date _____ Tester Initials _____

Scoring for Complete Short Physical Performance Battery

Test Scores

Total Balance Test score	_____	**points**
Gait Speed Test score	_____	**points**
Chair Stand Test score	_____	**points**
Total Score	_____	**points (sum of points above)**

Appendix F

Fall calendar used in follow-up study for 1 year after interview

Study participants who agreed to accept the fall calendar, or relatives who agreed to fill one in on their behalf, were given a comb-bound booklet with a six month calendar starting from the date of interview, followed by a second calendar if they were happy to continue a further six months, each with a supply of pre-paid envelopes to return each weekly tear-off page to the study office.

The following pages show:

- Instruction sheet at front of each calendar booklet

- Weekly tear-off page format in which to mark whether and, if so,
  when a fall occurred with prompts for basic details

- Reverse side of each tear-off page allowing space to provide any further information

FALL CALENDAR

It is very common to feel unsteady on your feet but the problem of falling is still not fully understood. What makes somebody fall over? How often does it happen? and most importantly Can it be prevented? These are some of the questions this research is hoping to answer, but we need your help.

We are asking you to try and keep a record of what happened if ever you are so unlucky as to have a fall. It is sometimes difficult to remember if you are asked to think back, but easier if you make a note soon afterwards. Even at the time, some people find it hard to say exactly what caused them to fall, but any details you can fill in will be extremely useful.

This is our FALL CALENDAR. If you should unfortunately fall, or nearly fall, you can mark in the day it happened and make a short note of where and how you fell. Even if you don't actually fall to the ground – say, if you landed on a chair or the stairs – we would like to know about that too. If possible, please contact our research nurse Jane Fleming to let her know what has happened as soon as possible after any fall you may have. She would then like to come and see you, unless you would not want her to visit.

The calendar has one week to a page and we would greatly appreciate it if you could send back a page each week, using the stamped addressed envelopes that the research nurse will give you. We would like you to send us these pages even if there is nothing to report – that is important information for us too.

It will help the research enormously if you could keep up sending us your fall calendar for six months, but we understand if you prefer just to try it for a while. If you can spare us the time to help with this it will provide a very valuable record of how much of a problem falling actually is.

Thank you very much for taking the time to consider this as well as for all your help so far.

To contact our research nurse, Jane Fleming, please phone: 01223 – 330341

PLEASE NOTE:
- this is not an emergency number
- she may not be in the office when you ring
- you can always leave an answer-phone message

BUT if you have just had a fall and need urgent help phone your doctor or 999

	Did you fall?	**What time did you fall?**	**Where did you fall?**	**How did you fall?**	**What were you doing?**
	Yes? No? Nearly?	Daytime? Evening? Night?	Outdoors? Indoors? What room? On stairs?	Trip? Slip? Dizzy? Blackout? Other reason?	Getting up from a chair? Getting out of bed? Going upstairs? downstairs? Going to the toilet? Reaching? or Hurrying?
MONTH					
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

FALL CALENDAR

Name……....Project number……

If you have any sort of fall please mark down when, where and how it happened. At the top of each section are some possible answers to each question, but please feel free to tell anything else you remember about how you fell. You can also use the extra sections below or, if you need more space, do continue on another sheet of paper and attach it to the week's page.

Date the fall happened:……...……

……

……

Date the fall happened:……...……

……

……

Any other information you think we should know about your fall or falls?……..……

……

IF YOU HAVE HAD A FALL, IF POSSIBLE PLEASE LET US KNOW BY TELEPHONING
OUR RESEARCH NURSE, JANE FLEMING, ON 01223-330341 (Remember this is not an emergency number)

When the last date shown overleaf has passed please use one of the pre-paid envelopes to send this page back, even if it is blank,
TO: Jane Fleming, Research Nurse
Department of Public Health and Primary Care,
Institute of Public Health, Cambridge University Forvie Site,
Robinson Way, Cambridge CB2 2YB

THANK YOU VERY MUCH FOR KEEPING THE FALL CALENDAR

Appendix G

Other study documentation

The following pages show copies of documentation used for tracing and re-enrolling participants in this latest survey of the Cambridge City over-75s Cohort study (known to the participants by its former name, the Cambridge Project for Later Life):

- letter to GPs
- letter to study participants
- information sheet
- consent form
- letter of thanks

UNIVERSITY OF CAMBRIDGE
Public Health and Primary Care

Date..……

Dr ……
…….
…….
…….

Dear Dr ……

Cambridge Project for Later Life

Many of your older patients have been interviewed a number of times over the past fifteen years as part of the Cambridge City Over 75s Cohort study (also known as the Cambridge Project for Later Life). As you are aware, the study first began with a project screening for dementia and the follow-up surveys have continued to investigate cognitive function along with many other aspects of older people's health and social circumstances. We are pleased to have been granted funding for a further wave of interviews and, with full ethical approval, will shortly begin contacting the study participants again.

We are very grateful for your continuing support for the study, and hope very much you can help us this time too. The help we would request is with up-dating our contact information since, although we have tracking systems to trace participants, obviously we need to double-check our records of death are absolutely correct. We would also be grateful for any other information that could affect an interview, given that many of those taking part in the study are now quite frail. Before visiting any of your patients we will always telephone the practice to ascertain whether there have been any recent developments.

Enclosed is a list of your practice patients who took part in the last survey, whom we believe to be still alive. With your permission we should like to write to them with the enclosed information sheet, asking whether our research nurse could call to see them and explain the study further. We would very much appreciate it if you could let us know if you feel any of your patients should not be approached for whatever reason. It is about three years now since the last interview round and we realise that much may have changed in this time for the individuals concerned and their families. In some of these cases, you may know of a relative or other carer that we could approach to request a proxy interview. If so, any such recommendations would be extremely helpful as it is vital that information is not lost on these individuals who are likely to represent some of the most vulnerable sections of the population.

Please could you return the enclosed form even if you have no reservations as we shall await your comments before we contact anyone.

Department of Public Health and Primary Care
Insititute of Public Health
University of Cambridge Forvie Site
Robinson Way, Cambridge CB2 2SR

Tel: 01223 330341
Fax: 01223 330330
E-mail: carolbrayne@medschl.cam.ac.uk

In this phase of the study we are adding a new focus on falls and fractures to the previous interview schedule. The enclosed *protocol* outlines the background and details the specific outcomes we seek to measure whenever possible. It is expected that only a minority of those interviewed would be willing or able to participate in the additional part of this study – piloting the feasibility of isokinetic muscle dynamometry and densitometry at Addenbrooke's. The two *study information sheets* enclosed for your information explain the main study and this additional element separately.

Our other research nurse, Jane Fleming, will be in touch with the practice to check whether you have any queries or issues to be discussed. She or I would be very happy to visit the practice to discuss this next phase of the study if you wish. We would welcome any comments you may have on either the information to be sent out, practical aspects or the protocol itself.

Thank you and your whole practice team for all the help that has been given over many years towards this project. Your vital contribution to its success is very much appreciated. Please let me know if there is any further information that you would find helpful.

Yours sincerely

Dr Carol Brayne
Professor of Public Health Medicine

(Please turn over for namelist)

Department of Public Health and Primary Care
Insititute of Public Health
University of Cambridge Forvie Site
Robinson Way, Cambridge CB2 2SR

Tel: 01223 330341
Fax: 01223 330330
E-mail: carolbrayne@medschl.cam.ac.uk

The following patients from your practice have previously taken part in the Cambridge Project for Later Life survey. Please could you indicate whether

- you would have any objections to us approaching any of them about a further interview (writing with information sheet about the study, then the research nurse calling to explain more)
- you feel we should be aware of any other information that might affect interview
- you would recommend we contact a relative or friend as well as or instead of the participant themselves

Name	**Date of birth**	**Address**	**Any objections to approaching**	**Any other information**	**Recommend also contacting proxy:**
……	……	……..……	……	……	Name……..……..
			……	……	Relationship ..……..
			……	……	Address…...……..
			……	……	Phone no.……..
……	……	……..……	……	……	Name……..……..
			……	……	Relationship ..……..
			……	……	Address…...……..
			……	……	Phone no.……..
……	……	……..……	……	……	Name……..……..
			……	……	Relationship ..……..
			……	……	Address…...……..
			……	……	Phone no.……..

It would help us greatly if you could return this form to: Jane Fleming, Research Nurse, Dept. of Public Health and Primary Care, Institute of Public Health, University Forvie Site, Robinson Way, Cambridge CB2 2SR.

by: …….

Thank you very much for your assistance with this and your continuing collaboration with the study.

UNIVERSITY OF CAMBRIDGE
DEPARTMENT OF PUBLIC HEALTH AND PRIMARY CARE

Tel: 01223 – 330341
Fax: 01223 – 330330

INSTITUTE OF PUBLIC HEALTH
ROBINSON WAY
CAMBRIDGE CB2 2SR

……(date)

……(name)
……(address)
……
……

Dear ……

Cambridge Project For Later Life

It is now more than fifteen years since we first began a study of health and well-being amongst our senior citizens in Cambridge. You were amongst those who kindly helped by allowing us to talk to you right from the start and on several occasions since then. We are very pleased to let you know that we are still continuing this important study which is now especially valuable and unique because people like yourself have helped us a number of times over many years.

We would be delighted if you could help us again, but if you would prefer not to please do let us know.

This time our study has an extra focus on a problem than can affect many people as they get older – falling. One of the main dangers if you do fall is the risk of breaking a bone, so we are particularly interested in the strength of bones and also muscles, whether you have ever had a fracture or fall and other related questions. The study aims to be of benefit to us all in the future by giving a better understanding of health and illness with age.

If you have no objections our project team research nurse, Jane Fleming, will try calling to explain the survey in more detail, to answer any of your questions and arrange a convenient time to visit you for another interview.

I am sending an information sheet about the survey but the nurse will go through this with you when she comes. If there is anyone such as a relative or friend that you would like to be there when the nurse comes they would be most welcome.

Meanwhile if you have any questions please feel free to telephone the nurse, Jane Fleming, on 01223 330341. This telephone may sometimes be connected to an answering machine. Please do not be concerned if this happens as we will return your call as soon as we can.

Thank you very much for your help.

Yours sincerely,

Dr. Carol Brayne

UNIVERSITY OF CAMBRIDGE
DEPARTMENT OF PUBLIC HEALTH AND PRIMARY CARE

Tel: 01223 – 330341
Fax: 01223 – 330330

INSTITUTE OF PUBLIC HEALTH
ROBINSON WAY
CAMBRIDGE CB2 2SR

CAMBRIDGE PROJECT FOR LATER LIFE - INFORMATION SHEET

Your doctor's surgery is collaborating with our department on a health survey of our senior citizens in Cambridge. We would like to invite you to take part in the survey by being interviewed at home by the project nurse.

We do hope you will be able to help us, and we very much appreciate the valuable contribution that our volunteers make towards important research, but of course you are under no obligation to agree to an interview. Taking part in the survey is entirely voluntary and you can stop at any time without having to explain why. Your care from your GP or any hospital department will not be affected, whatever you decide.

What is the study about?

The researchers are studying changes in older people's health that may develop gradually over time. The study is a long-term project and results from earlier surveys are helping us to develop new research questions all the time.

What will the interview ask?

As the research covers many aspects of older people's well-being the interview includes quite a range of questions - for example about health problems, how you have been coping with daily activities, what medications you perhaps take, etc.

In this survey we are particularly looking into what might cause some people to fall or even break their bones, so we would like to ask you for some extra help with this part of the study.

What is involved?

There are three assessments that may be important clues to understanding falls and fractures better:

- some simple measures of balance and leg strength, for example how far you can reach forward, how you are on your feet, etc. These would usually take about 15 minutes at the most.

- a quick measure of bone strength using a portable ultrasound scanner which the research nurse can bring with her. The test is like putting your heel in a dry footbath and it takes only a few minutes.

(Please turn over)

- a record of whether you have any falls, using a "fall calendar" that the nurse will show you. She will explain how to fill it in and, if you think you could spare us the time to make a note if ever you are unfortunate enough to fall, she will give you some stamped addressed envelopes to send us back the calendar page regularly. We know that it is very common to feel unsteady on your feet and this will provide a very valuable record of how much of a problem falling actually is. It will help the research enormously if you could keep this up for six months, but we understand if you prefer just to try it for a while.

Of course there is no pressure on you to take part in any of these either, and you can always stop even if you have said you would join the survey and then change your mind.

What about confidentiality?

Any details recorded about you for the study, results of scans or other measures, information you give on questionnaires, and so on will all be treated in strictest confidence. Data are processed by computer in accordance with University of Cambridge registration under the Data Protection Act 1998, with all records securely stored.

What happens now?

If you would prefer that we do not contact you please do let us know as we would then not wish to trouble you. Otherwise, you do not need to do anything for now. Our research nurse, Jane Fleming, will be contacting you in the next few weeks to arrange a time to visit you and explain more about the study. She will go over this information sheet with you and answer any questions you may have. You may like to talk this over with a friend or relative, and if there is anyone that you would like to discuss it with you are very welcome to ask them to be there too when the nurse comes. She will not expect you to decide on the spot whether to take part in the survey. If you would like more time to consider this she will be happy to contact you again to see whether you would like her to come back another time to interview.

How to contact us:

Meantime, if you would like any further information about the research, or have any concerns about taking part that you wish to discuss, please contact: Dr Carol Brayne

or the project research nurse: Jane Fleming
by telephone on: 01223 – 330341
or by writing to: Department of Public Health & Primary Care,
Institute of Public Health,
Robinson Way, Cambridge CB2 2SR

Whatever your decision all the research team would like to thank you very much for taking the time to consider helping us.

UNIVERSITY OF CAMBRIDGE
DEPARTMENT OF PUBLIC HEALTH AND PRIMARY CARE

Tel: 01223 – 330316
Fax: 01223 – 762515

INSTITUTE OF PUBLIC HEALTH
ROBINSON WAY
CAMBRIDGE CB2 2SR

CAMBRIDGE PROJECT FOR LATER LIFE
FALLS AND FRACTURES STUDY

CONSENT TO PARTICIPATE

I.....(name)

of.....

.....(address)

hereby fully and freely consent to participate in the Cambridge Project for Later Life Falls and Fractures Study.

I understand that the study is designed to add to medical knowledge. I acknowledge that the nature and purpose of the study has been explained to me by the research nurse.....and that I had an opportunity to discuss any questions with her. I have received a written explanation of the study and the measurements to be taken.

I note that I may withdraw my consent at any stage in the interview and that I need not give any reason for this. I understand also that my decision whether to participate or not will not in any way affect my current or future treatment or care.

I am aware that if the research team discover that I need medical treatment for anything they are obliged, under conditions of the Local Research Ethics Committee, to take steps to ensure that this is provided. I understand and agree that my scan results will be reported to my GP, and that the research team will wish to inform my GP if they identify any problems requiring medical attention.

I am aware that details about me will be recorded for the study and grant permission for my medical notes to be consulted. I understand that all information, results of scans or other measurements will always be treated in strictest confidence. Data are processed by computer in accordance with University of Cambridge registration under the Data Protection Act 1998, and all records are securely stored.

(Please turn over)

CAMBRIDGE PROJECT FOR LATER LIFE - FALLS AND FRACTURES STUDY

EITHER:

CONSENT TO INTERVIEW AND MEASUREMENTS

I understand that the interview could include some additional measures of bone and muscle strength. I consent to the research nurse taking a heel ultrasound scan and some mobility and balance measures as well as interviewing me. (Delete either of these if you like – if you don't mind having a scan but prefer not to have the other measures,or vice versa)

Signed .....….....(volunteer) Date .....

OR:

CONSENT TO INTERVIEW

I consent to the research nurse interviewing me for the survey, but would prefer not to have the ultrasound scan or the mobility and balance measures.

Signed .....….....(volunteer) Date .....

WITNESS to the volunteer's signature and to the fact that she has read the information sheet and has freely given her consent:
(N.B. The witness must not be a member of the research team)

Signed ..... (witness) Date .....

I confirm that I have explained to the volunteer the nature and purpose of the screeening assessment.

Signed .....….(research nurse) Date .....

This research is being sponsored by the NHS Executive Eastern Region and is being conducted by researchers from the University of Cambridge Department of Public Health and Primary Care collaborating with partners in general practice and Addenbrooke's Hospital NHS Trust.

UNIVERSITY OF CAMBRIDGE
Public Health and Primary Care

Cambridge Project for Later Life

Thank you so much for helping us again in this valuable study. We very much appreciate the time and effort involved in answering all our questions. By taking part in the past you have already helped us to understand changes in health and well-being which take place with age. In taking part this further time you have contributed even more to this understanding.

Everything you have told us is completely confidential and if you have any queries or comments regarding the study we would be very pleased to answer your questions.

If you need to make contact with us please ring Jane Fleming, the project nurse, on Cambridge 330341. There may be an answer-phone if she is not in when you call, but please leave your message and she will get back to you as soon as she can.

Dr Carol Brayne
Professor of Public Health Medicine
Honorary Consultant in Public Health Medicine

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