Technical Report 1

The Economic Costs of falls and fractures in people aged 65 and over in Ireland

Technical report to NCAOP/HSE/DOHC

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Section 1: Introduction

1.1 Introduction

Falls, fractures and osteoporosis are important public health issues, particularly as the incidence increases with age and the population of older people is projected to increase significantly (Chang *et al.* 2004). Older people aged 65 and over in Ireland currently account for approximately 11% of the total population and this proportion is expected to increase over the next twenty years. The risk of falls and fractures has been shown to increase with age and are a major concern for many reasons. Many falls and fractures result from the condition of osteoporosis, proven to be more prevalent among older women in particular. A fall can have far-reaching consequences for both the older person and the health services. The negative impact a fall can have on a person's quality of life, independence and general well-being has been well documented. A fall can also have a major impact on the health services, as often injuries sustained can lead to long hospital stays and ultimately to the person entering long-term care with a resultant heavy financial burden. Indeed, research in Australia has estimated that the total cost of osteoporosis (for all age groups) amounted to €226 million in 1994, (Harris *et al.* 1998). Recent research using data for one year from one hospital in Ireland, estimated the hospital costs of admissions due to falls among older people at €10.8 million (Cotter *et al.* 2005).

In Europe, it is estimated that 30% of people aged 65 years and over fall each year and that approximately 10% of these result in fractures and that 20% require medical care (Towner and Errington 2004). Approximately one third of woman and one fifth of men aged 50+ suffer from osteoporosis, (WHO). However, the overall economic burden that falls and fractures places on the Irish economy is currently unknown. Understanding the current burden of falls and fractures in Ireland is also very important in light of changing demographics. The number of people aged 65 and over in Ireland has remained relatively constant at around 11% since the 1950s. However, this trend is expected to change significantly over the next few decades. Currently around one out of every ten people is aged 65 or over. In twenty years time it is expected that one out of every six people will be aged 65 or over. This change in demographics has many consequences for future health care in

Ireland. All other things being equal the economic burden of fractures and falls will increase as the population ages.

In the context of the evolving National Strategy on Falls and Fractures, the current economic cost and projected costs going forward are of vital importance, and lay the foundation for future evaluation of the Strategy. This report aims to estimate the economic burden of falls and fractures in Ireland, and to project these costs over the next 20 years, in the absence of a National Strategy. Unless we know these baseline costs, it will be impossible to evaluate the reduction in costs that may arise from the implementation of a National Strategy. The estimates provided by this report are therefore invaluable.

1.2 What are falls and fractures?

A fall can be defined as "an event which results in the person coming to rest inadvertently on the ground or other lower level" (Todd and Skelton 2004). Falls are a common but preventable cause of morbidity among older people, very often resulting from osteoporosis and other bone conditions. Fractures are one of the main consequences of falls. The most common resulting fractures are of the hip, vertebrae and wrist (colles). For example, it is estimated that over 95% of hip fractures are related to falls (Cox and Warren 2004).

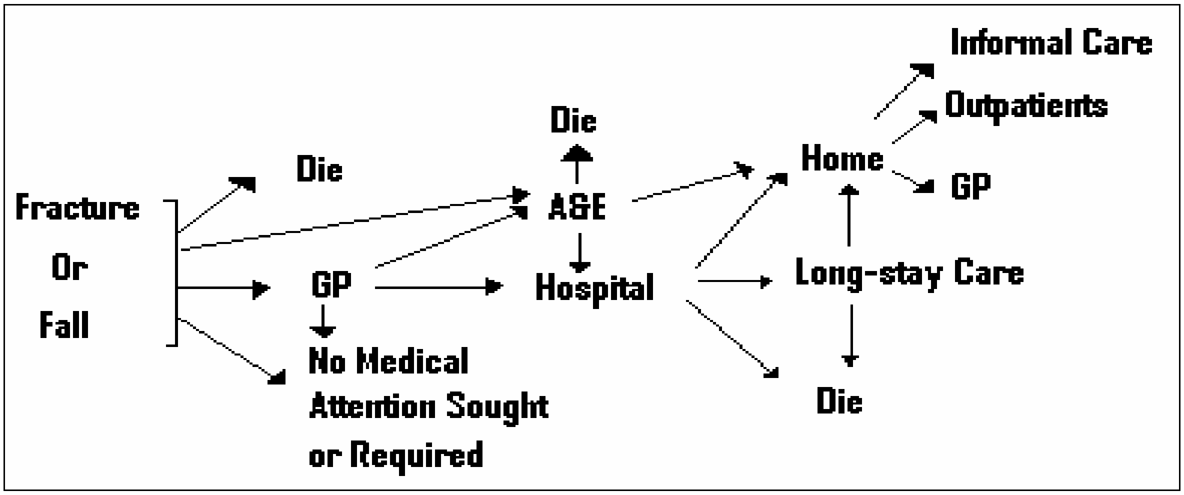
A bone fracture is a break in a bone; the soft tissue surrounding the break may also be injured; most bone fractures are the result of injuries from falls or vehicle crashes, but fractures can also be caused by certain diseases such as osteoporosis, (Parmet *et al.* 2004). Osteoporosis is a progressive, systematic skeletal disorder characterised by low bone mass, deterioration of the micro-architecture of bone, increased bone fragility and increased risk of low trauma fracture, predominantly of the femur, vertebrae and distal radius (Kanis *et al.* 2004). Osteoporosis is defined by the World Health Organization (WHO) as either a bone mineral density 2.5 standard deviations below peak bone mass (20-year-old person standard) as measured by DXA (Dual Energy X-ray Absorptiometry). The weak bone condition in those with osteoporosis increases the likelihood that a fall will result in a fracture.

In this study we estimate the cost of falls and fractures for older people. It is useful to point out that falls and fractures are related but different. People may fall and not incur a fracture, but it is also likely that fractures in older people result from a fall. There are many possible trajectories following a fall or fracture. Figure 1.1 describes these pathways and helps us to understand the logic of this study.

Some people may fall at home or in the community and not attend their GP or ED. These people are not included in this analysis (but cost estimates are provided in a sensitivity analysis later on). We focus on the cost of care for people who fall and make subsequent demands on the health and social care services. People who fall may go direct to ED, or they may attend their GP and then, if necessary, go to hospital. In hospital, a person may die, or be later discharged to home or long-stay care. Some of those discharged will attend GP or outpatient clinics. People returning home may also receive informal care from family carers.

In terms of HIPE information, for fractures, people will follow a similar trajectory but it is more probable that people will attend their GP or ED. Many will be admitted to hospital. On discharge from hospital, their care requirements will likely be higher than those who suffered other injuries due to falls only. In terms of HIPE data, 'fractures' are coded as ICD-9 CM 800-829 as their principal diagnosis. Overall, in this report, we are dealing with two distinct groups; firstly, those who those who have a 'fracture' (ICD-9 CM 800-829) and secondly, those who suffer an injury other than a fracture as their principal diagnosis: 'other injuries due to falls' (ICD-9 CM 830-959) and secondary diagnosis of accidental falls as external cause of injury (ICD-9 CM E880-E886, E888). This distinction is critical towards the economic costing of falls and fractures, and we will discuss the different assumptions related to each diagnosis throughout this report.

Figure 1.1 Pathways following a fracture or fall



On experiencing a fall and/or fracture there are four possible outcomes:

1. Die

2. Medical attention not sought

3. Visit GP: One may then:
    i. Be referred to ED
    ii. Be admitted to hospital
    iii. Require no further medical attention

4. Visit ED: One may then be:
    i. Sent home
    ii. Die
    iii. Admitted to hospital: One may then:
        a. Be sent home
        b. Discharge to long-stay care/rehabilitation/convalescence: One may then:
            - Die
            - Go home
        c. Die

1.3 The Economic Burden of Illness

The economic burden of a disease on society is the value of all resources used to prevent, diagnose, treat and generally cope with the disease (O'Shea and O'Reilly 2000). The role of burden-of-illness (BOI) studies is to increase understanding of the clinical and economic implications of a disease as opposed to resource allocation[1]**.** BOI studies can be used to estimate the extent of the problem and its consequences, to find out if there are areas lacking data and to identify country-specific target populations for screening where necessary. It may provide an indication as to the contribution of each individual health-care resource used in the management of a particular health condition. BOI studies when used in conjunction with demographic projections can be useful for predicting future trends (Sedrine *et al.* 2001).

BOI studies deal with the direct, indirect and human costs of fractures and falls. Direct costs are costs directly related to the illness and include both medical and non-medical costs, which are related to treatment but do not result directly from it, e.g. hospital 'hotel' costs. Indirect costs represent the losses resulting from premature death, morbidity or disability as a result of the illness and items such as lost leisure time, as well as the unpaid activities of the patient and the carer. The intangible or human costs such as pain, suffering and reduced quality of life of patients who experience the illness should also be included, though these costs are more difficult to estimate.

In general, BOI studies are subject to data limitations. When estimating overall disease costs, it is necessary first to quantify the number of people affected and then to assign a unit cost to the identified resources. This poses several difficulties in BOI studies and consequently the cost of illness relies on a range of assumptions and extrapolations from international studies. The interpretation of the results relies heavily on these assumptions. Therefore, it is critical in a BOI study that each assumption is stated explicitly. For example, for this study we do not have information on the number of people attending outpatient clinics following discharge from hospital. We therefore follow a study by Dolan and Torgerson (1998) and apply their

[1] Resource allocation decisions are better made with studies that include not just the costs but also the effectiveness of the health-care interventions

outpatient visiting rates to our study. As BOI studies are heavily dependent on the underlying assumptions, there is a justification for sensitivity analysis. In this study, we vary some of the main assumptions to give us a range of estimates of the various factors in the cost of falls and fractures.

This study will deal with direct costs, indirect costs and intangible costs. In terms of direct costs, the main areas of burden dealt with in this report are inpatient acute care, outpatient care, ED care, GP care, long stay care and prescription costs. Indirect costs in this study include deaths (mortality and life years lost) and opportunity costs (i.e. time given by carers). The main intangible cost in this study is the cost of reduced quality of life.

1.4 Objectives of this study

A National Steering Committee has been established to develop a Strategy to prevent falls in older people and promote bone health in the population. The terms of reference for this group include (among others); (1) identifying the components necessary for an effective falls and fracture strategy in an ageing population, based on best practice from both national and international literature; (2) in relation to falls in older people, to document the extent of the problem and the impact on the health services, including costs to the health service. These two objectives will form the core of our proposed study – the principal outcome will be an estimate of the economic burden of fractures and falls**.**

The objective of this study is to use secondary data[2] to estimate:

- the current economic cost of falls and fractures for people aged 65 and over, based on for example, the number of deaths, hospital admissions, bed utilisation, and long-term care. Pathways following a fall will be costed.
- the trends in the burden of falling and related costs over next 20 years in the absence of a Fall Prevention Strategy
- the number of people affected by osteoporosis in Ireland – i.e. the number with this condition

[2] The data used in this study includes data from the CSO, the Hospital Inpatient Enquiry (HIPE) System and the Quarterly National Household Survey (QNHS). These datasets are discussed in more detail in section 3 and 4.

The main questions we propose to answer in this report are:

1. How many people aged 65 and over are affected by falls and fractures?
2. How many people in Ireland have the condition of osteoporosis?
3. What are the current economic costs of falls and fractures for people aged 65 and over?
4. How will these costs rise or fall over the next 20 years?

We also discuss some potential interventions to reduce the number of falls and fractures among older people.

1.5 Research Approach

A literature review of similar studies is carried out to inform both our methodology and to indicate the resources required for the study. Using secondary data, we focus on the direct, indirect and intangible costs associated with fractures and falls. Firstly, we describe the current and projected population of older people in Ireland and show the number of people affected by falls and factures. We then calculate the current costs for Ireland. As far as possible we follow best practice in international literature with specific amendments for the Irish population where necessary. Using forecasts of population changes, we will also project the burden of fractures and falls over the next twenty years**.** Given changes to the age structure of the population**,** this is achieved under two scenarios i.e. (1) constant increase in incidence of falls and fractures (2) reduction in falls and fractures due to technological improvement (e.g. more DXA scanners).

In areas of uncertainty it may be necessary to use assumptions and it will be important to test the sensitivity of our results to these assumptions. For example, in our calculations we generally apply the average cost but we also look at the range of the costs involved and test if the overall costs are sensitive to using either the minimum or maximum cost. There may also be a number of data limitations. For example, it is difficult to measure quality of life. Nonetheless, we are confident that our calculations are as comprehensive as possible and in some cases improve on international research to date.

The costing of any potential reduction in falls and fractures is not possible without knowing the exact impact of future interventions. The value of any decision on potential investment in interventions or proposals to reduce falls and fractures is not addressed in this report. The development of a new strategy is in progress and any discussion on the returns of any such interventions is best left until then.

1.6 Conclusion

This study will primarily examine the direct and indirect costs of fractures and falls using secondary datasets such as the Hospital Inpatient Enquiry (HIPE) system and data from the Central Statistics Office (CSO)[3]. Costs on the falls and fractures are from the DOHC casemix model. This study on the economic burden of fractures and falls in Ireland serves a number of purposes. Firstly, it is vital to estimate the extent of this burden in Ireland as other international studies have found it to be quite high. Secondly the population of older people in Ireland is expected to increase dramatically over the coming decades which may result in an even greater burden on Irish society, all other things equal. Thirdly, fractures and falls are one of the leading health concerns of older people and can have drastic consequences for their quality of life as a result of the pain and loss of independence involved.

While it would be interesting and highly useful to incorporate the costs of osteoporosis and predict costs of developing a service for osteoporosis, data are very poor and nothing really can be deduced from the point of view of costs. This highlights the poor awareness of osteoporosis in Ireland.

The remainder of this study is outlined as follows: section 2 contains a review of international literature on the cost of fractures and falls; section 3 estimates the number of people with osteoporosis, fractures and falls; section 4 estimates the cost of fractures and falls; section 5 looks at projections for the next 20 years; section 6 concludes.

[3] The data are discussed further in section 3 and 4.

Section 2: Literature Review on Cost of Falls and Fractures

2.1 Introduction

In Ireland, there is a local study by Cotter *et al.* (2005) and a study by Carey and Laffoy (2005). Along with the international studies the latter studies highlight some methodological approaches to estimating the cost of falls and fractures. Furthermore, this allows us to see limitations in economic costing. Before we discuss some of the main results of the international cost of falls/fractures/osteoporosis studies, we first outline some of the main points addressed in Sedrine *et al.* (2001). Their paper reviews the methodology underlying economic burden-of-illness studies in relation to osteoporosis and the issues involved. The paper suggests that the costs involved can be categorised into three groups: direct, indirect and intangible costs.

- Direct costs consist of medical costs, which are related to the treatment of disease or to the disease itself, and non-medical costs, which are linked to the treatment of the disease but do not result directly from it, such as transport to out-patient rehabilitation. As these costs are imperative in BOI studies they should be reported in detail, so that the contribution of each element to total health-care expenditure can be calculated. The inclusion of non-direct medical costs is not usually considered compulsory as they are not as readily accessible or as easy to identify and value as direct medical costs.

- Indirect costs or productivity costs try to capture the value of present and future production losses resulting from premature death, morbidity or disability caused by the disease. These costs can also include items such as time lost from leisure, and the unpaid activities of the patient or caregivers. Sedrine *et al.* (2001) suggest that a consensus has not been reached on whether or not to include these costs in the BOI studies and consequently results should be provided both with and without productivity costs included. A frequent method used to estimate indirect costs is the ‘human capital’ approach, which is based on gross earnings, where the total value of income potentially lost by the worker due to absence from work is counted. This method raises a number of concerns. The main concern in our case lies in the fact that the impact of among the elderly is greater than for younger people and the majority of the population at risk has reached retirement age. Consequently, if the results of the BOI for fractures and falls are compared to BOI studies for other diseases, inequality in programme prioritization may result. Sedrine *et al.* (2001) makes a number of suggestions regarding indirect costs: they should not be restricted to time lost from work but should also cover time lost from all other kinds of activities; take the caregiver's time into account; and should be expressed in physical units rather than given a monetary value, for example, the number of hours of care.

- Intangible costs are costs are difficult to quantify and value, for example costs due to the pain, suffering and reduced quality of life of patients who have the disease. These costs are usually not included in BOI studies.

Sedrine *et al*. (2001) note that allowance for uncertainty can be made using a sensitivity analysis. This analysis could be carried out by identifying the uncertain parameters or features, defining a plausible range of variation of these parameters and modifying the analysis under the alternative options so as to investigate the effect on the results. Their paper concludes that it is very important to ascertain the extent of the burden of osteoporosis in order to prevent adverse consequences, such as unmanageable situation of high mortality and costs.

Table 2.1 Summary of Cost of Falls/Fractures/Osteoporosis Studies

Author	Methodology	Results	Limitations
Cotter *et al.* (2005) Ireland	• No. of inpatient bed-days • Average daily cost of an orthopaedic speciality bed • No. of rehabilitation bed-days • Readmissions episodes within one year costed • Cost analysis of a hip fracture	• Age 65 and over • 810 fall-related admissions, 8,771 bed-days • Female (79%). • Acute hospital inpatient stay cost €7.46m. • 6,220 rehabilitation bed-days cost €2.9 m. • Total yearly cost €10.8m. • hip fracture admissions cost €14,339 each	Did not include: • emergency room • outpatient departments • cost of institutional care
Praemer *et al.* (1992) United States	• Lost productivity: no. of people with musculoskeletal conditions, disability/ impairment rates and average earnings. • Mortality costs: no. deaths and expected value of future earnings. • Direct costs = no. of services by unit prices/charges.	• Total cost: $126 million • 54% of costs for females • Hospital inpatient care= 36%. • Direct costs:$61 billion/12.7% of total personal health care expenditure for all illnesses • Morbidity costs $59.6 billion • 44,787 deaths.	• Did not include cost of pain and suffering • Difficulty valuing lost productivity
Scuffham et *al.* (2006) UK	• Inpatient costs: health related grouping (HRG) by the mean reference costs. • National data sources used to estimate all other unit costs.	• In 1999 647,721 fall related ED attendances for people aged 65 and over. – 204, • 000 admissions • 66% occurred in people 75+ years. • Total cost of falls for age 60+: about £981 million.	Uncertainty regarding: • Duration of long term institutional care, • No. follow-up GP • No. outpatient consultations.
Parrott (2000) UK	• Costs of fractures of the neck of the femur • 47,471 of these fractures • Average length of stay = 20 days. • Assumed 50% of fractures need an ambulance-call out	• Total cost per annum of hip fractures in the UK= £726m. • About half of this cost due to social care costs.	Data unavailable: • No. of people who care for their elderly relatives. • Travel unavailable.
Harris *et al.* (1998) Australia	• Hip fractures: Australian hospital separations data • Others: fractures rates from Rochester, Minnesota • Assumed all minimal trauma fractures admitted to hospital are osteoporotic.	• In-hospital mortality after hip fracture is around 5%. • Total cost of the treatment of osteoporosis in Australia estimated at $226.72 m. • Hospital treatment comprises about 75% of cost.	• Non-hip fractures limited. • Cost of reduced quality of life not calculated.

2.2 Review of Cost of Falls, Fractures and Osteoporosis Studies

In this section, we provide an overview of the cost of illness studies that are related to falls, fractures and osteoporosis. A summary of these studies is provided in Table 2.1 and we now discuss each of these in turn. We provide a synopsis of the methodology used, the results obtained and a brief critique on the limitations of these studies. This review is crucial to the understanding of the methodology employed in our study (to be discussed in detail in sections 3 and 4).

The first study summarized in Table 2.1 was carried out in Ireland by Cotter *et al.* (2005). This paper examines the financial implications of falls in older people for an acute hospital. Data were collected for one year from May 2002 to April 2003 at a University teaching hospital with on-site acute orthopaedic and geriatric medical services. The hospital inpatient enquiry system (HIPE) system was the main source of data, although this was supplemented by a review of the hospital case-notes or emergency department records. The amount of inpatient bed-days occupied by fall-related admissions in the acute hospital was estimated. The bed-day cost used for the analysis was the average daily cost of an orthopaedic speciality bed as most admissions sustained a fracture. This included 'hotel costs' for each bed-day and average medical, nursing and therapist time. In addition, the number of rehabilitation bed-days at the affiliated geriatric rehabilitation and orthopaedic hospitals was calculated. Subsequent readmissions episodes within one year following discharge from the incident fall were quantified and cost-analysed. A detailed cost-analysis of a hip fracture was carried out using the case notes of five randomly selected cases.

In one year there were 810 fall-related admissions of people aged 65 and over the majority were female (79%). In 80% of cases a fracture was sustained. There were a total of 8,771 bed-days consumed by fall-related admissions. Of these, 26 were intensive care days. The mean length of stay was 10.8 days, with a mean length of stay of 15.3 days for a hip fracture episode. The cost of acute hospital inpatient stays was €7.46 million. These patients also consumed a further 6,220 rehabilitation bed-days, with an associated cost of €2.9 million. It was found that there was a 10% readmission rate for an older person following an incident fall-related admission episode at one year. Sixty per cent of these were directly attributable to the initial fall, with a further 480 acute and 170 rehabilitation bed-days occupied. The total cost for one year of fall-related admissions to this acute hospital was €10.8 million. The cost of hip fracture admissions averaged from the five randomly selected cases was €14,339. Therefore, the total cost for the 324 fall-related hip-fracture admissions in older patients in 2002 was approximately €4.65 million.

This study was one of the first in Ireland to quantify the cost of fall related admissions to a public hospital[4]. However there were some limitations. Presumably due to data limitations, it did not provide information on (1) emergency (ED) admissions for those not subsequently admitted, (2) outpatient departments or (3) the cost of institutional care. Nonetheless the Cotter *et al.* (2005) study is an important one, and we will compare our estimates to their micro level cost estimates where possible.

The next two studies summarised in Table 2.1 are from the UK. In general the health structure of the populations in the UK and Ireland are relatively similar, so studies from the UK may provide useful baseline data from which we can extrapolate to Irish demographics[5]**.** The first study is by Parrott (2000). This paper attempts to estimate the costs of hip fractures in the UK among the older population (the specific age group is not defined). Hip fractures account for approximately 20% of orthopaedic bed occupancies in the UK and estimates show that there are 47,471 fractures of the neck of the femur annually. The average length of stay is estimated to be 20 days and the marginal cost per day is estimated at £106. It is assumed that 50% of fractures need an ambulance-call out and that the cost per patient journey is £171, so total ambulance costs are estimated to be £4,058,770. The social costs of hip fracture are estimated for four categories of patients (long stay hospital care, long stay hospital care followed by death, long stay residential care after discharge, discharged to home. The total social cost amounted to £490,042,118. GP costs are estimated to be £5,060,384 and outpatient costs are estimated to be £787,630. Patients travel costs were also estimated.

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[4] Carey and Laffoy (2005) also gave the estimated cost of fractured hips and intracranial injuries.
[5] We should however bear in mind that financing of the health systems are different.

The total cost per annum of hip fractures in the UK is therefore £726 million. Approximately half of this cost is accounted for by social care costs. It is estimated that if a patient survives and spends a year in long stay residential care, the cost of a single hip fracture amounts to approximately £25,424.

This paper provides a good breakdown of hospital costs, outpatient costs, GP costs and social costs. However, there are some limitations in terms of indirect costs, for example, it does not include data on the number of carers. The methodology set out in this study is appropriate to our study. Our study hopes to improve on their methodology, by allowing for costs of carers and prescription costs.

The second UK study we review is by Scuffham *et al.* (2006). This study estimates the number of emergency department (ED) attendances, admissions to hospital, and the associated costs as a result of unintentional falls in older people. Data were obtained from a comprehensive database with detailed data on 10,000 falls admitted to ED. Inpatient costs were estimated by multiplying the health related grouping (HRG) in the data by the NHS mean reference costs. This gives an approximation of inpatient costs. A number of assumptions were made in order to calculate the additional costs after discharge from hospital or treatment in ED. For example, it was assumed that those referred to a GP or an outpatient clinic incurred the cost of one attendance. The parameters with the greatest uncertainty were the duration of long term institutional care attributable to a fall, the number of follow up GP and outpatient consultations. These parameters were the subject of a sensitivity analysis, for example when calculating long-stay care costs they assumed 6 months of care initially and increased this to 24 months in their sensitivity analysis. The number of GP visits and outpatient visits were also varied.

Scuffham *et al*. (2006) estimated that in 1999, there were over 647,721 fall related ED attendances for those aged 65 and over. Of these, 66% occurred in those over 75 years of age. These falls led to 204,424 admissions to hospital, of which 78% were over 75 years old. Falls resulted in 4,800 fatalities. For all age groups most falls were categorised as "falls on the same level (slip/trip/stumble)." For people in the younger age groups the second most common fall category was "falls on or from stairs or steps." The number of falls in the category "unspecified falls" increases with age. People presenting to ED with an unspecified fall are more likely to be admitted to hospital. People aged 75 or more had the highest hospitalisation rates and were four times more likely to be hospitalised after an unintentional fall than those in the 70-74 year age group. For people in the 60-64 year age group, about 64% of ED attendees were examined and required no further treatment. However, this percentage decreases with age. In all age groups the most common outcome was "discharged; referred to an outpatient clinic." The outcome "admitted or transferred to long stay care" was the most likely outcome for those aged 70 or above.

The total cost of falls in the UK for those aged 60 years and above was about £981 million, of which 53% was attributable to unspecified falls. About 30% of this cost can be attributed to falls on the same level as a result of a slip or a trip. About 66% of the costs of unintentional falls are incurred by those aged 75 years or above. People aged 60-64 only contributed to 8% of the total cost. Inpatient admissions were the largest component of costs for all age groups (49%). Long term care comprised 48.5% of costs for people aged 75 years and above. The cost of GP visits was the lowest cost component (0.2%) and the costs of ED attendances were also small.

These results were sensitive to the duration of long term stay attributable to a fall when a sensitivity analysis is done, but the number of follow up outpatient or GP consultations made little difference to the results.

Scuffham *et al.* (2006) use the general methodology we wish to employ in our study. We hope however to build on their study by also estimating a value for quality of life and the opportunity costs of carers.

The next study we review was carried out in the US by Praemer *et al*. (1992). While the demographic structure is currently quite different, this study is nonetheless very relevant to people in Ireland, as we can learn from their experiences. This study estimates the costs of musculoskeletal conditions in the United States using the human capital approach, whereby a person produces a stream of output that is valued at market earnings or the imputed value of housekeeping activities. The burden of illness comprises both direct and indirect costs. Direct costs were defined as costs whereby a payment is incurred and indirect costs are costs whereby resources are lost.

Outpatient costs were 25.3% of total inpatient services. In 1988 the mean surgical fee per procedure was $1,357. The cost of physician visits were calculated based on the number of days of care for hospitalised patients and assuming that only half of the visits result in a charge. The charge per visit used ($37.30) was the mean fee for a follow-up visit for orthopaedic surgery. Other costs included nursing home costs calculated as the number of residents by annual charge, prepayment and administration costs based on the percentage of these costs to total personal health care expenditure (5.8%) and non-health care sector costs. These latter costs were estimated to be 15% of total direct care costs less prepayment and administration costs.

The prevalence of musculoskeletal conditions in the U.S. is high and cost the economy $126 million. These costs were incurred almost equally by men and women. People aged 45 to 64 accounted for the largest share of costs at 37%, those aged 65 and over comprised 35%. Direct costs amounted to $61 billion or 12.7% of total personal health care expenditure for all illnesses in that year, of which 36% is accounted for by hospital inpatient care. Morbidity costs amounted to $59.6 billion, which is 92% of indirect costs. As a result of musculoskeletal conditions there were 44,787 deaths.

One limitation of this study is exclusion from quality of life from the indirect costs. Our study aims to fill this gap in the context of costs in Ireland.

The final study we review is by Harris *et al.* (1998). This study estimates the cost of illness associated with the treatment of osteoporosis in Australia in 1994. Data on the proportion of fractures which can be attributed to osteoporosis by fracture type are used to estimate the cost associated with osteoporosis. Both direct medical and non-direct medical costs were estimated. This study estimates the total cost of fracture treatment by combining national or state level data on service use by fracture type, with sample estimates of the average cost of each service type.

The hospital admission data used in this study were found to be limited, because apart from hip fractures, many fractures do not result in hospital admissions. It is assumed that all minimal trauma fractures admitted to hospital were osteoporotic. For cases not admitted to hospital and where there is no evidence of an absence of major trauma, population-attributable risks were applied to estimated fracture rates. Therefore, it is assumed that in addition to those admitted to hospital, 50% of all hip fractures, 20% of all Colles' fractures, and 30% of all humeral fractures who present to emergency departments, and are not admitted, are attributable to osteoporosis.

The total cost of the treatment of osteoporosis in Australia is estimated to be $226.72 million. Hospital treatment comprises approximately three quarters of that cost. Within acute hospital care, 85% of the total cost is accounted for by hip fracture. Pharmaceuticals accounted for 9% of the total cost and are the second largest category. The In-hospital mortality rate after hip fracture is estimated at approximately 5% in Australia.

Some of the methodology and data quoted in this study are of much relevance to our study. For example, we may apply the rate of ED attendance rate by fracture type to our data. Nonetheless, similar to previous studies, Harris *et al.* (1998) does not include information on carers or quality of life.

2.3 Conclusion

The studies reviewed above indicate that falls and fractures are a serious burden on society. Calculating the cost of this burden can be difficult, especially when it comes to the more qualitative aspects of the burden. For example, the cost of quality of life is not estimated in any of the studies reviewed. The studies also indicate that a number of assumptions may have to be made to overcome areas where data were lacking.

Section 3: Number of People with Falls, Fractures, Osteoporosis

3.1 Introduction

The data for cost of illness studies are often taken from a variety of sources, most usually from secondary sources. Two main types of data are required, firstly the number of people affected and secondly the associated costs. In this section we concentrate on the number of people and return to costs in the next section. In order to obtain an accurate understanding of the burden of falls and fractures in Irish society in people aged 65 and over a number of data sources were used. First, to get a picture of the current and future demographics in society, information was obtained from the Census data held at the Central Statistics Office[6] (CSO). Second, in terms of the numbers of people affected by falls and fractures, this information is less readily available and consequently comes from a range of sources, including the HIPE data and the QNHS (Quarterly National Household Survey) Health Module 2001.

3.2 Demographics

The Census is the principal source of information regarding population and demographics in Ireland. It is conducted by the CSO and aims to acquire information on every member of the population. The most recent census was carried out in April 2006 and is generally carried out every five years. For the purposes of this report, we use information such as the number of people in different age groups, the causes of death and the number of people in rural and urban areas. We also use the CSO population projections. The CSO projects the population using different assumptions for fertility and migration, and provides six different scenarios regarding how the population may change. This information can be used to investigate the future change in the age structure of the population.

The population of Ireland is currently over four million and has increased by over half a million in the last twenty years and increased by about 8% since 2002. There are about

[6] Much of this data are available at www.cso.ie.

470,000 in the 65 and over age group and this has increased by almost 8% since 2002, in line with the overall population trend. The proportion of people aged 65 and over has remained quite consistent since 2002 at approximately 11% of the total population. Table 3.1 shows that in 2002 there was a ratio of 1.3 females to males in the 65 years and above age group. This ratio has shown a slow decline since and in 2006 was about 1.26.

Table 3.1 Population Changes in the 65 and over age Group (in thousands)

Year	Total	Male	Female	Ratio of Females to Males
2002	436.0	189.2	246.8	1.30
2003	442.8	192.8	250.0	1.29
2004	450.8	197.1	253.7	1.28
2005	460.7	202.4	258.3	1.27
2006	470.7	207.9	262.7	1.26

Data Source: CSO: Population and Migration Estimates April 2006

Table 3.2 provides population projections, up to 2026 showing that the proportion of people aged 65 and over is expected to increase[7]. In fact, it is expected that by 2031, there will be 1.04 million people aged 65 and above. The consequences of these changing demographics are very important to the future economic burden of fractures and falls.

Table 3.2 Population Projections (000's)

Year	All Ages	Under 65	65 and Over	Ratio of those 65 years and over to those under 65	Ratio of those 65 years and over to rest of the population
2006	3,993	3,541	451	1/8	1/9
2016	4,227	3,646	580	1/6	1/7
2026	4,333	3,571	760	1/5	1/6

Data Source: Barrett and Bergin 2006

In terms of life expectancy, in 2002, it was estimated that men aged 65 could expect to live for another fifteen years and men aged 75 could expect to live for another nine years. Women aged 65 could expect to live for another nineteen years and women aged 75 years

[7] Population projections are taken from Barrett and Bergin (2006). Their projections follow closely to those of the CSO 2004.

could expect to live for another eleven years (CSO 2004). The increase in life expectancy for women in particular is of much relevance to our study and has implications for the current costing of falls and fractures. Furthermore, by using data on life expectancy we can estimate the years of life lost due to falls and fractures.

Table 3.3 Life Expectancy

At Age	Year	65	75
Male	1926	12.8	7.7
	2002	15.4	8.9
Female	1926	13.4	8.4
	2002	18.7	11.2

Data Source: CSO 2004 *Irish Life Tables No. 14 2001-2003*

3.3 Number of population aged 65 and over with falls and fractures

We now look at the number of people who have experienced a fracture or a fall in Ireland. The data were available in a number of formats and from a range of sources, so we discuss each of these in turn. First we look at the incidence of falls in Ireland. Second, we report the number of admissions to acute public hospitals for falls and fractures. Third, we provide estimates on the number of admissions to public hospitals with osteoporosis as their main diagnosis. Fourth, we show the number of admissions to public hospitals with a secondary diagnosis of osteoporosis. Fifth, because the latter is likely to underestimate the number of people in the community with osteoporosis, we provide alternative estimates of the number of people in the community with osteoporosis.

a. Incidence of Falls

To calculate the number of older people who fall each year in Ireland, we refer to European statistics (WHO 2004) and apply these rates to the population of aged 65 and over in Ireland. Applying WHO fall rates to Ireland suggests that 30% or approximately 130,000 people aged 65 and over fall each year. Of these, according to WHO, about 80% or 104,000 are non-injurious and not reported to a health professionals, leaving about 26,000 older people with potentially serious injuries. From HIPE discharge statistics 2004, we know that 1,472 were admitted to hospital for other injuries due to falls (primary diagnosis) and 6,813 admitted to hospital for fractures (the majority of these are due to falls). This means that about 18,000 may attend their GP (14,000) or ED (4,000)[8] but are not admitted to hospital. We do not have specific data on these individuals for costing purposes, but we will make some assumptions and include the costing for these people in our sensitivity analysis in section 4.

b. Admissions with Falls and Fractures to Acute Public Hospitals

Data on the number of hospitalisations as a result of a fracture are available from HIPE (collected for the Department of Health and Children by the ESRI), which is a computer-based discharge abstracting system designed to collect demographic, clinical and administrative data on discharges and deaths from acute general hospitals nationally. Table 3.4 shows that there were 6,813 admissions to public hospitals for all fractures in 2004. Hip fractures accounted for almost half of all of these admissions. Of course, this underestimates to some extent the total number of people with fractures in Ireland as these figures exclude private hospitals[9]**,** people who go to their GP surgery and those who do not attend anywhere. It's important to note that most of these fractures result from falls (about 85%), i.e. the HIPE data records fractures as the primary diagnosis and falls as the secondary diagnosis (external cause of injury).

[8] In section 4, we estimate about 4,000 attend ED and not subsequently admitted to hospital.

[9] Two private hospitals are included in HIPE but had not been made available to the HSE at the time of writing this report. Most injuries will be emergencies and will be admitted via ED to a public hospital, as private hospitals do not have ED.

Table 3.4 Number of admissions aged 65 and over to Public HIPE reporting Hospitals with Fractures

	All Fractures[10] #		Colles #		Hip #		Vertebrae #		Ankle #	
Age	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
65-69	302	645	7	105	66	131	32	24	29	83
70-74	346	800	~	103	119	238	28	25	28	48
75-79	350	1,061	7	96	131	466	26	48	27	41
80-84	346	1,322	~	100	215	746	14	32	14	29
85+	307	1,334	~	54	207	864	16	21	*	12
Total	6,813		482		3,183		266		311	

Data Source: HIPE & NPRS Unit, ESRI. (Total for other fractures is 2571)

* For patient confidentiality reasons, 80-84 and 85+ categories were combined to form 80+ group.
~ = five or less cases.

The number of 'other injuries due to falls' discharges are also available from HIPE 2004. Overall, in Table 3.5, we see that 1472 cases aged 65 and over were admitted to hospital with principal diagnosis of injury other than fracture (ICD-9 CM 830-959) and with a secondary diagnosis of accidental fall as external cause of injury (ICD-9 CM E880-E886, E888).

Table 3.5 Number of admissions aged 65 and over to Public HIPE reporting Other injuries due to falls

Age	Male	Female
65-69	159	80
70-74	160	113
75-79	123	162
80-84	131	222
85+	91	231
Total 65+	1,472	

Data Source: HIPE & NPRS Unit, ESRI.

In this report, we are mainly concentrating on principal diagnosis of fractures (many resulting from a fall) and other injuries due to falls. Nonetheless, there is another group of patients that we should mention that have a condition potentially resulting in a fall. The main diagnoses include orthostatic hypertension, syncope and collapse, abnormality of

[10] As defined by a principal diagnosis of All Fractures (ICD-9 CM 800-829), Colles # (ICD-9 CM 813.41, 813.51), Hip # (ICD-9CM 820) Vertebrae # (ICD-9 CM 805, 806), and Ankle # (ICD 9 CM 824).

gait, lack of co-ordination and dizziness[11], and the total number of cases is 3,620. We do not include these into our main estimate of the cost of falls and fractures, but will return to these in the sensitivity analysis.

c. Admitted with osteoporosis to acute public hospitals (primary and secondary diagnosis)

As mentioned earlier in section 1, osteoporosis is a condition that very often results in falls or fractures, and is therefore itself an important condition to be considered while estimating the economic cost of falls and fractures. Data on the number of people with osteoporosis are more difficult to obtain, as many people have not been diagnosed but yet are living with this condition. While the HIPE data is mainly collated by the fracture of an individual it is very possible that they suffered osteoporosis. Due to the nature of the HIPE data, it is impossible to deduce costs. We note this as an important drawback in the costing of osteoporosis and without greater awareness and diagnosis of the condition, it will be difficult to estimate a national cost.

The number of admissions to hospital with osteoporosis is available in two ways, first by principal diagnosis and second by secondary diagnosis. The condition of osteoporosis is coded under ICD code 733.0 but generally it is not the principal diagnosis of a person when admitted to hospital. We show in Table 3.6 that the number of cases with a principal diagnosis of osteoporosis is very low. The figures in 2004 are 17 men and 105 women.

[11] CM Codes 458.0, 780.2, 780.4, 781.2, 781.3.

Table 3.6 Number of cases with principal diagnosis of osteoporosis (ICD-9 CM 733.0)

	2000		2001		2002		2003		2004	
Age	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Under 65	15	14	~	16	8	12	11	13	6	12
65-69	~	15	~	13	0	15	0	8	0	10
70-74	~	30	~	22	0	18	~	12	~	11
75-79	~	38	~	32	6	33	~	38	~	27
80-84	~	30	~	39	~	31	~	20	~	21
85+	0	32	~	22	~	28	~	24	~	24
All Ages	26	159	24	144	19	137	25	115	17	105

Data Source: HIPE & NPRS Unit, ESRI. (~ = five or less cases)

The number of admissions diagnosed with either primary or secondary diagnosis of osteoporosis is, however, much higher. Table 3.7 shows that in 2004, 901 males and 5,212 females were admitted to public hospitals with this diagnosis**.** The final row of Table 3.6 above is a subset of the final row of Table 3.7, so overall 884 men and 5,107 women were admitted to hospital with a secondary diagnosis of osteoporosis. Ideally, we would like to subtract the numbers in table 3.6 from those given below to obtain the number of admissions in each age group with secondary diagnosis of osteoporosis. However, given the small numbers with primary diagnosis within each group, it is not possible to give a precise number of people with secondary diagnosis only within each age group. So even the information on secondary diagnosis of osteoporosis is very low and no conclusions may be drawn from it.

Table 3.7 Number of admissions with principal or secondary diagnosis of osteoporosis (ICD-9 CM 733.0)

	2000		2001		2002		2003		2004	
Age	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Under 50	90	152	81	165	124	174	127	201	179	237
50-54	28	111	39	112	32	125	52	116	47	137
55-59	26	103	37	112	42	132	36	156	39	192
60-64	39	199	49	207	67	265	82	271	70	347
65-69	58	332	56	339	98	430	81	483	78	574
70-74	54	456	85	489	80	591	101	694	125	708
75-79	75	695	107	695	115	982	105	1,000	114	1,052
80-84	63	529	81	649	92	867	99	921	142	1,130
85+	38	453	43	512	60	686	75	719	107	835
All Ages	471	3,030	578	3,280	710	4,252	758	4,561	901	5,212

Data Source: HIPE & NPRS Unit, ESRI.

Some of those with a secondary diagnosis of osteoporosis will be admitted with a principal diagnosis of fractures, but many with a different principal diagnosis. For example, we know from HIPE statistics that of those with a secondary diagnosis of osteoporosis, only 476 cases, or 8% had a principal diagnosis of fractures. Moreover, many more people may be unaware that they have osteoporosis and so these figures may underestimate the true prevalence of osteoporosis. Even when known to the patient, osteoporosis may not be recorded – technically, a secondary diagnosis should only be recorded if treatment was received for it.

d. Number with osteoporosis in the community

Another source of information on the condition of osteoporosis is the QNHS Health Module 2001. The survey covered items such as consultations with GP or family doctor, other health appointments, waiting lists, private medical insurance, medical cards, perception of health and health conditions. Health conditions include osteoporosis. This dataset contains information on 44,844 people, of which 8,705 are aged 65 and over. The dataset also contains a weighting so that population estimates can be derived. The main limitation of specifying numbers of people with osteoporosis from this survey is that the information is self-reported. The condition of osteoporosis is therefore most likely underestimated. Using the 2001 QNHS data, it was estimated that 3.7% of people aged 65 and over have osteoporosis, amounting to 16,132 people, though many people aged 65 and over may not be aware that they have osteoporosis. International literature suggests that 1/3 of women aged over 50 and 1/5 of men aged over 50 suffer from osteoporosis. If we apply these rates to the age group 65 and over, we estimate that about 84,567 women and 39,420 men have osteoporosis (in 2004).

3.4 Conclusion

The increase in the projected number of people aged 65 and over, as well as increases in life expectancy has important implications for this study, as all other things equal the burden will increase. In this section, we set the scene for the number of older people in Ireland and the number currently suffering from falls and fractures. We looked at how the structure of the population will change over the next 20 years. This will have implications for our projected estimates of cost of falls and fractures.

We then provided figures for each element of the trajectory from initial occurrence of fall or fracture to hospital admission. For osteoporosis, the calculation was less straightforward – it is likely the official statistics are grossly underestimated as many people do not know they suffer from the condition. The European figures of one third of women and one fifth of men over 50 are not evident from either HIPE or QNHS data. In this section, we showed that over 5,000 people with osteoporosis age 65 and over are treated in hospital, 16,000 reported having the condition, but WHO (2004) figures would suggest about 85,000 women and 39,000 men would have osteoporosis. This study does not aim to estimate the cost of osteoporosis, but these figures will prove useful in the context of costing the development of an osteoporosis service.

For falls and fractures, this section estimated that approximately 130,000 individuals aged 65 and over fall each year – of these about 108,000 do not seek medical attention, about 1,500 are admitted to hospital for other injuries due to falls and almost 7,000 are admitted to hospital for fractures. The remaining 18,000 may have attended their GP, of which some (approximately 4,000 would attend ED[12]). These numbers are most relevant to the overall aim of this report, i.e. to estimate the economic burden of falls and fractures for the 65 and over age group in Ireland. In section 4 we will estimate the costs incurred as a result of fractures and falls.

[12] The estimation of 4,000 attendances to ED is provided in section 4.

Section 4: Costs of Falls and Fractures

4.1 Introduction

In section 2 we reviewed the methodologies used in previous international literature. A critique of these studies highlighted the resources required for a cost of illness study, such as the cost of ED attendances and inpatient costs, and subsequent limitations. We now aim to build a model of economic costing of falls and fractures in Ireland. Firstly, we will calculate the overall annual cost of fractures and falls, including both the direct and indirect costs. These include hospital inpatient costs, outpatient costs, ED costs, long-stay care costs and GP costs, mortality costs, the cost of the lost quality of life and the cost of informal care. Secondly, a sensitivity analysis is conducted on parameters with the greatest uncertainty.

Costs of falls and fractures may be summarized as those arising from direct costs and indirect costs. The economic burden of a disease on society is the value of all resources used to prevent, diagnose, treat and generally cope with the disease. This study will examine the burden of illness using the methodology of O'Shea and O'Reilly (2000), where possible. Five main areas of economic burden are covered as follows: mortality and life years lost, inpatient acute care, primary and community care, family care and long-stay care. Direct, indirect and intangible costs are estimated where possible but due to some data constraints there are some notable limitations. Consequently a number of assumptions and extrapolations have to be made, for example we extrapolate the number of GP visits from a study in the UK (Dolan and Torgerson 1998). A sensitivity analysis was carried out on the parameters with the greatest uncertainty, such as the cost of an informal care hour.

Before providing a description of the methodology and analysis of the results, we explain the data sources used in our costing.

4.2 Data Sources for Costing

Estimation of the economic cost of falls and fractures requires knowledge of the number of people with each condition and information on unit costs for each type of care required. In section 3 we presented detailed numbers of people with falls and fractures – a brief summary is now provided in Table 4.1. The numbers are rounded off for ease of exposition.

Table 4.1 Summary of cases of falls and fractures

	N aged 65 and over
No medical attention	104,000
GP	9,000
ED	4,000
Hospital in-patient other injuries due to falls	1,500
Hospital in-patient fractures	6,800

The majority of fracture admissions represent an emergency and not planned elective surgery. In 2004, for people aged 65 and over, about three quarters of all procedures were surgical, with a mean length of stay of 13.3 days. However, across each type of fracture the range of length of stay was quite high – people admitted with a Colles' fracture stayed on average 4.1 days, whereas those with a hip fracture had a mean length of stay of 17.1 days. For other injuries due to the falls the average length of stay was 8.3 days.

Following discharge from hospital, a number of pathways were observed in Figure 1.1 earlier – these include GP attendance, outpatient visits, long-stay care, rehabilitation care, convalescence care, informal care, death. To estimate the cost of care after discharge from hospital, we need to know the proportions going home or to long-stay care. Table 4.2 provides these proportions for each type of fracture.

On discharge from hospital, about half of the fracture patients aged 65 and over went home with the remainder being admitted to a health facility. However, only about one third of hip fracture patients went home, whereas about two thirds went to another hospital or long-stay facility and about 4% may have died. About half of vertebrae fracture patients go home and most of the remainder go to a health facility.

Table 4.2 Destination on Discharge from Hospital for age 65 and over

	All Fractures (%)	Colles (%)	Hip (%)	Vertebrae (%)
Home	49	85	30	55
Health Facility[13]	50	15	66	41
Other[14]	1	0	4	4

Data Source: HIPE & NPRS Unit, ESRI.

For other injuries due to falls, 68% went home following discharge from hospital.

Similar to any cost of illness study, the cost information are taken from a variety of sources. Table 4.2 summarises our sources for cost of falls, fractures and osteoporosis.

Table 4.3 Cost Data Sources

	Cost Data Source
Direct	
ED	HSE
Hospital Costs	HIPE & NPRS Unit, ESRI and the Department of Health and Children
Outpatient	HSE
Long-stay care	HSE
Prescriptions	St. James's Study
Ambulance Costs	HSE, Hospital Charges
Indirect	
Carers (informal)	No. of hours–Charatan (200) Opportunity cost–uprated from O'Shea and O'Reilly
Mortality/years life lost	CSO, Cost taken from International Literature
Quality of Life	Borgstrom et al. (2005)

The data sources for direct costs are relatively self-explanatory. However, the indirect costs are usually more difficult to quantify and finding suitable sources of information can be problematic. For informal care, we based our estimates of hours of care on international literature (Charatan 2002) and the opportunity cost of caring was up-rated from O'Shea and O'Reilly (2000). To cost the mortality resulting from falls and fractures we use information on deaths attributable to falls and fractures, provided by the CSO. In

[13] Nursing homes, long-stay accommodation, acute hospitals, psychiatric hospitals, convalescence, rehabilitation facilities and hospices.
[14] Categories 'Died', 'Self-Discharge', 'Prison', 'Absconded' and 'Other'.

2004, the number of deaths from falls and fractures for people aged 65 and over, was 297. The estimated value of life is taken from Krupnick *et al.* (2000) and Jackson *et al.* (2005). The quality of life estimates were based on Borgstrom *et al.* (2005). In the next section, we explain all of these data sources in more detail.

4.3 Methodology and Results

Direct Costs for Fractures

We now outline the specific direct costs that we will estimate. These are costs incurred by a patient (with fracture) in hospital (inpatient, ED, and outpatient costs) and other costs such as GP costs and the cost of long-stay care. We set out these costs in the context of pathways following a fracture (see figure 1.1).

ED Costs

Our ED costs are estimated as follows: (1) we calculated the number of admissions to ED and (2) multiplied this by the unit cost of an ED visit.

(1) Most likely a person who suffers a hip fracture will attend ED[15]. It is reasonable to assume that all ED room attendances for hip fractures resulted in hospital admission, (World Health Organisation 2003). For other types of fracture, people may not be admitted and could be referred to an outpatient facility or their GP. We do not have information on the number of ED visits resulting in non-admittance to hospital, so we use rates from an Australian study (Harris *et al.* 1998). For example, they found that 65% and 93% of people with Colles' and vertebrae fractures respectively, were admitted to hospital. We assume the rate of 65% for ankle and other fractures.

(2) The average cost per case of an ED visit is approximately €189, within a range from €100 to €330. We multiply the average cost by our estimated number of ED admissions. The total cost of ED resources for people admitted to hospital was €1,228,000 and for

[15] Indeed some people with osteoporosis fractures (e.g. vertebrae) will not attend ED. This does not concern this element of our study as we are simply looking at total hospital costs. It's more likely that costs for these individuals are indirect (e.g. quality of life).

people not admitted to hospital was €346,000, giving a total ED cost of almost €1,634,000. As the hospital inpatient costs include the ED component of the admission, we only include the cost for those not subsequently admitted to hospital to our overall costs.

Table 4.4 ED Costs

	Total ED Admissions	Cost if admitted (€, 000s)	Cost if not admitted (€, 000s)	Total ED Cost (€, 000s)
Hip	3,183	602	0	602
Colles'	742	91	49	140
Vertebrae	286	50	4	54
Ankle	478	59	32	90
Other	3,955	486	262	748
Total	9,122	1,288	346	1,724

Source: Authors calculated costs using data from HIPE and Harris *et al*. (1998)

Hospital Inpatient Costs

Data on the number of discharges for falls, fractures and osteoporosis to acute hospitals and their average length of stay were obtained from the Hospital In-Patient Enquiry (HIPE) system for 2004. Considering that the majority of fractures would result in hospital admission there is particular attention given to hospital stays in our economic costing. Ideally, we would like to use the cost incurred for each patient. As part of the Department of Health and Children casemix model, at discharge from hospital, each inpatient is assigned to a Diagnostic Related Group (DRG) based on its principal diagnosis, secondary diagnosis, procedures performed, age, gender and discharge status, and each DRG in turn is assigned a value or cost relative to the national average case. Thus, the overall costs for a selected subgroup of cases can be estimated by aggregating their respective DRG costs. This information has been given to us by the Strategic Health Planning, National Population Health Directorate, HSE.

The limitation to this approach is that each inpatient fracture may have different costs but we are focusing on the average.

Hospital costs are set out in Table 4.5 and are calculated as follows.

Table 4.5 Inpatient Hospital Costs for All Fractures Age 65 and over

	Male		**Female**	
	Average Cost per case €	Total Cost €	Average Cost per case €	Total Cost €
65-69	7,020	2,120,041	5,909	3,811,590
70-74	8,365.64	2,894,511	6,353	5,228,050
75-79	9,249	3,237,152	7,879	8,360,038
80-84	10,418	3,604,777	9,376	12,395,035
85+	11,094	3,405,848	9,902	13,209,512
Total	9,244	15,262,328	8,331	43,004,224

Data Source: HIPE & NPRS Unit, ESRI and Department of Health and Children

The total inpatient cost for fractures for the over 65 age group is €58 million; hip fractures represent two thirds of this cost.

On discharge from hospital a person with a fracture will have a number of outpatient and GP visits (mainly staff time). We now discuss the cost of each of these medical visits.

Ambulance Costs

Ambulance costs were calculated by multiplying the total estimated number of ambulance journeys by the cost of a journey, which is €83. The number of journeys was estimated by assuming that 40% of those who attended the ED department as a result of a fracture or a fall were transported there by ambulance. The estimated cost of ambulance journey is €0.3m for fractures.

Outpatient Costs

The calculation of outpatient visits costs requires two main assumptions. The first main assumption here is in relation to number of visits per patient. Following discharge from hospital, pathways for an individual include either going home or moving to a long-stay care institution. In an Australian study (Harris *et al.* 1998) it is estimated that approximately 50% of hip fracture patients are either discharged home or to the home of a carer and have at least one outpatient appointment for physiotherapy and one for the orthopaedic clinic. We noted earlier that 30% of admissions for hip fractures of those aged 65 and over are discharged to home – 35% of all ages were discharged home. For all discharged patients we obtain outpatient costs by assuming a visiting rate for each of these patients. These visiting rates are taken from Dolan and Torgerson (1998) – they assumed a range of outpatient visits depending on type of visit and type of fracture (see Appendix for details). We take an average of these visits to obtain the average visits per person, as presented in Table 4.6 below. The second major assumption here is that the average consultant led cost per outpatient case is €154[16]. Our total costs for outpatient visits are estimated to be €5.94 million.

Table 4.6 Outpatient Visits Costs

	% Home (rate of discharge for all ages)	N	Visits	Total Visits	Cost €m
Hip	35	1,114	9	10,026	1.54
Colles	90	434	8	3,472	0.53
Ankle	90	280	9	2,520	0.39
Vertebrae	65	173	14	2,422	0.37
Other	87	2,237	9	20,133	3.10
Total		4,238		38,573	**5.94**

Data Source: Dolan and Torgerson 1998; HIPE & NPRS Unit, ESRI and Department of Health and Children

GP Costs

The main community costs arise from GP visits. Previous research had included physiotherapy costs (Harris *et al.* 1998) but we assume that this has been included in the outpatient costs. Dolan and Torgerson (1998), finds that fractures lead to a substantial number of excess GP visits for all fracture types (see Appendix). Patients who experience

[16] These figures relate to the 2006 case-mix model which is based on 2004 activity. We are grateful to HSE for these figures.

a vertebral fracture show the biggest increase in GP visits, with an extra 14 visits a year. People who experience hip fractures attend the GP 10 additional times. To obtain an estimate of GP visits by people with fractures we multiply the number of visits by the GP visiting rate of €45[17]. Table 4.7 presents our total estimated GP cost of €1.37 million.

Table 4.7 Community Costs (GP)

	Hip	Colles'	Vertebrae	Ankle	Other
GP	1,114	434	173	280	2,237
No. of visits	10	4	14	6	6
Cost per visit			€45		
Total Cost			€1.37m		

Data Source: Dolan and Torgerson 1998; HIPE & NPRS Unit, ESRI and Department of Health and Children

Long-stay Care Costs

The next direct cost to be estimated is long-stay care. To estimate the total long stay care costs, we calculate (1) the number of people requiring care and (2) the total cost of care.

(1) The percentage of those going into long-stay care was estimated using HIPE data. Unfortunately our data did not distinguish between those going to long-stay nursing homes and rehabilitation institutions. The latter are likely to cost more but the numbers going to the latter type of institution would be small.

(2) We use a value of €700 a week in our calculations, (source: HSE communication). In Table 4.8, we show that the total annual estimated cost of long-stay care for fracture residents is €88 million. Almost 80% of this cost was consumed by hip fracture residents at €72 million.

[17] Irish Health 2006, Patients avoiding 'too costly' GPs, http://www.irishhealth.com

Table 4.8 Long Stay Costs

	No. Admitted	% Long-stay care	No. Long-stay Care	Cost of Long-stay Week	Annual Cost €m
Hip	3,183	62	1,973	700	71.8
Colles	482	9	43	700	1.55
Vertebrae	266	33	88	700	3.2
Ankle	311	9	28	700	1.02
Other	2,571	11.5	296	700	10.76
Total			2,428		**88.4**

Data Source: HSE Communication; HIPE & NPRS Unit, ESRI and Department of Health and Children

Indirect Costs for Fractures

We now discuss indirect costs - these include informal care, mortality costs and quality of life costs.

Informal Care

Our first indirect cost is for informal care. To obtain the cost of informal care three components are necessary (1) the amount of people who require extra care (2) the amount of care required and (3) the cost of this care. We discuss each of this in turn.

(1) The amount of people who require extra care is difficult to estimate. In a study which investigated 330 people three months following a hip fracture, about 42% required extra carer help (Cox and Warren 2004). In a US study, 32% of people of all ages reported to recover to a near normal state after one year (Barefield 1996). To obtain the number of people requiring care in Ireland, we look at the numbers discharged from hospital to home and assume these require informal care.

(2) It has been estimated that most carers give approximately 50 hours of care a week for older people (Charatan 2002). So we assume that older people with hip fractures require 50 hours of care. Information on the number of hours of care for people with other types of fractures is not available, so we make the assumption that they may need four hours of care a day, i.e. 28 hours of care a week.

(3) O'Shea and O'Reilly (2000) calculated the cost of family care using estimates from a study which randomly sampled carers in Ireland. The alternative use of one hour of caring was estimated: 24% would go to paid work; to unpaid work in the home; 7% to voluntary work; and 32% to leisure activities. After valuing these alternatives the opportunity cost was estimated to be £1.21. We up-rated this figure using the CPI to give a value of €2.15 in 2004. This value was multiplied by the estimated number of hours care provided, to get a total cost of informal care. We explored several alternative methods. These included using the minimum wage or the average industrial wage[18]. After calculating a range of costs using these alternative methods, we decided to use opportunity cost figure of €2.15. It is likely that the alternative methods would overestimate the cost of informal care.

Final estimates of informal care are provided in Table 4.9. Those who were categorised as 'Other' resulted in the highest annual cost of about €7 million. This was due to the large number of people in this category. The second highest category was those who had hip fractures. Assuming 52 weeks of care, this group resulted in an annual cost of approximately €6 million. In total, informal care results in an annual cost to the economy of almost €16 million.

Table 4.9 Informal Care

	No. Admitted	Discharged Home		Cost of Care Week	Annual Cost
		%	N	€	€m
Hip	3,183	34	1,082	107.5	6.05
Colles	482	91	439	60.2	1.37
Vertebrae	266	65	173	60.2	0.54
Ankle	311	90	280	60.2	0.88
Other	2,571	87	2,237	60.2	7.0
Total	6,813		4,210		15.84

Data Source: Charatan 2002; O'Shea and O'Reilly (2000) HIPE & NPRS Unit, ESRI and Department of Health and Children

[18] The average weekly industrial wage in 2004 was €588.92 for men and €406.83 for women (Finfacts Ireland 2006).

Quality of Life

The next indirect cost is equally as difficult to quantify, and that is the cost of quality of life. The reduced quality of life experienced by people as a result of fractures, falls and osteoporosis is very important. In a survey by Salked *et al*. (2000) 80% of women aged 75 years or above stated that they would rather die than endure the loss of independence and reduced quality of life associated with a bad hip fracture. 40% of hip fracture patients are unable to walk independently and 60% requiring assistance a year later. Approximately a third of patients are completely dependent or in a nursing home a year following a hip-fracture (International Osteoporosis Foundation 2005)**.** This loss of independence greatly affects the quality of life of these people.

Borgström *et al.* (2005) found that the mean reduction the quality of life was 0.17, 0.26 and 0.06 for hip, vertebrae and Colles' fracture patients respectively. Following Eichler *et al.* (2004), in Sweden they assume that the societal value of a full quality of life year (QALY) is €66,000. Therefore, their estimate of the value of lost quality of life for a hip fracture is €11,220. In Table 4.10 we set out the number of people with fractures, the estimated reduction in quality of life and total value of quality of life lost (i.e. number of fractures multiplied by estimated reduction in quality of life). We estimate the societal value of quality of life loss at approximately €54 million.

Table 4.10 Estimated cost of Quality of Life (QOL) reduction

	N	Mean Reduction in QOL	Value of QOL lost €	Total of QOL lost €m
Hip	3,183	0.17	11,200	35.65
Vertebrae	266	0.26	17,600	4.68
Colles	482	0.06	3,960	1.91
Other (including ankle)	2,882	0.06	3,960	11.41
Total				53.65

Data Source: Borgstrom et al. (2005) and HIPE & NPRS Unit, ESRI.

Direct and Indirect Costs for other injuries due to falls

In section 3, we noted that there were a distinct group of hospital admissions for injuries due to falls (almost 1,500) but who did not have a resulting fracture. We therefore estimate their cost separately. In international literature, there is less comprehensive information available on numbers and costs for people who just fall but do not have a resulting fracture. Nonetheless, Scuffham *et al.* (2006) give an indication of the proportions needing outpatient care, long-stay care or GP care, so we apply this information to our hospital discharge data from HIPE where possible. The methodology overall is similar to that for fractures, so rather than re-produce each step we simply report aggregate costs. Table 4.11 provides a summary (excluding mortality costs). We provide estimates for each direct and indirect cost and obtain a total estimate of €18 million for other injuries due to falls.

Table 4.11 Summary of Direct and Indirect Costs for Other Injuries Due to Falls

	€m
ED	0.52
Inpatient	5.7
Outpatient	0.46
GP	0.18
Ambulance Costs	0.16
Long-stay	2.15
Informal care	3.12
Quality of Life	5.83
Total	**18.12**

Data Source: Authors' Own Calculations (mortality costs not included above)

Mortality Cost

Calculation of mortality costs is less straight forward than any of the costs estimated so far in this report. This requires knowledge of numbers of deaths from falls and fractures and the corresponding value of life lost. Mortality costs are estimated by using information on mortality rates and estimates of the cost of life lost. In previous cost of illness studies (e.g. O'Shea and O'Reilly 2000) a monetary value was not placed on this indirect cost due to the difficulty in estimating these costs. O'Shea and O'Reilly (2000) discuss how most people in the 65 and over age group are retired from market-productive work. Although these people may be involved in some form of non-market productive activities, either in a private or voluntary capacity, the monetary valuation of this activity is difficult.

However, a number of studies, attempt to place a monetary value on the value of life which we now discuss**.** Desaigues (2004) found that in France there were a range of values for the value of a life year (VOLY) lost, ranging from €21,000 to €56,000 for all age groups**.** In Canada, Krupnick *et al.* (2000) found a value of a statistical life to be C$0.6 million for people aged 70 and above (€460,000) and in the UK Jackson et al. (2005) found the value of life to be £300,000 (€450,000). These authors estimate these values using a technique based on willingness-to-pay (for reduction in current and future risk of death) rather than on market earnings. In the absence of similar data in Ireland, we take the average of the two values above and estimate the value of life lost at €455,000. In Table 4.12, we multiplied the estimated value by the number of deaths (averaged over 5-year period 2000-2004) caused by falls and fractures (297) and obtained a total mortality cost of €135 million.

Table 4.12 Estimated mortality cost for falls and fractures

Average Annual No. of Deaths (5-year average)	Estimated WTP for reduction in risk of death	Total
	€	€m
297	455,000	135

Data Source: CSO Vital Statistics Report and Authors' Own Calculations

The main drawback in the estimate of mortality cost is that this figure is not estimated using Irish value of life data.

Total Estimated Costs for Falls and Fractures

Our total estimated costs for falls and fractures are summarised in Table 4.13.

Table 4.13 Summary of Results

	Cost €m
Fractures: Direct	
Hospital Costs	
Inpatients	58.26
Ambulance	0.30
ED	0.40
Outpatients	5.93
Long-stay care	88.4
Community costs: GP	1.37
Fractures: Indirect	
Carers	15.84
Quality of Life	53.65
Other injuries due to Falls: Direct	7.02
Other injuries due to Falls: Indirect	11.10
Mortality	135.00
Total Costs	**377.27**

Data Source: Authors' Own Calculations

The total annual cost to the economy is estimated at approximately €377.27 million (before we add in prescription costs). About one third of overall costs are accounted for by other injuries due to falls; two thirds by fractures. Resource use in relation to hospital inpatient care and long-stay care accounts for the difference between the two. Preliminary analysis of prescriptions costs for expenditure on medications for osteoporosis therapy shows that costs exceed €24.8 million (source: Pharmaeconomics Centre, St. James's Hospital). The overall cost to the economy is therefore approximately €402 million.

4.4 Sensitivity analysis

A number of variables in our study were tested in a sensitivity analysis in order to ascertain how sensitive our results were to changes in these variables. The variable that was met with most uncertainty was the value of life. Testing this variable we found that halving and doubling our current value of life (€455,000) resulted in total mortality costs of €67 million and €270 million respectively. These variations have huge impacts on our overall costs. So the valuation of life matters for the costs of falls and fractures in Ireland.

The next variable that was subject to testing was the number of informal care hours received. The baseline estimates used in the calculations were 50 hours for hip fracture and 28 hours for all others. As part of the sensitivity analysis we assumed all fracture patients received 50 hours of care a week; and all patients received 28 hours of care a week. The results obtained were €25 million and €14 million respectively. This variable, while significant, has a less dramatic impact on overall costs than the value of life.

The next variable tested was the length of long-stay care for fracture patients. Baseline assumptions were that people stay 12 months in long-stay care at a weekly cost of €700. For sensitivity analysis, we assume that length of stay was six months for hip fracture patients and three months[19] for all other fracture patients. The resultant cost was €40m.

We estimated in section 3 that about 14,000 people aged 65 and over fall, some or all of whom attend a GP. For the purposes of our sensitivity analysis, we assume that they each visit the GP once, amounting to a cost of €603,000 in 2004. This is very small relative to the overall costs.

Finally, for sensitivity analysis, we noted that other relevant discharges from hospital included some diagnoses that could also potentially result in falls. The total inpatient cost is about €10.3 million (Data source: HIPE & NPRS Unit, ESRI and the Department of Health and Children).

4.5 Conclusion

This section of the report provided detailed cost estimates of falls and fractures for the over 65 age group. The main costs estimated were those relating to inpatient hospital stays, ED visits, Outpatient visits, GP visits, Long-Term care, Informal Care, Mortality and Quality of Life. Out final estimated cost is €402 million. Sensitivity analysis showed that the overall costs change dramatically by assuming a range of value of life figures. Similar analyses on long-term care and informal care had less dramatic effects. In the

[19] This is a very general assumption - it may be that many patients are managed on a day basis, ED or at home.

next section, we use this overall cost of €402 million to project costs for the next 20-25 years.

Section 5: Projections for Next 20-25 Years

5.1 Introduction

In this section, we use the estimated cost from section 4 and population projections from section 3, to project forward the costs of falls and fractures for the next 20 years. The calculations are based on the absence of a National Strategy on Falls and Fractures. Of course, it is likely that the proposed National Strategy will help to prevent many of these falls and associated fractures, and, in that case, the economic costs going forward should be less. The objective of this study however, is to deal with costs in the absence of a strategy.

5.2 Projections for Next 20-25 years

Over the next twenty years the number of people aged 65 and above will increase by approximately 70%, as will life expectancy. All other things being equal, the burden of fractures and falls should increase proportionately. Three key factors will likely affect projections of future costs of falls and fractures over the next 20 years. These are summarized in Table 5.1.

The structure of the population will inevitably change leading to an increase in future costs. We know exact changes in this projected population from section 3 of this report. Inflation will also contribute towards higher costs – we assume an average rate of inflation of 3.5%. Disability prevalence among the elderly in general has decreased by 1% or more per year over the last few decades in the USA as a result of improvements in medical technology and behavioural changes (Cutler, 2001). In section 4, we estimated the current burden to be €402 million so we now look at how this cost will increase over the next 25 years, assuming two different scenarios: (1) constant increase in number of people with falls and fractures (2) assume less falls and fractures (1% decline per annum) due to technological improvements.

Table 5.1 Impact of factors on future numbers of falls and fractures

	Impact on Future Costs	% change by 2020
Demographics	+	+ 54.5%
Inflation	+	+3.5% p.a.
Technology/disability prevalence	-	-1% p.a.

Data Source: Authors' Own Calculations

(1) Constant increase in fractures

This is the simplest scenario whereby we assume no improvements in technology, and more importantly this scenario estimates project costs in the absence of a National Strategy. Table 5.2 shows the % increase in population aged 65 and over from 2005. For example, in 2010 this population will increase by 11.5%. If we simply apply this increase to our current estimated cost for 2004 (€402 million) and assume an average rate of inflation of 3.5%, we find that in 2010 the cost to the economy of falls and fractures will be approximately €551 million, rising to €2,043 million in 2030.

Table 5.2 Projected Costs Scenario 1

	Population aged 65+	Population (% increase on 2005)	Cost €m
2010	508,750	11.5	551
2020	705,058	54.5	1077
2030	948,419	107.8	2043

Data Source: Authors' Own Calculations

(2) Disability Prevalence Reduction/Technological Improvements

In this scenario, we estimate the relative reduction in fractures among older people, as a result of technological improvements. We are still assuming no national strategy, so any reductions would purely result from the fact that there was some advance in technology (e.g. more DEXA scanners). The exact potential reduction in fractures is difficult to ascertain, so again we assume some basic figures. We will assume that the number of people with falls and fractures will decrease by 1% per year. Compared to the final column of Table 5.2, this could lead to a reduction of about 15% in overall costs by 2020.

Table 5.3 Projected Costs Scenario 2

	Cost after Tech. €m (Assume 3.5% inflation)
2010	520
2020	922
2030	1587

Data Source: Authors' Own Calculations

5.3 Potential Impact of Interventions

There are a number of interventions that may be effective in the prevention of falls and osteoporosis. We discuss these in turn, review some relevant literature and estimate how these interventions could reduce costs.

Tinetti *et al.* (1994) carried out a study on a multi-factorial intervention to reduce the risk of falling among elderly people living in the community. The subjects were aged 70 and over and received either a combination of modification in their medication, behavioural instructions and exercise programmes aimed at reducing their risk factors. During a one year of follow-up, there was a lower number of falls in the treatment group compared to the control group, with 47% of the control group falling compared to 35% in the treatment group. Close *et al.* (1999) used a randomised control study to examine the benefit of a structured interdisciplinary assessment of people who had fallen. The treatment group received detailed medical and occupation-therapy assessment and referred to further services if required. After one year, the treatment group had 183 falls compared to 510 in the control group. Gillespie *et al.* (2003) documented a number of interventions that were found to reduce the number of falls, including multi-factorial intervention programmes, individual programmes, home hazard assessment and exercise intervention. Kenny *et al.* (2001) examined the literature on the effectiveness of both multifactorial and single interventions to prevent falls. Environmental modification and medication reviews were found to be effective in reducing the number of falls. Elements of multifactorial interventions such as reductions in the number and dosages of prescribed medications, exercise programmes and medical assessment were found to be beneficial.

There are also a number of interventions that may be effective in the prevention of osteoporosis. Estimating how many fractures would actually be prevented is quite difficult and depends on many factors including, proportion of patients identified, age identified, risk factors, treatment involved, other non-pharmacological interventions, duration of treatment and compliance with treatment. A few interventions that have proved effective are now outlined. A Canadian report has detailed a strategy that includes a number of interventions. It is suggested that that in the next five years, 3000 ED visits, 3000 hospitalisations and 750 deaths could be prevented, (Osteoporosis Action Plan Committee, 2003). A study by Eastell *et al.* (2001) suggested that biphosphonates may decrease the risk of further fracture in patients with previous fragility fractures by 50%.

In Ireland, if a strategy could be implemented to reduce fractures by for example 10% annually, assuming similar costs as above, then the economic burden of fractures would be €1,260m in 2020.

5.4 Conclusion

In summary the projected costs vary depending on the scenario chosen. In 2010, the estimated costs will range from €551 million (scenario 1) to €520 million (scenario 2). In 2020, the estimated costs will range between €1,077 million (scenario 1) and €922 million (scenario 2). The limitations of our projected cost exercise are similar to those found in economic cost of illness studies more generally. For example, it is difficult to predict how disability prevalence will decrease over the next 20 years as a result of lifestyle changes and technological advancements. This section therefore provides the best estimate feasible with current knowledge.

Section 6: Conclusion

Falls, fractures and osteoporosis are important public health issues, particularly as the incidence increases with age and the population of older people is projected to increase significantly (Chang *et al.* 2004). This interim technical report aimed to quantify the cost of falls and fractures to the Irish economy. The main objectives included (1) current cost to economy (2) cost of pathways following a fall (3) projected cost over next 20 years in the absence of a National Strategy. We also report the number of people with the condition of osteoporosis.

Our main findings are as follows:

- The estimated current cost of falls and fractures is €402 million
- Projected future costs vary between from €551 million (scenario 1) to €520 million (scenario 2) in 2010
- The number of people with osteoporosis is around 120,000. This is based on extrapolation from WHO (2004).

Our overall estimated cost of €402 million represents about 0.32% of GNP. This result compares favourably with estimates in the US. Englander *et al.* (1996) provide an estimate of annual economic costs imposed by fall injuries, which includes fractures, at 0.3% ($20.2 Billion) of GNP ($7,071 Billion). In the UK, Scuffham *et al.* (2005) find that the costs of falls are less at 0.11% of gross national income, but they did not include costs of informal carer or mortality.

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Appendix

Table A1 Mean change in number of GP visits after fracture and their cost

Fracture Type	Cases	Controls	Difference
Hip	10.75	1.62	9.13
Wrist	5.36	1.34	4.02
Vertebrae	14.69	0.88	13.81
Other	7.28	1.5	5.78

Source: Dolan and Torgerson 1998

Table A2 Number of Outpatient Visits by Fracture Type

	No. of Visits After Fracture	No. of Visits Before Fracture	Difference	Total No. of Visits	Average No. of Visits
Hip	7	2.6	4.4		
	32	3	29		
	11.6	3.4	8.2		
	0.6	0.4	0.2		
	9	4	5		
				46.8	9.36
Wrist	23.2	2	21.2		
	5.8	3.4	2.4		
	0.4	0.2	0.2		
	12.4	5.8	6.6		
				30.4	7.6
Vertebrae	22.2	4.6	17.6		
	17.6	6	11.6		
	4.2	0.4	3.8		
	33.6	9.4	24.2		
				57.2	14.3
Other	23.2	2.4	20.8		
	9.4	4.8	4.6		
	1.4	0.4	1		
	15.2	5.4	9.8		
				36.2	9.05

Source: Dolan and Torgerson 1998 and Author’s own calculations