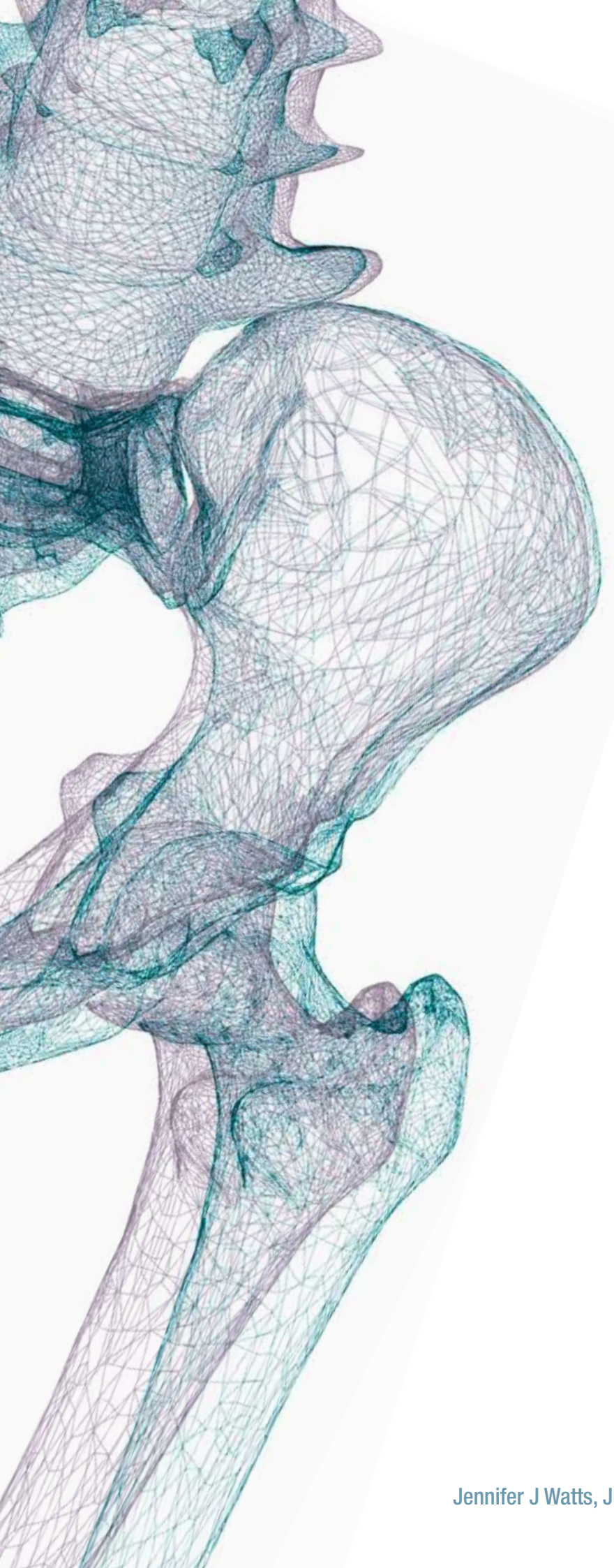

Osteoporosis costing all Australians A new burden of disease analysis – 2012 to 2022

osteoporosis australia

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Authors
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Osteoporosis costing all Australians *A new burden of disease analysis – 2012 to 2022*
This report was prepared for Osteoporosis Australia, Level 2, 255 Broadway, Glebe, NSW 2037
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Australian Study of Cost and Utilities Related to Osteoporotic Fractures (AusICUROS) Team:

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Forwards

Professor Peter Ebeling
Medical Director, Osteoporosis Australia

Previous studies have underestimated the burden of osteoporosis.

This study focuses on the over 50 population and shows osteoporosis and osteopenia (low bone density) currently affect over 66% of adults over 50, accounting for 4.74 million Australians and resulting in 140,822 fractures (2012).

The study accurately quantifies the cost of this significant health burden – total direct and indirect costs of $2.754 billion (2012). The report also clearly demonstrates that osteoporosis is a common disease resulting in 'first fractures', and of more concern repeat fractures. It is important to recognise these fractures are costly to repair – $1.617 billion in total direct fracture cost alone (2012). Hip fractures remain the most costly type of fracture and all types of fracture (hip, wrist, spinal and other) will continue to rise as the Australian population ages.

Osteoporosis can be diagnosed and managed to reduce fracture rates, and in many cases could be prevented. However osteoporosis remains under-diagnosed, even when a fracture has occurred.

We urgently need to support re-fracture prevention and community education to break the cycle of poor bone health and fractures in Australia.

John Hewson
Chairman, Osteoporosis Australia

It is time the nation took bone health seriously. This report outlines the staggering cost of osteoporosis, osteopenia and fractures, and predicts the significant rise in the cost burden over the coming decade (2013-2022) if action is not taken.

Millions of Australians are affected by poor bone health. Poor bone health costs the community and governments, and comes at a great personal cost to those diagnosed with osteoporosis or osteopenia and potentially dealing with debilitating fractures.

In 2012 the total costs of osteoporosis, osteopenia and fractures in Australians over 50 years of age were $2.75 billion. It is predicted that in 2022, the total costs will be $3.84 billion (2012$) for that year alone. The total costs over the next 10 years will be $33.6 billion (2012$).

Costs include ambulance services, hospitalisations, emergency department and outpatient services, rehabilitation, aged care and community services.

Osteoporosis Australia is calling on the Federal Government to renew its commitment to osteoporosis as a national health priority. We are calling on health care professionals to make bone health a higher priority and the community to be aware of the risk factors and prevention strategies.

Action today can reduce the impact of this disease, both in the short-term and for the future of bone health in Australia.

Executive Summary

This report updates previous burden of disease analysis undertaken in 2001 and 2007, and shows little progress is being made in preventing and managing osteoporosis in Australia. With an ageing population, it is now critical that real steps are taken to address this silent and often under-diagnosed disease affecting women and men that is costing governments, the community and comes at a great personal cost to the individuals affected.

The new information in this report on the current and future costs of osteoporosis in Australia will aid government policy makers, funding bodies, clinicians, researchers and health care organisations in assessing the importance of reducing osteoporosis and osteoporosis – related fractures, promoting bone health and in identifying future resource needs.

Key Findings

Poor bone health: 2012-2022

- 4.74 million Australians over 50 years of age (66% of people over 50) have osteoporosis or osteopenia or poor bone health.
- Based on the 4.74 million Australians with poor bone health, 22% have osteoporosis and 78% have osteopenia.
- By 2022, it is estimated there will be 6.2 million Australians over the age of 50 with osteoporosis or osteopenia. That is a 31% increase from 2012.

High fracture rates: 2012-2022

- In 2013 there is 1 fracture every 3.6 minutes in Australia. This equates to 395 fractures per day or 2,765 fractures per week.
- By 2022 there will be 1 fracture every 2.9 minutes. That is 501 fractures per day and 3,521 fracture per week.
- This compares to a fracture every 8.1 minutes in 2001 and a fracture every 5-6 minutes in 2007.
- In 2012 there were 140,822 fractures that occurred as a result of osteoporosis or osteopenia. In 2022 it is expected there will be a 30% increase in the annual number of fractures resulting in 183,105 fractures per annum.
- The estimated total number of fractures over the next 10 years is over 1.6 million. This includes new fractures and re-fractures.
- Osteoporosis and osteopenia is not just a 'women's disease'. Men account for up to 30% of all fractures related to osteoporosis and osteopenia, and their associated costs.

Alarming costs to Government, the community and to individuals

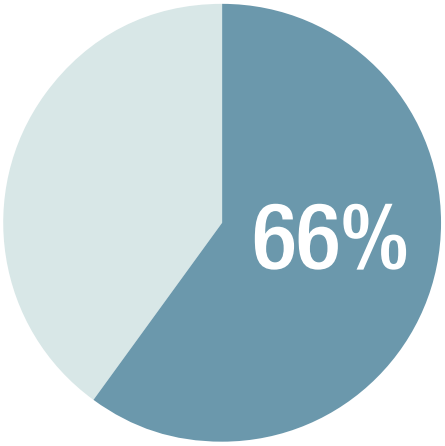
- In 2012, the total costs of osteoporosis and osteopenia in Australians over 50 years of age were $2.75 billion.
- It is predicted that in 2022, the total costs will be $3.84 billion (2012$).
- That is a total cost of fractures of $22.7 billion over the next 10 years. These costs include ambulance services, hospitalisations, emergency department and outpatient services, rehabilitation, aged care and community services.
- Total direct and indirect cost of osteoporosis, osteopenia and associated fractures over 10 years is $33.6 billion (2012$).

Call to action

Previous reports have included recommendations for action. What is telling is that the recommendations here are the same as previous reports.

- That a re-fracture prevention initiative be funded to follow-up and co-ordinate the care of every Australian who has sustained their first fragility fracture.
- That bone density testing for menopausal women aged 50 with risk factors for osteoporosis be reimbursed.
- That more funding be provided for education and awareness programs about healthy bones as prevention is best, and the high rates of osteopenia are alarming.

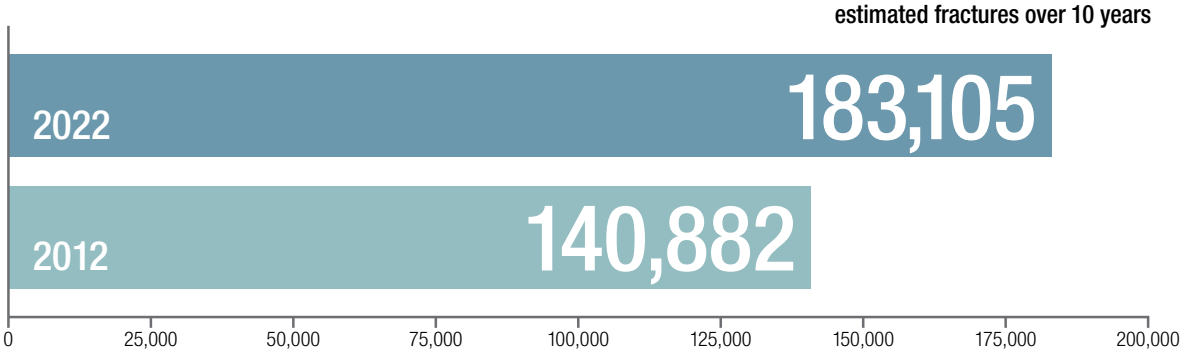
Australians over 50 who currently have osteoporosis and osteopenia



4.74 million
Australians over 50

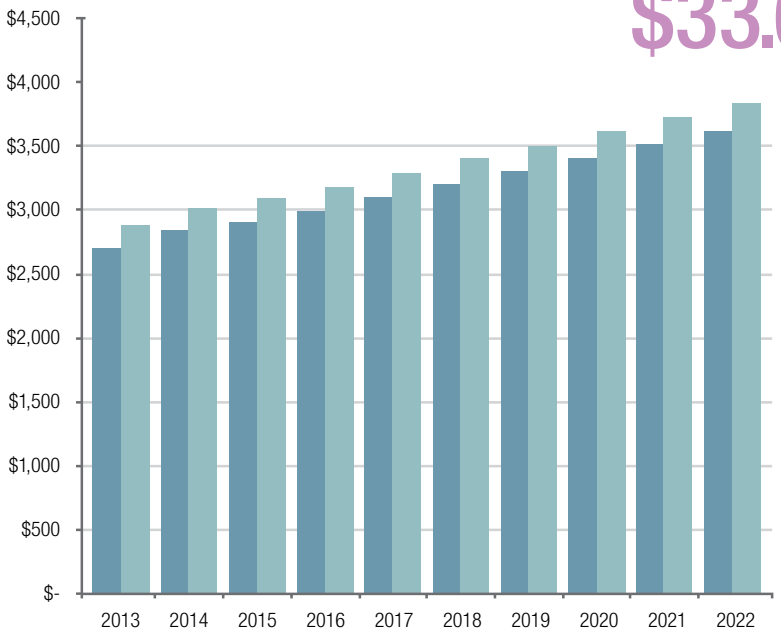
Number of fractures due to osteoporosis and osteopenia

1.6 million
estimated fractures over 10 years



Total direct and indirect costs osteoporosis, osteopenia and fractures, 2013-2022 (2012$) $millions

$33.6 billion
total cost over 10 years



Mean direct cost per fracture type (Table 1, 2012$)

Fracture type	Female		Male	
	50-69 years	70+ years	50-69 years	70+ years
Hip	$23,276	$33,576	$23,243	$31,562
Wrist	$5,289	$7,084	$4,386	$5,147
Vertebral	$5,651	$9,176	$7,105	$5,630
Other	$8,996	$12,295	$7,052	$12,195

Contents

Background

Osteoporosis is a disease in which the density and quality of bone are reduced, leading to weakness of the skeleton and increased risk of fracture, particularly at the hip, spine and wrist.[8-10] The World Health Organisation defines osteoporosis and osteopenia in terms of bone mineral density (BMD). Using dual-energy X-ray absorptiometry (DXA), osteoporosis is defined as a T-score at the hip and/or lumbar spine at or below 2.5 standard deviations (T-score) below the average values for a young healthy adult reference population, and osteopenia when the bone mineral density is between 1 and 2.5 standard deviations below the reference population.[9]

Osteoporosis is a relatively common disease that is usually silent until a fracture occurs. The Geelong Osteoporosis Study (GOS) measured BMD in a random sample of men and women. When extrapolating the results to the Australian population in 2006 they estimated that approximately 6% of men and 23% of women over 50 years would be expected to have osteoporosis, increasing to 13% of men and 43% of women aged over 70 years.[6] Other sources of prevalence data based on self-report of osteoporosis[11] are likely to be a significant underestimate as the diagnosis is often made following a fracture (in both men and women).[11] Therefore of the 1.2 million Australians likely to have osteoporosis, most will not know that they have the disease.[6] Without intervention, this number is expected to increase to 3 million by 2021 as a result of population ageing.[12] In addition, it is estimated that there are now 6.3 million Australians with thin bones (osteopenia). The disease predominantly affects women over the age of 55 years, though increasingly men are also affected.[12,13] This report focuses only on the burden of osteoporosis and its precursor, osteopenia in Australian adults aged 50 years and older.

The most common fracture sites associated with osteoporosis and osteopenia are hip, wrist, spine, humerus and pelvis though other skeletal sites are also affected. While 20% of women with fracture aged 50 to 59 years, have osteoporosis (defined by BMD), this proportion increases to almost 70% in those aged over 80 years. The prevalence of osteoporosis in women with fracture is twice that observed in the population although most fractures occur in women whose BMD does not fall into the osteoporosis BMD definition.[14] This reflects the high number of older adults with osteopenia. Reducing the population burden of fractures requires attention to those with osteopenia as well as osteoporosis because over half of the fragility fractures in the population arise in these individuals, and women with osteopenia plus a prevalent fracture have the same fracture risk as women with osteoporosis.[2]

While some international studies have shown an increase in the age-adjusted hip fracture incidence for countries such as Finland, Germany and Taiwan[15-17] several other population-based studies in USA, Canada, Sweden, Denmark[18] and Switzerland have shown evidence of declining age-standardised hip fracture rates. In Australia the incidence of hip fractures appears to have declined over the last decade by 13 to 25%.[5,19,20] Population ageing has contributed to an increase in the number of fractures since most of the burden of fractures (almost 70%) arises from older adults[14]. The increased number of people surviving into their seventies, eighties and nineties translates to an increased number of hip fracture cases.[3,20-26] Less information is available for total fracture rates since, unlike hip fracture, hospital separation data is not a reliable indicator of the total number of people with incident fracture. Rates of wrist fracture appear relatively stable in North America, Australia, Scandinavia and The Netherlands[27] but age-standardised hospitalisation rates for pelvic fractures in New South Wales have increased by 50%.[28]

The decline in hip fracture rates has been partly attributed to an increase in diagnosis and treatment of osteoporosis,[24] including bone-active agents, the increased prevalence of obesity[20] and preventive programs that have increased awareness of the risk factors of falls.[21] A recent Canadian study has reported declines in major osteoporotic fracture rates and attributed this primarily to still unexplained improvements in BMD.[29] Other possible explanations include improvement in functional abilities among older adults, a cohort effect of a healthier ageing population, better nutrition and protective effect of increased body weight and hence higher BMI or due to unknown protective factors.[23,30-32]

Previous studies have reported lower hip fracture rates in rural compared to urban communities. In south eastern Australia, hip fracture rates were 32% lower and the total fracture rate was 15% lower among rural than urban residents.[33] Such studies suggest that a rural environment is associated with a lower fracture risk in the elderly (possibly through bone health or lower risk of falls in the elderly population). If the national rate of hip fracture could be reduced to that of the rural population the authors postulate that hip fracture numbers would remain stable despite the aging Australian population.[33] A review of the secular trends in osteoporotic fracture rates highlights the substantial temporal trends in hip fracture rates during recent decades. Cooper and colleagues note that the extent to which the risk factors studied to date (including smoking, alcohol, physical activity, obesity and migration status), as well as the changing rates of risk assessment and treatment contribute to these temporal trends remains uncertain.[27]

Worldwide, osteoporotic fractures have been shown to account for 0.83% of the global burden of non-communicable disease and 1.75% of the global burden in Europe.[34] Osteoporotic fractures in Europe have been reported to account for more DALYs lost than common cancers (except lung cancer) with DALYs lost due to osteoporosis estimated at 2 million compared to DALYs lost to osteoarthritis and rheumatoid arthritis at 3.1 and 1.0 million respectively. Osteoporosis has been demonstrated as a significant cause of morbidity and mortality.[34]

Osteoporosis is a common disease that manifests itself as fractures, occurring at multiple skeletal sites. In older age groups the burden of disease attributable to osteoporosis is significant, not only the consequent health service utilisation but also the burden on individual utility, health related quality of life, family and households. This burden can be measured in monetary units ($) as lost productivity or impact on household income, or as disutility (impact on quality of life). Osteoporosis places a financial burden on individuals, families and governments. Earlier studies estimated the cost of osteoporosis in Australia to range from $227 million AUD in 1994 to 700 million AUD in 1995[35, 36] while direct costs relating to osteoporotic fractures have been estimated at 1.9 million dollars each year in Australia.[12, 37] In addition, the contribution of the Australian government towards the cost of alendronate, medication prescribed for osteoporosis was $105 million AUD in 2007, while $5.5 million AUD was spent by the government in 2007 to support osteoporosis research.[38]

A Swedish study has estimated indirect costs (loss in value of production due to sick leave) comprise about 10% of the total cost for a fracture.[39] The study estimated the mean fracture-related cost the year after a hip, vertebral and wrist fracture as €14,221, €12,544 and€2,147 respectively. The corresponding mean reduction in quality of life due to the fractures was 0.17, 0.26 and 0.06 for the hip, vertebral and wrist fracture respectively. Although hip fractures have the greatest burden to society the study revealed that the loss in quality of life in the year after a hospitalised spine fracture is the same or greater than that following a hip fracture.[39] The annual burden of osteoporosis in Sweden was estimated at€0.5 billion. Another similar study demonstrated that the mortality caused by hip fractures accounted for approximately 1% of all deaths and 1000 life-years lost per year in Sweden[40, 41] with fractures shown to account for approximately 1-2% of the total health care costs of which the dominant costs are inpatient care costs.

The Australian study of cost and utilities related to osteoporotic fractures is the Australian arm of the International Costs and Utilities Related to Osteoporotic fractures Study (AusICUROS) initiated through the International Osteoporosis Foundation (IOF).[42] Results from the first 505 participants (79% women) have been used in this analysis. Using a uniform study design to estimate costs and quality of life related to fractures, AusICUROS is being conducted at eight centres across Australia (Nepean and Royal North Shore Hospitals in Sydney; Austin Health and Western Health in Melbourne; Barwon Health in Geelong; Sir Charles Gairdner in Perth; Toowoomba Health Service, Queensland; and Menzies Research Institute in Hobart, Tasmania (see Acknowledgements). Prospective data is collected from patients with recent fracture at four time points: Phase 1 collects information within two weeks of fracture and documents quality of life before (recollected) and immediately after fracture and phases 2 to 4 collect data 4-,12- and 18-months post-fracture. Self-reported health and community service resource use is collected at phases 2 to 4. This includes direct health care costs as well as informal care and community services. At most study centres hospital service utilisation has been verified using medical records. Eligibility includes diagnosis of a low energy fracture and age at least 50 years. Recruitment occurs largely through emergency departments and orthopaedic wards of acute hospitals. Not all fractures are admitted to hospital, some are managed as outpatients without an inpatient episode.

Australian studies, including prospective longitudinal cohort studies such as the Geelong Osteoporosis Study and Dubbo Osteoporosis Epidemiology Study have provided an accumulating picture of osteoporosis in Australia, including both disease prevalence and fracture incidence. This burden of disease study aims to bring together data from these multiple Australian sources, and with the new data from the AusICUROS cohort on health service utilisation, community service utilisation and morbidity, construct a cost model using a bottom up approach to determine the total direct and indirect costs of osteoporosis, osteopenia and related low trauma fractures for the Australian population in 2012.

Objectives

The primary aim of this study is to determine the annual burden of disease of osteoporosis from a societal perspective in the Australian population in 2012, and then model the assumptions from this analysis to predict the annual disease burden from 2013 to 2022. The objectives of the analysis are:

1. to use the best available Australian data on incidence and prevalence and health service utilisation to estimate the burden of disease relating to osteoporosis and low trauma fractures (prevention and management) and the total disease burden attributable to osteoporosis in Australia in 2012;
2. to model the burden forward 10 years from 2013 to 2022 to estimate the population numbers of osteoporosis and osteopenia (and associated fractures both new and re-fractures) and the total costs (direct and indirect), and
3. to model the impact of bisphosphonate medication (as the total number of fractures avoided) from 2013 to 2022.

Method

This represents the method for the determination of the annual burden of disease attributable to osteoporosis in Australia in 2012. There are two major components to the method to determine costs in 2012: the data sources that have been used as a basis for the population rates of osteoporosis, osteopenia and fractures; and the methods used to analyse the cost data. These data were used to determine the average direct health care and non-health care total costs and the indirect costs of a fracture in 2012, as well as the average community health service costs of managing someone with osteoporosis or osteopenia. The costs were then used as the basis to model the burden of osteoporosis for 10 years from 2013 to 2022.

Population Estimates for Osteoporosis by Age and Gender

Australian population data

Australian population data were used from the estimated resident population for Australia at June 30th 2012 based on the 2011 census.[4] Population data by gender and 5-year age bands from aged 50 years and over were used to generate population estimates for men and women in two age groups (50-69 years and 70+ years). Refer to Figure 1.

Incidence/prevalence data for osteoporosis and osteopenia

The Geelong Osteoporosis Study (GOS) measured BMD in a random sample of men and women recruited from the Barwon Statistical Division (Geelong and surrounding district).[43] When extrapolating the results to the Australian population in 2006 it was estimated that approximately 6% of men and 23% of women aged over 50 years would be expected to have osteoporosis, increasing to 13% of men and 43% of women in those aged over 70 years.[6] To determine the proportion of the Australian population in 2012 with osteoporosis and osteopenia, the 5-year age interval data from the Geelong Osteoporosis Study [6] were used. The 5-year rates were then applied to the 5-year population cohorts from the ABS[44] to determine the weighted average proportions (by population) for osteoporosis and osteopenia for men and women in two age groups (50-69 years and 70+ years) (refer to Tables 2 and 3).

Table 2: Estimated resident Australian population by age group and gender, June 30 2012[4]

	Age Groups		
	50-69	70+	**All Ages**
Men	2,486,789	945,293	**3,432,082**
Women	2,522,923	1,188,267	**3,711,190**
Total	**5,009,712**	**2,133,560**	**7,143,272**

Table 3: Osteoporosis and osteopenia age and gender standardised prevalence (percentage)[6]

	Osteoporosis		Osteopenia	
Age Group	Men %	Women %	Men %	Women %
50-69 years	3.2	13.0	54.6	48.9
70+ years	12.9	43.2	59.1	46.1

Fracture incidence

The Geelong Osteoporosis Study cohort[43] was followed prospectively for approximately five years after baseline for fracture ascertainment.[1,2] Fracture cases were categorised according to their BMD scores at baseline (categorised as normal, osteopenia and osteoporosis). The proportion of all fractures in each BMD category was used to estimate the population-standardised number of fractures in each BMD category over a 5-year period. The rate of incident (first) fractures by age (50-69 years and 70+ years) for men and women and within each BMD category at the femoral neck (normal BMD, osteopenia and osteoporosis) occurring over 5 years were provided from the Geelong Osteoporosis Study cohorts.[1,2] All fractures were confirmed by radiology.[45] From the 5-year incident rates for incident (first) fracture the annual rate was determined and then attributed to the 2012 population data for fracture incidence within the categories of osteoporosis, osteopenia and 'normal' BMD (see Table 4 for annual fracture incidence rates). The fractures arising from those with BMD in the normal category (BMD above a t-score of -1) were not attributed to osteoporosis and not included in the analysis of cost and burden of osteoporosis.

Table 4: Annual incidence of first fracture by gender, age group and BMD category (percentage)[1]

Age Group (years)	**Normal BMD %**	**Osteopenia %**	**Osteoporosis %**
Men			
50-69	0.7	1.1	8.6
70+	1.5	2.3	5.3
Women			
50-69	1.3	2.0	5.5
70+	2.4	4.0	6.8

Proportion of each fracture type

The next stage of the population analysis was to estimate, from the population with osteoporosis and osteopenia who fracture, the proportion or distribution of each fracture type (hip, wrist, vertebral and 'other'). These proportions were stratified by gender and 5-year age groups and data from the Sanders et al study were used.[3] These data were from population estimates in 1994 to 1996 and since then Crisp et al have found declining incidence of hip fracture rates by 20% and 13% in women and men respectively.[5] The proportion of hip fractures observed by Sanders et al was reduced by 20% in each 5-year age cohort for females and by 13% in each 5-year age cohort for males to account for these changes. The proportion of non-hip fractures was then increased so that the overall number of fractures remained the same as observed in the prospective population group with osteoporosis and osteopenia.[1] The fracture distribution was assumed to be the same in both osteoporosis and osteopenia populations but varied by gender and age (in 5-year age bands).

The distribution of fractures by site, gender, 5-year age intervals and BMD category are shown in Table 5 below. The proportion of people classified as having 'other' fractures was high relative to the proportion with hip, wrist and vertebral fractures. 'Other' fractures observed in the Sanders et al study[13] included humerus, ankle, lower limb, as well as other 'low trauma' fractures such as rib, pelvic, forearm (not classified as wrist), patella, foot and hand fractures. Skull and facial fractures were not included. The total number of fractures categorised as 'other' was high, however the proportion of any single one of these fracture types observed in the population was low. Given the estimate of total fractures, the data were used to estimate the proportion of each fracture type, thus any redistribution of fractures from the 'other' category would have the effect of increasing the number of hip, wrist and vertebral fractures.

Figure 1 shows a diagrammatic representation of the method used to ascertain population estimates with osteoporosis, osteopenia with or without a fracture (hip, wrist, vertebral and other) by age group, gender and BMD category (osteoporosis or osteopenia).

***Figure 1:** Flow diagram showing data sources for population estimates with osteoporosis, osteopenia and fractures, by age group and gender*

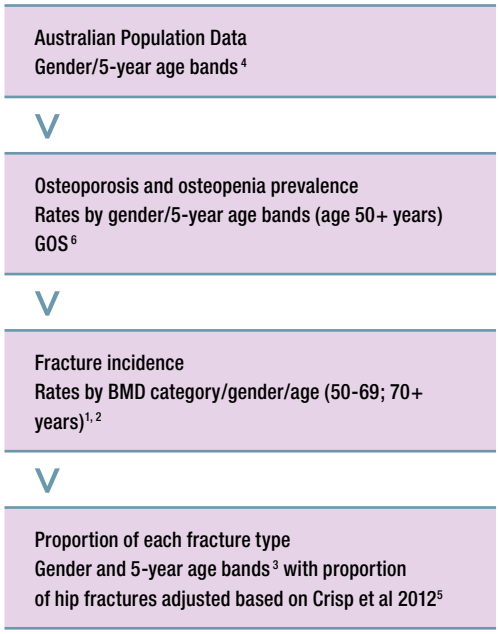


***Table 5:** Fracture site distribution by gender and 5-year age groups (percentage)*

Fracture Type	Age Group 50-54 %	55-59 %	60-64 %	65-69 %	70-74 %	75-79 %	80-84 %	85+ %
Women								
Hip	1.4	3.9	2.5	8.7	11.8	22.2	30.4	44.9
Vertebral	10.3	11.3	20.2	21.1	24.5	28.1	23.6	16.4
Wrist	20.5	18.6	18.1	21.8	19.1	14.0	19.5	13.2
Other[1]	67.9	66.2	59.2	48.3	44.6	35.7	26.6	25.5
Men								
Hip	3.3	5.8	6.2	9.7	21.8	26.7	25.9	49.5
Vertebral	4.0	8.3	16.4	16.0	19.8	15.8	16.2	17.9
Wrist	4.0	9.6	5.7	1.0	5.8	4.6	5.5	7.1
Other[1]	88.8	76.3	71.7	73.8	52.6	52.9	52.4	25.5

[1] *Other fracture are all non-hip, non-wrist and non-vertebral fractures*

Figures 2a and 2b are flow diagrams that show the starting population from the ABS estimated resident population at June 30th 2012[4] for both men and women, the number in each age group (50-69 years and 70+ years), the number and proportion in each BMD category (normal, osteoporosis and osteopenia) based on the prevalence data;[6] the predicted number of fractures (Pasco et al under review) and the predicted number and type of fracture (hip, wrist, vertebral and 'other') (Sanders et al MJA 1999) associated with each population group. These represent the population numbers and proportions assumed in each sub-category that were used to determine the total burden of disease attributable to osteoporosis over a one year period in 2012.

***Figure 2a:** Female population aged 50+ years with normal BMD, osteoporosis and osteopenia, and numbers of hip, wrist, vertebral, and 'other' fractures, and non-fracture populations*

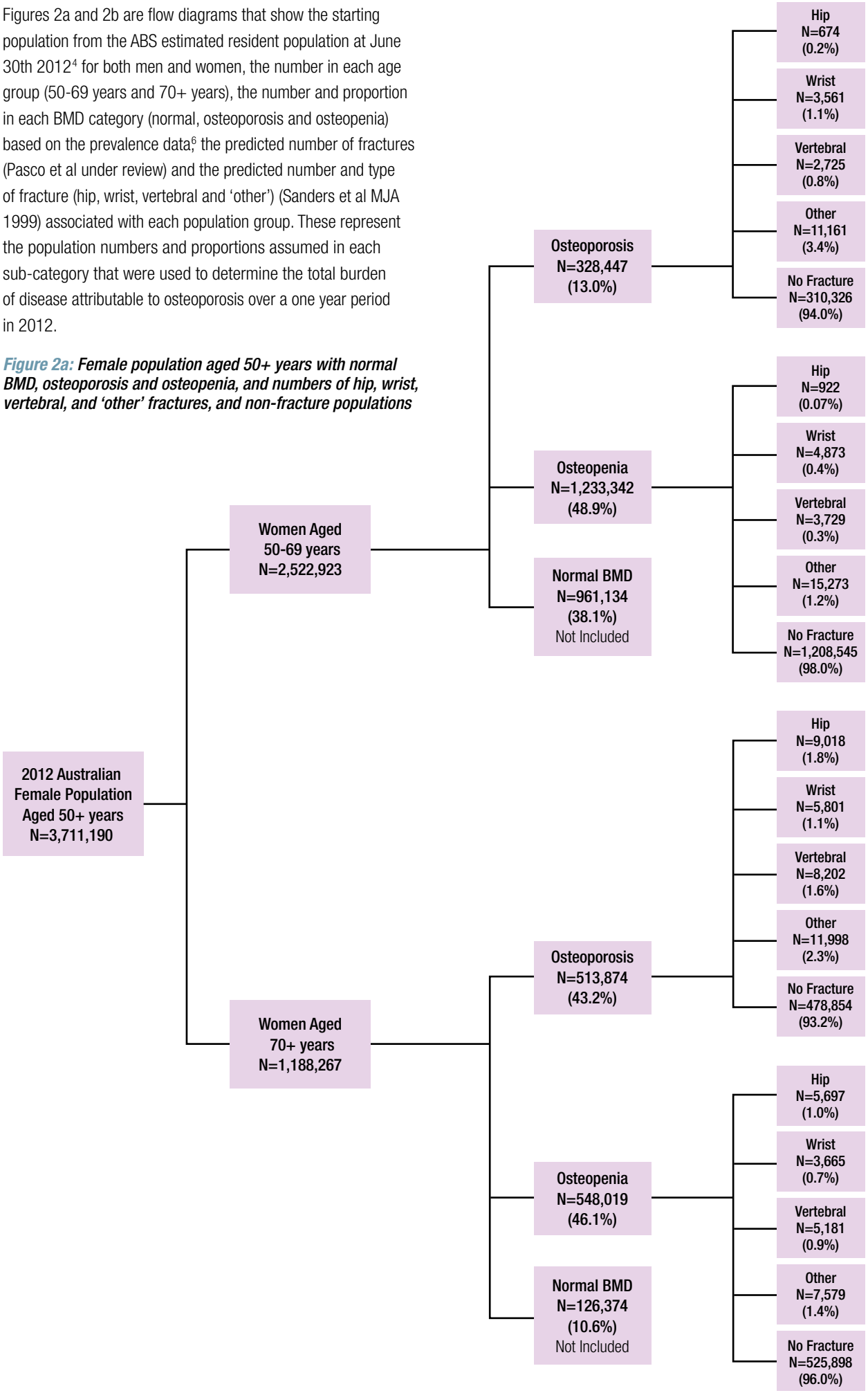
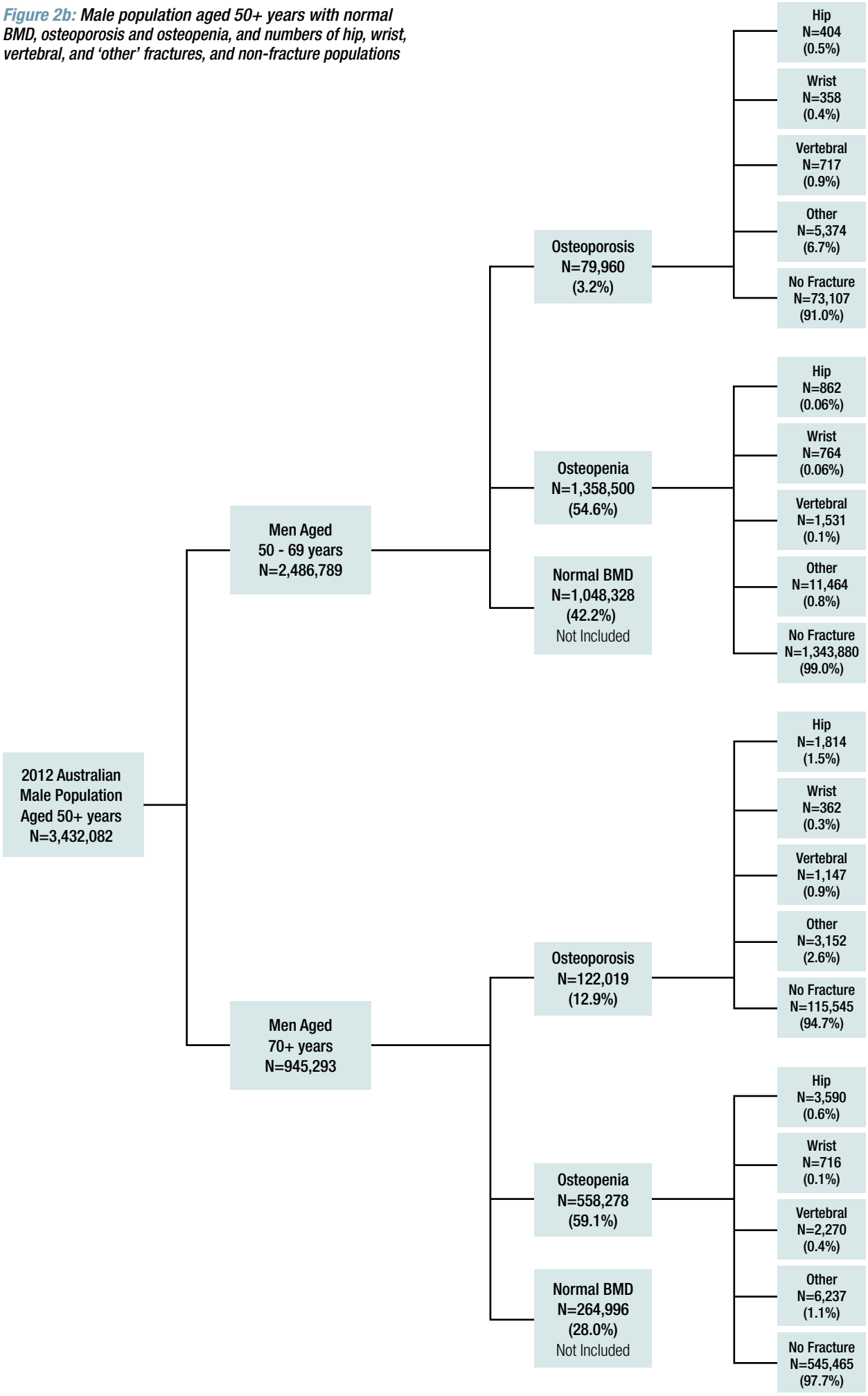


Figure 2b: Male population aged 50+ years with normal BMD, osteoporosis and osteopenia, and numbers of hip, wrist, vertebral, and 'other' fractures, and non-fracture populations



Cost and Resource Utilisation Estimates for Osteoporosis and Osteopenia in 2012

Data sources for cost and service utilisation rates

Data from existing sources (published) and from new data collections on fractures (AusICUROS) and associated health service utilisation have been used and combined with cost/price data from the MBS, PBS and hospital costing to attribute costs to treatment of fractures (by fracture type), drug treatment for management of osteoporosis and screening for osteoporosis.

A bottom-up costing approach was used to determine the total burden attributable to fractures based on service utilisation data reported to the AusICUROS study. From this study at August 2012 there were completed baseline to 12 month follow-up data for 505 people with low trauma fractures (refer to Table 6 below). Fractures included hip, wrist, vertebral and 'other'. The distribution of the 'other' group of fractures in the AusICUROS fracture cohort is indicated in Table 7.

***Table 6:** Fracture numbers from AusICUROS on which health care and service utilisation is based*

Fracture Type	Age 50-69 years			Age 70+ years			Total
	Men	Women	Both	Men	Women	Both	
Hip	5	20	25	16	71	87	112
Wrist	23	122	145	8	76	84	229
Vertebral	12	12	24	10	15	25	49
Other	21	50	71	12	32	44	115
ALL	**61**	**204**	**265**	**46**	**194**	**240**	**505**

***Table 7:** Distribution of 'other' group of fracture in the AusICUROS cohort*

Fracture Type	Number	% of all fractures
Foot and ankle	44	8.7
Humeral	27	5.3
Tibia/Fibula	14	2.8
Other femoral and pelvis	11	2.2
Rib	7	1.4
Clavicle	3	0.6
Forearm (not wrist)	2	0.4
Other (not specified)	7	1.4
Total	**115**	**22.8**

Data from AusICUROS included patient records and self-reported questionnaires about health and non-health service use following fractures from eight Australian study sites. From these data the resources collected included:

- Direct health care utilisation (hospitalisation, ambulance, imaging, medical services, pharmaceuticals and supplements, non-admitted, sub-acute/rehabilitation and community-based services including GP and physiotherapy services);
- Direct non-health care utilisation rates (residential care, meals on wheels, and other community services); and
- Indirect costs (Informal care and production loss).

Fracture numbers in Table 6 were categorised according to fracture type (hip, wrist/colles, vertebral and 'other'), age group (50-69 years and 70 years and over), and gender. There were low numbers of fractures for men aged 50-69 years with a hip fracture (n=5) and men aged 70+ years with a wrist fracture (n=8). For all other fracture types by age/gender split there were 10 cases or more. Where there were missing data or low utilisation rates for some services the age groups, gender and/or fracture type were combined to determine the utilisation rate and/or the service cost.

Where there were a large number of missing data from the AusICUROS cohort (particularly in the follow-up period from 4 to 12 months post-fracture) or low utilisation rates these have been compared to other data sources (where available). This is particularly relevant for assumptions around nursing home utilisation. In general there are more published sources for health care utilisation and residential care following hip fractures than for the other fracture sites. Therefore in most cases the assumption has been made that AusICUROS data represent the best source (even though numbers are low for some fracture populations).

Itemised tables by category of resource are provided with the average resource utilisation rate for the fracture population in 2012 in Appendix A and the unit cost for each resource (as AUD 2012) in Appendix B. Assumptions made for each rate and cost are included in the Appendices as well as the source of the data. All costs are reported as AUD 2012, where secondary sources have been used with costs reported in earlier years these have been inflated using the general inflation rate for Australia by financial year.[46]

Direct health care service costs

Acute care

Pre-hospital (ambulance) and hospitalisation

The rate for ambulance paramedic transport for each fracture type by age group and gender was determined from AusICUROS data. People with hip fractures were the most likely group to utilise ambulance paramedic services and wrist fractures the least likely. Rates for ambulance use are included in Appendix A and unit costs are reported in Appendix B. The cost attributed to all ambulance paramedic services was $689 per case[47] which was the inflated average cost of all cases transported by road in Victoria in 2011[1]. All people transported by ambulance were assumed to have been taken to a hospital emergency department.

The rate for admitted hospital care for each fracture type by age group and gender was determined from AusICUROS data. All men and women with hip fractures were admitted to a hospital in both age groups. Admission rates for non-hip fractures differed by both age and gender. In general women were more likely to be admitted than men in the same age group with the exception of vertebral fractures in the younger age group. Hospital admission rates for each fracture by gender and age are included in Appendix A.

[1] The 2011 reported cost of $675 was inflated to 2012 AUD.

Barwon Health Geelong, one of the hospitals participating in the AusICUROS study, had the highest number of participants who were hospitalised. Case level hospital costs were obtained from Barwon Health for all participants in the AusICUROS cohort admitted to a Barwon Health facility. Unit costing data from admitted patient systems that use a bottom-up approach to hospital costing generally represent good quality hospital cost data, from which both a mean cost, mean length of stay and standard deviations in a population sub-group can be determined. This contrasts to data reported at the diagnosis related group (DRG) level. Therefore patient level data from Barwon Health are likely to be a better representation of the average cost of patients in a given age group with low trauma fractures (more likely to be caused by osteoporosis/osteopenia) than the average cost for the DRG. Hospital costs were assumed to vary by fracture type and age group, but to determine the mean total cost of hospitalisation the hospital cost data for men and women were pooled.

The number of fractures in each subgroup, mean total hospital cost, mean length of stay and relevant standard deviations (SD) from Barwon Health data are shown in Table 8. Case numbers for people with a vertebral fracture from Barwon Health who were hospitalised were low (N=6) and all in the 70 years and over age group therefore the mean cost was assumed for all vertebral fracture admissions. For hip, wrist and 'other' fractures the mean costs and length of stay for hospital admissions were calculated and reported separately for each age group (50-69 years and 70+ years).

The mean costs of patients admitted to hospital included costs for Emergency Department care, pathology, imaging, and allied health so where a person was admitted to hospital for a fracture, these costs were assumed in the total inpatient cost for fracture management, not separately included (to avoid double counting).

***Table 8:** Costs of acute hospital episode and length of stay by fracture, and age group*

	Men and Women			
	50-69 years		70+ years	
	Mean Hospital Cost 2011/12$ (SD)	Mean LOS (days) (SD)	Mean Hospital Cost 2011/12$ (SD)	Mean LOS (days) (SD)
Hip	N=8		N=32	
Mean (SD)	17123 (9306)	6.9 (2.7)	22532 (12002)	11.5 (5.7)
Colles	N=30		N=22	
Mean (SD)	7310 (1888)	1.6 (0.6)	6885 (2884)	2.4 (1.5)
Vertebral			N=6	
Mean (SD)			6684 (3408)	5.4 (3.8)
Other	N=41		N=31	
Mean (SD)	10184 (7314)	4.5 (5.2)	11605 (11480)	11.1 (10.8)

Source: Barwon Health AusICUROS cohort

Non-admitted hospital services (Emergency Department and Outpatient Services)

The rates for Emergency Department (ED) care for fractures, where the person was not subsequently admitted to hospital, were determined from AusICUROS data. All people with a fracture transported by ambulance were assumed to go to a hospital Emergency Department, AusICUROS showed those who were admitted, the remainder were assumed to have been managed in the ED and then discharged and managed in the community or as an outpatient. Emergency Department costs were attributed to these people, as a non-admitted patient service.

For people in the AusICUROS cohorts who attended the Emergency Department but were not transported by ambulance, the same rates of hospitalisation were used as observed in the AusICUROS cohort. Of the remainder they were assumed to have attended the hospital ED[2] or to have been treated in the community by a general practitioner.

Rates of Emergency Department use for non-admitted people were separately calculated for wrist, vertebral and 'other' fractures (all people with a hip fracture were admitted to hospital) by age group and gender. These rates are included in Appendix A. Emergency Department costs were attributed to those managed in the ED but not admitted, as a non-admitted patient service. Costs attributed to Emergency Department attendance were taken from the Australian Independent Hospital Pricing Authority.[48] Wrist fractures were assumed to be Triage Category 5 and vertebra and 'other' fractures Triage Category 4 (all hip fractures were admitted, so no assumption regarding the triage category was required). Therefore, the cost for a non-admitted Emergency Department attendance relating to a wrist fracture was $251 and for vertebral or 'other' fracture was $361. These costs are shown in Appendix B.

Whether a fracture was managed in a hospital outpatient clinic was also reported in the AusICUROS cohort. Outpatient clinic fracture management occurred following a hospital admission or for those people seen in the Emergency Department without an admission. An average rate of outpatient attendance was determined for all people with a fracture irrespective of whether there had been an admission. The rates differed by fracture type, but were the same for both age groups and gender. Sixty one percent of people with a hip fracture visited an outpatient clinic. These rates are shown in Appendix A. Costs for outpatient department attendance were determined from the Australian IHPA 2012[48] based on the rate of $191 for an orthopaedic clinic. These are shown in Appendix B. It was assumed that all outpatient department attendees had 3 visits for fracture management, irrespective of fracture type, age and gender.

Sub-acute care (rehabilitation)

Of those people admitted to hospital for fracture management a certain proportion were discharged to a subacute care facility for inpatient rehabilitation. The rates reported in the AusICUROS

[2] Some of the AusICUROS sites only recruited through the ED.

cohort differed for hip and non-hip fractures and by age group. Thirty nine percent of people with a hip fracture aged 50-69 years and 32% of those aged over 70 years were discharged from acute care to a rehabilitation facility. For non-hip fractures the rates were 18% and 14% respectively (see Appendix A). The cost of a rehabilitation episode was determined from the Barwon Health costing data for a small number of people (N=30) who had been admitted to the Barwon Health rehabilitation facility. The mean cost $12375 (SD: 8557) for a rehabilitation episode was determined across all fracture types and both age groups. So although the rate of rehabilitation differed for hip and non-hip fractures the same rehabilitation episode cost was assumed.

Aged care and community services

Residential aged care

The rates assumed for residential aged care following a fracture were 11% for hip fracture[49] and 1% for non-hip fractures (AusICUROS) in the 70 years and over age group only. The rates are shown in Appendix A. The average length of stay over 12 months in a residential aged care facility following a fracture in 2012 was assumed to be 6 months. It was assumed that once admitted to a residential aged care facility that the person would remain in residence there for the remainder of 2012. As fractures occurred throughout 2012, a length of stay of 6 months was chosen as a midpoint. The average cost per day was $163[50] based on the mean annual cost of a low level care resident in 2010.[3] It was assumed that once admitted to residential aged care there was no further health care service use specific to the fracture. However management costs for osteoporosis/osteopenia whilst in residential aged care were assumed to continue.

Community fracture management

Medical care for fracture management (general practitioner and medical specialist)

Fracture management that occurred in the community rather than in the hospital setting (either admitted or non-admitted) was assumed for the remainder of people who did not report attending a hospital ED or who had a hospital admission from the AusICUROS cohort. Community fracture management was assumed to be by a general practitioner. The rates were small for each fracture type (ranging from 0.02 to 0.09) reflecting a possible recruitment bias in favour of people with a fracture presenting to a hospital ED. Attributed resource use for community fracture management was assumed to be three general practitioner visits and one radiological examination. The cost assumed for each general practitioner visit was $36 (the recommended Schedule fee for Item Number 23; MBS Online 2012);[51] and for radiological examination the MBS recommended Schedule fee was used specific to the fracture site (refer Appendix B).

Participants in the AusICUROS cohort reported visits to an orthopaedic medical specialist following discharge to the community from either a hospital emergency department, acute or sub-acute care ward. Where reported it was assumed that this was a private medical specialist and that these people did not also attend a hospital outpatient clinic. The rates varied for fracture type but were not significantly different by age or gender. The average number of visits reported in AusICUROS across all fracture types was 2.5 visits and the cost attributed was $84 (the recommended Schedule fee for Item number 104; MBS Online 2012).[51]

Physiotherapy

Participants in the AusICUROS cohort also reported visits to physiotherapists post-discharge from hospital. An assumption was made that if a person attended a private physiotherapist then they did not also attend a hospital outpatient clinic. The attributed rate was an average for each fracture type from the AusICUROS cohort with no differentiation for age group or gender (see Appendix A). People post discharge from a sub-acute facility, or in conjunction with private medical specialist or general practitioner fracture management may have attended private physiotherapy sessions. The cost attributed per session was $62 (Item Number 10960; MBS Online)[51] and the average reported number of sessions was taken from the AusICUROS cohort (9 sessions following a hip fracture, 5 sessions following a wrist fracture, 4 sessions following a vertebral fracture and 6 following 'other' fractures).

Pharmaceutical management of fracture

Pharmaceutical use following a fracture was taken from self-reported data in the AusICUROS study. All reported medications were recorded and sorted according to whether they were for fracture management or supplements for osteoporosis prevention or treatment (bone active medications). Drugs specific to fracture management included analgesia (including over-the-counter (OTC) medications, and opioids) and non-steroidal anti-inflammatory drugs (NSAIDs). Rates were determined by fracture type and gender, and whether the medication was taken on a routine basis or 'as needed.' From self-reported rates for all medications falling into the fracture management category, the average daily rate was determined for each drug type (weighted by whether taken regularly or as needed). The mean cost per day was determined for each drug based on routine use with prices taken from the Pharmaceutical Benefits Scheme website[52] or an online pharmacy direct site[53] (for common over-the-counter medications). A weighted mean cost per day was then determined for the fracture management medication group as a whole and used to derive a total cost over the 4 months following a fracture. Rates of use and weighted mean costs were specified for fracture type, age and gender.

[3] The 2010 reported per diem cost of $117 was inflated to 2012 AUD.

Health care services for osteoporosis and osteopenia management

Medical services

In addition to specialist medical services (assumed to be orthopaedic specialist visits) reported in the AusICUROS study there were other self-reported doctor visits also recorded. It was assumed that these medical services were for general practitioner attendance, for either fracture management or ongoing management of osteoporosis/osteopenia. The average number of reported medical visits was 2.4 per year; this was attributed to the entire population with osteoporosis or osteopenia and/or a fracture. The assumption was based on the need for likely follow-up investigations and/or pharmacological scripts for the management of osteoporosis/osteopenia.

Diagnostic imaging

The relevant diagnostic imaging procedure for osteoporosis/osteopenia is Dual-energy X-ray Absorptiometry (DXA). The total cost for DXA in 2011/12 was taken from the MBS total expenditure[54] on Item Numbers 12306, 12309, 12321, and 12323. The assumption for this was that the majority of DXAs are undertaken for osteoporosis. To determine the total cost of screening the patient gap contributions of 15% were added to the total expenditure reported in the Medicare statistics.

Pathology

Assumptions were made about the type and number of pathology tests that could be attributed to osteoporosis based on expert opinion. Firstly for Vitamin D tests, it was assumed one test every 2 years for the entire population with osteoporosis or osteopenia. The other relevant pathology test was a general blood test for renal function and serum calcium, and it was assumed that the entire population with osteoporosis or osteopenia would have this test twice per year. The MBS schedule fee in 2012 was used, for Vitamin D (MBS item number 66608) the fee was $39 and for a routine pathology test (based on 3 tests from one blood sample) the schedule fee (MBS Item number 66506) was $14 [51]. Refer Appendix B for unit costs.

Pharmaceuticals and supplements for osteoporosis/osteopenia prevention and treatment

Osteoporosis prevention

Self-reported pharmaceutical use from the AusICUROS cohort relating to the prevention/treatment of osteoporosis was used to determine the rate of osteoporosis prevention supplements use pre-fracture. Supplements for osteoporosis prevention included calcium and vitamin D separately and in combination. Thirty nine per cent of AusICUROS participants reported that they were on calcium or vitamin D prior to their fracture.[55] It was assumed that people who reported taking these supplements on a regular basis were likely to use the recommended dose over a 12 month period. Dosage used was the recommended daily dose for each drug. The cost was determined from drug prices from either the PBS[52] or pharmacy online;[53] and the cost over 12 months was determined by weighting the relative rate of use (from the AusICUROS cohort) for each medication.

Osteoporosis treatment

To determine the total utilisation of osteoporosis (bone-active) medications for osteoporosis treatment, the volume of dispensed scripts by the PBS and Repatriation Pharmaceutical Benefit Scheme (RPBS) the Item Reports from Medicare Australia[54] were used for the 2011/12 financial year. Medications where osteoporosis (including post-menopausal and steroid-induced osteoporosis) was listed under the authority restriction included:

- Alendronate preparations
- Denosumab
- Etidronate preparations[4]
- Raloxifene
- Risedronate preparations
- Strontium ranelate
- Teriparatide
- Zoledronic acid

To determine the annual cost, the reported number of services from the PBS and RPBS was multiplied by the schedule fee for each unit of service to determine the total cost.[54] No costs have been attributed for the use of hormone replacement therapy (HRT) with the exception of raloxifene (where osteoporosis was listed under the authority restriction). See Appendix C for osteoporosis (bone-active) medications including the relevant PBS codes for use in osteoporosis and the schedule fee.

This method for cost, medication based on the PBS and RPBS scripts is conservative as it does not include the cost of medications that may have been administered by a hospital and therefore not included in the PBS/RPBS volume reports. Particularly the injection formulations such as denosumab and zoledronic acid may have been administered in the hospital environment to achieve compliance.[56] The cost method also does not take into account any additional co-payment made by the patient.

[4] Etidronate is no longer available on the PBS in Australia in 2013.

Indirect costs comprised of two components namely; the value of time lost from work as a result of caring for a person with an osteoporotic fracture (referred to as informal community care) and the value of time lost due to hospitalisation in acute care or subacute care (rehabilitation) as a result of an osteoporotic fracture (referred to as production loss).

Direct non-health care costs

Community non-health services (home help, meals on wheels)

The use of community (non-health) services post-fracture were also available from the AusICUROS data. From these data the average rate of use for each home help and meals on wheels could be determined. In the AusICUROS cohort the number of hours used per week for home help was collected at 4 months and then at 12 months. The utilisation rates for home help are shown in Appendix A. The weighted average number of hours used over the 12 month period was calculated for those individuals who self-reported any home help and determined by fracture, age group and gender (see Table 9). The casual rate for home help in 2012 was approximately $25 per hour.[57]

Table 9: Community non-health services ('home help') mean hours per week (weighted over 12 months) by fracture type, gender and age-group

	Age 50-69 years		Age 70+ years	
Fracture Type	Men	Women	Men	Women
Hip	0.00	0.50	1.62	1.18
Wrist	0.00	0.61	0.33	0.79
Vertebral	0.00	1.89	0.99	1.30
Other	0.34	1.10	0.37	0.78

For meals on wheels the daily cost was $16.50 (Geelong City, 2012) and it was assumed that people would use the service for 12 months. In the AusICUROS data only people in the age group 70 years and over self-reported using meals on wheels, and there were more women than men using these services.

Informal community care

Informal community care was estimated from self-reported data in the AusICUROS study. The method was similar to that reported for community (non-health) service use post-fracture. The number of hours of use reported at 4 months and then again at 12 months was weighted to determine the average hours per week over 12 months by fracture, age group and gender (see Table 10). The rates are shown in Appendix A. The same hourly rate ($25) was used as for home help[57] on the assumption that if informal care by a family member was not possible then the person would have required paid community services.

Table 10: Informal community care mean hours per week (weighted over 12 months) by fracture type, gender and age-group

	Age 50-69 years		Age 70+ years	
Fracture Type	Men	Women	Men	Women
Hip	1.90	1.90	4.58	7.79
Wrist	0.83	5.51	0.00	3.44
Vertebral	10.31	7.36	4.08	3.67
Other	3.70	3.70	3.70	3.70

Indirect costs from production loss

Productivity losses were estimated for the total number of days spent in acute and subacute care as a result of the fracture. This was estimated for anyone who fractured aged 50 years and over. This method assumes that all adults have some kind of productivity irrespective of their age, employment status or labour force participation. These costs were calculated by multiplying the average length of stay (ALOS) in hospital as days by the average daily earnings in Australian dollars (AUD).[58] The costs were categorised by fracture type, age groups and BMD category. The ALOS data for acute and subacute care were obtained from Barwon Health – Geelong Hospital (see Table 11 below). The average daily earnings was calculated from the average weekly total earning at May 2012 ($1058.7)[58] divided by 7 to account for hospitalisation that may extend beyond a normal 5-day working week. A 7-day week also does not differentiate paid or unpaid work.

Table 11: Average length of stay (days) by fracture type and age groups

	50-69 years old		70+ years old	
Fracture Type	Number of cases	ALOS (SD)	Number of cases	ALOS (SD)
Hip	8	6.89 (2.67)	32	11.54 (5.7)
Wrist	30	1.58 (0.56)	22	2.39 (1.50)
Vertebral			6	5.43 (3.80)
Other	41	4.47 (5.17)	31	11.07 (10.8)

Mortality

Mortality rates used were those reported in the AusICUROS study. Mortality recorded in the AusICUROS study occurred during the first 12 months following hospitalisation due to the fracture. It was therefore assumed to occur as a result of the fracture. Numbers were small so the same mortality rate for all fractures was used for 50-69 year olds (rate=0.01) while different mortality rates were determined for hip and non-hip fracture for adults aged 70 years and over (hip 0.08; non-hip 0.05). The numbers of people presumed to have died as a result of fracture in Australia in 2012 were determined by BMD category, fracture type, age and gender. For the purposes of this Burden of Disease Study indirect costs due to lost productivity have not been attributed to those who die.

Burden of Osteoporosis and Osteopenia in Australia from 2013 to 2022

The second part of the Burden of Disease study was to project the burden of osteoporosis and osteopenia and related fractures forward for 10 years from 2013 to 2022. The model was based on the populations (fracture and non-fracture) by gender, age group and BMD and the costs determined from 2012.

Population 2013-2022

The ABS annual population projection series B[5] were used for the Australian population from 2013 to 2022.[59] To determine the annual prevalence of osteoporosis and osteopenia in men and women aged 50-69 years and aged 70 years and over, the projected population in 5-year age intervals were used and the rates from the Geelong Osteoporosis Study applied[6] as for 2012. The incidence of new fractures by gender, age and BMD was determined using the same rates as for 2012.[1,2] The proportion of each fracture type was applied to each age group (50-69 years and 70 years and over) based on the Sanders et al[3] data with the Crisp et al[5] adjustments, and weighted by the 5-year population fracture distribution observed in 2012 (see Table 12).

Each year the previous year's population (alive at the end of the period) was carried forward into the model in the following cohorts (by age group, gender and fracture type) with associated assumptions concerning osteoporosis (bone active) medications:

1. Osteoporosis with previous fracture[6] – 100% on osteoporosis (bone active) medications
2. Osteopenia with previous fracture – 100% on osteoporosis (bone active) medications
3. Osteoporosis no fracture – 35% on osteoporosis (bone active) medications[7]
4. Osteoporosis no fracture – 65% not on osteoporosis (bone active) medications
5. Osteopenia no fracture – 100% not on osteoporosis (bone active) medications

Table 12: Distribution of fracture type by gender and age group[3,5]

	Women		Men	
Fracture Type	50-69 years	70+ years	50-69 years	70+ years
Hip	4%	26%	6%	28%
Wrist	20%	17%	5%	6%
Vertebral	15%	23%	10%	18%
Other	62%	34%	78%	49%
	100%	100%	100%	100%

[5] Series B reflects current population trends for life expectancy, birth rates, migration and mortality.

[6] This was based on the fractures first observed in 2012, and then increased by fractures occurring in each year thereafter.

[7] This 35% is the assumed prevalence of osteoporosis (bone active) medications in the community.

Medication use

The total use of osteoporosis (bone active) medication based on the assumptions described above[8] was approximately 500,000 people in 2012. By applying the annual cost of alendronate (approx. $365) per individual to this population the total cost of osteoporosis (bone active) medications in 2012 was approximately $180 million (which was consistent with the total cost of $179 million in 2012). This assumption meant that the individual use of medication could be attributed in the model and the effect carried through the model in terms of costs and the number of fractures (including the number of fractures 'avoided' as a consequence of the medication).

Similar to an assumption made in a Canadian study,[60] alendronate was chosen as the most widely prescribed generic bisphosphonate in Australia, for which there is the most evidence as to its effectiveness in reducing fractures, including a Cochrane Review.[61] Thirty five percent use of the cohort with no fracture (Cohort #3) were assumed to be taking osteoporosis (bone active) medication. This cohort was assumed the prevalence group, and the new fractures from 2012 were assumed to commence medication in 2012 as a result of the fracture. A non-adherence rate of 40%[60] after the first year of use of osteoporosis (bone active) medication was attributed to the group commencing medications, but not the medication prevalence group.

The effect of the osteoporosis (bone active) medications is to reduce the fracture and re-fracture rates attributable to osteoporosis and osteopenia. The reduction in fracture risk assumed was based on the rates reported in a Cochrane Review of alendronate[61] and shown in Table 13 below as a weighted relative risk in fracture reduction.

Table 13: Weighted relative risk reduction (%) of fracture for alendronate by fracture type and year[61]

	Weighted relative risk reduction		
Fracture Type	Year 1	Year 2	Year 3
Hip	29	50	55
Wrist (non vertebral)	45	31*	18
Vertebral	21	62	48
Other (non vertebral)	45	31*	18

**The Cochrane Review was not able to determine a rate in Year 2 for non-vertebral, non-hip fractures, therefore a linear relationship between Years 1 and 3 was assumed*

In the first year of the model (2013) it was assumed that everyone on osteoporosis (bone active) medications had the benefit of the medication for one year (Year 1 relative risk reduction in fractures) attributed to the re-fracture rate (for those who had a fracture from 2012) and to the osteoporosis fracture rate (for those who had not fractured in 2012). In the second year of the model (2014) 40% of the fracture group from 2012 had ceased medication, so resumed the fracture risk without medication, and the remaining 60%, as well all the osteoporosis group without a fracture from 2012, had the benefit of the

[8] These assumptions are also consistent with the PBS prescribing restrictions for bisphosphonates in osteoporosis.

medication for 2 years (Year 2 relative risk reduction in fracture). No further decline in osteoporosis (bone active) medication use was assumed, so both groups had the benefit of medication use in the 3rd year. This method for determining the total number of fractures (first fractures and re-fractures) in each population group (age, gender and BMD) was carried forward for each year of the model, for 10 years from 2013 to 2022. The same assumptions were used, that is new medication use in the new fracture group each year and a constant 35% prevalence of medication use in the osteoporosis population.

The effects of osteoporosis (bone active) medications were able to be attributed according to each population cohort, carried forward through the model. From these assumptions the number of new fracture and re-fractures could be determined (with and without bisphosphonate therapy).

Fracture numbers: new fractures and re-fractures

For each year of the model (2013-2022) the number of fractures was determined by fracture site, BMD, gender and age group (as 'first fracture' and 're-fracture'). The predicted number of first fractures was determined for each year of the model based on the same assumptions used in 2012 and described above, with the benefit assumed from bisphosphonate therapy (also described above).

To determine the number and type of re-fractures, the relative risk of re-fracture rates applied were 1.97 for women and 3.47 for men irrespective of age group and BMD.[62] These were adjusted for bisphosphonate therapy accordingly. The distribution of fracture type was assumed the same as for first fracture.

For each year the number of first fractures and re-fractures were determined according to gender, age group (5-year age groups for new fractures; and 50-69 years and 70 years and over for re-fractures), BMD (osteoporosis and osteopenia), whether on therapy or not, and by the type of fracture (hip, wrist, vertebral and 'other').

Additional analysis was also undertaken on the assumption of 'no medication' and the consequent number of first fracture and re-fractures (by gender, age group, BMD and type of fracture) that would be expected to occur. Each year the difference between the medication and no medication assumptions were calculated as the potential fractures avoided as a result of bisphosphonate therapy.

Cost of osteoporosis, osteopenia and associated fractures, 2013-2022

The average annual direct and indirect costs of a fracture (by gender, age group and fracture type) determined from 2012 were attributed to the fractures that occurred each year. The annual average direct cost included nursing home in the year of the fracture as well community services related to the fracture. The average annual indirect cost assumed lost productivity as a result of the fracture. The same total fracture costs were assumed for both first fractures and for re-fractures. The total cost (direct and indirect) for each year was determined by fracture site, age and gender.

For the community management of osteoporosis or osteopenia (irrespective of fracture) the following assumptions were made concerning medication, investigations and medical care. The total costs of bisphosphonate therapy as well as the total population assumed to be on medication each year from 2013 to 2022 were determined. It was assumed that everyone with a new fracture would have one DXA in the year of the fracture, and that the rest of the population with osteoporosis or osteopenia (including the re-fracture population) would have one DXA every three years (an annual rate of 0.33).[9] Pathology tests for Vitamin D were assumed once every 2 years for the entire population with osteoporosis or osteopenia, and routine pathology tests were based on the same assumption as for 2012 (i.e. two routine tests annually). General practitioner visits were assumed at a rate of 2.4 visits annually for the population with osteoporosis or osteopenia irrespective of fracture (as assumed in 2012).

Nursing Home costs were included in the average annual direct cost of a fracture determined from 2012 in the year that the fracture occurred. For each subsequent year the annual cost of a nursing home was attributed to those in residential care, with a 10% annual attrition rate assumed. The costs of subsequent residential care each year were also determined.

All costs were determined in 2012 dollars for comparability and then an annual inflation rate of 3.4%[46] applied to the total annual cost for each year (2013-2022). The total cost for each year from 2013 to 2022 was determined. To compare with the total costs from 2012, the total cost less nursing home and re-fracture costs, was used as these costs were not included in the 2012 total cost.

[9] The total cost of DXA in 2012 was determined from the MBS expenditure data and not attributed to individuals.

Results

Table 14 below shows the Australian population data that were used to determine the total burden of disease of osteoporosis by gender, age-groups (50-69 years and 70+ years), and BMD category (osteoporosis, osteopenia) in Australia in 2012. The total population consists of the population 50 years and over with fracture (hip, wrist, vertebral and 'other') and without fracture (osteoporosis and osteopenia only).

Table 15 indicates the number in the starting population by osteoporosis and osteopenia, gender and age group with fractures and without fractures. The number of hospitalisations, admissions to residential aged care and deaths during 2012 are also shown. The numbers of individuals with osteoporosis or osteopenia that were presumed alive at the end of 2012 are included, these were the numbers carried forward in the 10-year projection model.

Table 14: 2012 Australian populations by gender, age group and BMD category

	Osteoporosis		Osteopenia		Normal BMD		Total Population		
Age Group	Women	Men	Women	Men	Women	Men	Women	Men	Both
50-69 years	328,447	79,960	1,233,342	1,358,500	961,134	1,048,329	2,522,923	2,486,789	5,009,712
70+ years	513,874	122,019	548,019	558,278	126,374	264,996	1,188,267	945,293	2,133,560
Totals	**842,321**	**201,979**	**1,781,361**	**1,916,778**	**1,087,508**	**1,313,325**	**3,711,190**	**3,432,082**	**7,143,272**

Table 15: 2012 Populations by gender, age group BMD category and fracture type

	Women					Men					All
	50-69 years		70+ years		Total	50-69 years		70+ years		Total	
Population	Osteoporosis	Osteopenia	Osteoporosis	Osteopenia	All Women	Osteoporosis	Osteopenia	Osteoporosis	Osteopenia	All Men	Total
Total Population	**328,447**	**1,233,342**	**513,874**	**548,019**	**2,623,682**	**79,960**	**1,358,500**	**122,019**	**558,278**	**2,118,758**	**4,742,441**
Population with fracture (Total)	**18,121**	**24,797**	**35,020**	**22,122**	**100,060**	**6,854**	**14,621**	**6,474**	**12,813**	**40,762**	**140,822**
Hip											
Starting population	674	922	9,018	5,697	16,311	404	862	1,814	3,590	6,670	22,981
Hospitalised	607	830	8,387	5,697	15,520	404	862	1,814	3,590	6,670	22,190
Died	8	12	745	471	1,235	5	11	150	297	462	1,698
Nursing home	-	-	992	627	1,619	-	-	200	395	594	2,213
Alive at year end	666	911	8,273	5,226	15,076	399	851	1,664	3,293	6,208	21,284
Wrist											
Starting population	3,561	4,873	5,801	3,665	17,900	358	764	362	716	2,199	20,099
Hospitalised	1,602	2,193	3,655	2,309	9,759	140	298	181	358	976	10,735
Died	20	27	173	109	330	2	4	9	17	31	360
Nursing home	-	-	48	30	78	-	-	2	5	7	85
Alive at year end	3,541	4,845	5,629	3,556	17,570	356	760	353	699	2,168	19,738
Vertebral											
Starting population	2,725	3,729	8,202	5,181	19,837	717	1,531	1,147	2,270	5,665	25,502
Hospitalised	899	1,231	5,495	3,471	11,097	359	765	573	1,135	2,832	13,929
Died	11	15	260	164	451	4	10	27	54	94	545
Nursing home	-	-	71	45	117	-	-	7	15	22	139
Alive at year end	2,714	3,714	7,942	5,017	19,387	713	1,521	1,120	2,216	5,570	24,957
Other											
Starting population	11,161	15,273	11,998	7,579	46,012	5,374	11,464	3,152	6,237	26,228	72,240
Hospitalised	6,474	8,859	8,639	5,457	29,428	2,311	4,930	2,112	4,179	13,531	42,959
Died	81	111	267	258	717	29	62	26	52	169	886
Nursing home	-	-	112	71	183	-	-	27	54	82	265
Alive at year end	11,080	15,163	11,731	7,321	45,295	5,345	11,403	3,125	6,185	26,058	71,353
Population without fracture	**310,326**	**1,208,545**	**478,854**	**525,897**	**2,523,622**	**73,107**	**1,343,880**	**115,545**	**545,465**	**2,077,996**	**4,601,619**

A total of (66%) of the Australian population aged 50 years and over in 2012 had osteoporosis or osteopenia. Of these 4,742,441 adults, 78% had osteopenia (n=3,698,140) and 55% (n=2,623,682) were female. Osteopenia in those aged 50-69 years formed the group with the largest number of people, comprising 1,358,500 men (55% of the male population aged 50-69 years) and 1,233,342 women (49% of the female population aged 50-69 years). Although substantially fewer people in this age group had osteoporosis, there were over four times as many women as men, with almost 330,000 women having osteoporosis compared to 80,000 men, representing 13% and 3% of Australian women and men aged 50 to 69 years, respectively. There were about the same number of women as men with osteopenia aged over 70 years, approximately half a million each (Table 15) representing 46% and 59% of women and men in this age group, respectively. It was estimated that another half a million women aged 70 years and over had osteoporosis in 2012 (n=513,874), representing 43% of this population group compared with 122,019 older men who had osteoporosis (13%).

Of the total population with osteoporosis and osteopenia aged 50 years and over in 2012, 3% (140,882) had fractures of which 16.3% had a hip fracture with the remainder sustaining non-hip fractures (14.3% wrist, 18.1% vertebral and 51.3% with 'other' fracture types). The fracture rate varied by gender and age group ranging from the lowest proportion of 1.1% in men aged 50 to 69 years to the highest in women aged 70 years and over (6.8%) (Table 4). Due to the higher prevalence of osteopenia compared to osteoporosis, fracture numbers were highest among those with osteopenia in each age and gender subgroup except for women aged 70+ years, where 60% more fractures occurred in women with osteoporosis compared to osteopenia (Table 15). There were twice as many fractures in men with osteopenia than osteoporosis (27,434 vs 13,328; respectively). In women the fracture numbers were more balanced due to the combination of higher population in the older age group and the very high fracture rate among these older women (and men) with osteoporosis (46,919 vs 53,141; osteopenia vs osteoporosis). Absolute fracture numbers were consistently higher in women than men (ratio women to men: 2.4 hip; 8.1 wrist; 3.5 vertebral and 1.8 'other' fracture sites).

There were 3,489[10] deaths resulting from fractures attributable to osteoporosis or osteopenia in 2012, of which the vast majority occurred in those aged 70 years and over (n=3,079) with 1,698 (49%) associated with a fracture of the hip, and 545 (16%) associated with a vertebral fracture. Seventy per cent of these deaths occurred in women aged 70 years and over (n=2,447). Within the fracture population, 97.5% were alive at the end of 2012.

Total Cost of Osteoporosis and Osteopenia in 2012

The total cost of osteoporosis in Australia in 2012 was $2.754 billion, of which $2.589 billion (94%) are direct costs. This included the direct costs of managing fractures (health and non-health care), as well as the non-fracture costs relating to the management of osteoporosis and osteopenia. These include the costs of bone health medications (pharmaceuticals predominantly bisphosphonates), DXA scans and routine pathology tests (including Vitamin D tests). Other fracture management direct (non-health care) costs included were for informal care in the community. With informal care costs excluded the direct costs in 2012 were $2.447 billion. The indirect costs from productivity losses associated with fractures due to hospitalisation (acute and rehabilitation) in 2012 were $165 million, which represented 6% of the total cost. This cost breakdown is shown in Table 16, more detail about the costs of each fracture by gender and age, as well as sector costs are shown in subsequent tables.

[10] Differences in whole numbers due to rounding.

Table 16: Total costs (Direct and Indirect) of osteoporosis and osteopenia in Australia in 2012

Cost	Total Cost ($)	% Total Cost (direct and indirect)
Total Direct Fracture Cost (excluding informal care)	**$1,617,821,009**	58.7
- Hip fractures	$695,403,602	
- Wrist fractures	$114,791,953	
- Vertebral fractures	$164,974,699	
- Other fractures	$642,650,754	
Total Cost Informal Care	**$141,751,682**	5.1
- Hip fractures	$35,799,492	
- Wrist fractures	$7,330,465	
- Vertebral fractures	$29,509,846	
- Other fractures	$69,111,879	
Total Direct Fracture Cost (including informal care)	**$1,759,572,690**	63.9
- Hip fractures	$731,203,094	
- Wrist fractures	$122,122,418	
- Vertebral fractures	$194,484,545	
- Other fractures	$711,762,633	
Total Direct Non-Fracture Cost	**$829,645,097**	30.1
- Routine medical and pathology (includes Vitamin D tests)	$626,703,911	
- DXA	$23,625,769	
- Pharmaceuticals – bone health (includes bisphosphonates)	$179,315,417	
TOTAL DIRECT COSTS	**$2,589,217,788**	94.0
TOTAL DIRECT COSTS (excluding informal care)*	**$2,447,466,106**	
Total Indirect cost (Productivity Loss due to Fractures)	**$165,173,079**	6.0
- Hip fractures	$64,033,917	
- Wrist fractures	$9,003,419	
- Vertebral fractures	$18,497,828	
- Other fractures	$73,637,915	
TOTAL DIRECT and INDIRECT COST	**$2,754,390,866**	
TOTAL DIRECT and INDIRECT COST (DUE TO FRACTURES)	$1,924,745,769	69.9

** Total direct cost (excluding informal care) was used as the denominator in percentage calculations in all tables (unless otherwise stated)*

Direct health care costs

Acute care

Acute hospital services (including Emergency Department and non-admitted services)

The total cost of acute hospital care for fractures associated with osteoporosis or osteopenia in 2012 was $1.18 billion, of which the total for acute inpatient hospitalisation was $1.14 billion (96% of total hospital costs). The remainder of $43 million was for non-admitted services (including emergency departments). Total costs of hospital care for fractures represented 46.5% of the direct total costs attributed to osteoporosis in 2012. Fractures accounted for 89,813 acute admissions to hospital in 2012, representing almost 670,000 bed-days, with an average length of stay of 7.4 days.

Hip fractures represented 44% of total acute hospital costs and 36% of bed-days, vertebral fractures 8% of hospital costs and 11% of bed-days, wrist fractures 7% of hospital costs and 3% of bed-days and 'other' fractures 41% of total acute hospital costs and 49% of acute bed-days. People aged 70 years and over accounted for 70% of total acute hospital inpatient costs, and costs for women were 72% of the total. The highest single category was acute inpatient care for women aged over 70 years with a hip fracture, with a total cost of $332 million representing 29% of total hospital costs. See Table 17 below for a summary of costs relating to hospital management of fractures.

Pre-hospital (ambulance paramedic)

The total cost of pre-hospital ambulance paramedic care for people with a fracture likely to be caused by osteoporosis or osteopenia in 2012 was $50 million, representing 2% of the total direct costs for osteoporosis in 2012. Ambulance transport for people aged over 70 years was $33 million, representing 67% of total ambulance costs. Although people with a hip fracture were more likely to use an ambulance the 'other' fracture category represented 44% of total ambulance costs, with hip fractures 30% of total costs and vertebral fractures 19% of the total ambulance costs. See Table 18 for a summary of costs relating to pre-hospital ambulance paramedic care.

Sub-acute care (rehabilitation)

Rehabilitation or subacute care for the management of fractures relating to osteoporosis or osteopenia cost $229 million in 2012, which represented 9.3% of the total direct cost. The cost of rehabilitation for people aged 70 years and over was $143 million (63% of total) of which nearly half (49%) was the cost of rehabilitation care for women. Women in both aged groups accounted for $167 million or 73% of the total costs of rehabilitation. The highest costs were associated with rehabilitation for hip fractures ($92.7 million or 41%), with the cost of rehabilitation following 'other' fractures $89.3 million or 39% of total rehabilitation costs. Summary total costs for rehabilitation are shown in Table 19. Rehabilitation in a sub-acute care facility following a fracture, caused by osteoporosis/osteopenia, accounted for 18,491 admissions in 2012, and 428,500 bed-days.

Table 17: Hospital (admitted and non-admitted) costs for fracture management by gender, age group and fracture type

	Women (Total Cost)				Men (Total Cost)				All		% Total Direct Costs
	50-69 years	% Total	70+ years	% Total	50-69 years	% total	70+ years	% Total	Total Cost	% Total	
Hospital Inpatient – Total Cost	**$225,456,606**	**20**	**$596,121,421**	**52**	**$106,130,784**	**9**	**$209,894,324**	**18**	**$1,137,603,135**	**100**	**46.5**
- Hip	27,337,136	2	331,546,201	29	21,682,984	2	121,761,583	11	**$502,327,904**	44	
- Wrist	27,741,192	2	41,060,608	4	3,198,142	<0.01	3,708,758	<0.01	**$75,708,700**	7	
- Vertebral	14,235,985	1	59,934,170	5	7,512,752	1	11,419,263	1	**$93,102,170**	8	
- Other	156,142,293	14	163,580,442	14	73,736,906	6	73,004,720	6	**$466,464,361**	41	
Hospital (Non-admitted services) – Total Cost	**$14,863,663**	**34**	**$14,620,048**	**34**	**$8,278,259**	**19**	**$5,512,715**	**13**	**$43,274,686**	**100**	**1.8**
- Hip	301,143	1	2,342,229	5	265,397	1	924,938	2	**$3,833,708**	9	
- Wrist	2,644,424	6	2,474,778	6	344,686	1	322,988	1	**$5,786,876**	13	
- Vertebral	2,867,141	7	4,234,166	10	872,151	2	1,313,113	3	**$9,286,570**	21	
- Other	9,050,955	21	5,568,875	13	6,796,025	16	2,951,676	7	**$24,367,531**	56	
All Hospital – Total Cost	**$240,320,269**	**20**	**$610,741,469**	**52**	**$114,409,043**	**10**	**$215,407,040**	**18**	**$1,180,877,821**	**100**	**48.2**
- Hip	27,638,279	2	333,888,431	28	21,948,381	2	122,686,521	10	**$506,161,612**	43	
- Wrist	30,385,616	3	43,535,386	4	3,542,828	<0.01	4,031,746	<0.01	**$81,495,576**	7	
- Vertebral	17,103,126	1	64,168,336	5	8,384,903	1	12,732,375	1	**$102,388,740**	9	
- Other	165,193,248	14	169,149,317	14	80,532,931	7	75,956,397	6	**$490,831,892**	42	

Table 18: Pre-hospital ambulance/paramedic costs following fracture by gender, age group and fracture type

	Women (Total Cost)				Men (Total Cost)				All		% Total Direct Costs
	50-69 years	% Total	70+ years	% total	50-69 years	% Total	70+ years	% Total	Total Cost	% Total	
Ambulance	**$10,603,507**	**21**	**$23,469,688**	**47**	**$6,275,348**	**13**	**$9,777,031**	**20**	**$50,125,574**	**100**	**2.0**
- Hip	989,281	2	9,421,742	19	871,853	2	3,720,613	7	**$15,003,488**	30	
- Wrist	812,881	2	2,020,443	4	100,407	<0.01	267,031	1	**$3,200,761**	6	
- Vertebral	2,977,254	6	4,883,634	10	897,686	2	941,013	2	**$9,699,587**	19	
- Other	5,824,090	12	7,143,870	14	4,405,403	9	4,848,375	10	**$22,221,738**	44	

Table 19: Subacute care (rehabilitation) costs following fracture by gender, age group and fracture type

	Women (Total Cost)				Men (Total Cost)				All		% Total Direct Costs
	50-69 years	% Total	70+ years	% Total	50-69 years	% Total	70+ years	% Total	Total Cost	% Total	
Subacute (Rehabilitation) Total	**$54,347,995**	**24**	**$112,773,917**	**49**	**$25,406,393**	**11**	**$30,233,211**	**14**	**$228,831,254**	**100**	**9.3**
- Hip	7,655,791	3	57,795,822	25	6,072,340	3	14,143,178	7	**$92,749,685**	41	
- Wrist	8,335,877	4	10,531,509	5	961,001	<0.01	3,610,263	2	**$20,779,636**	9	
- Vertebral	4,678,371	2	15,834,605	7	2,468,915	1	3,653,925	2	**$25,998,860**	11	
- Other	33,677,956	15	28,611,981	13	15,904,136	7	8,825,844	4	**$89,303,074**	39	

Table 20: Community health care service costs for fracture management (GPs, radiology, physiotherapy, pharmacy) by gender, age group and fracture type

	Women (Total Cost)				Men (Total Cost)				All		% Total Direct Costs
	50-69 years	% Total	70+ years	% Total	50-69 years	% Total	70+ years	% Total	Total Cost	% Total	
Community care of fractures (GPs, Imaging, Physiotherapy, Drugs)	**$8,278,743**	**36**	**$8,252,088**	**36**	**$3,959,762**	**17**	**$2,588,252**	**11**	**$23,078,844**	**100**	**0.9**
- Hip	488,407	2	1,656,081	7	384,832	2	388,177	2	**$2,917,496**	13	
- Wrist	1,643,982	7	1,731,405	8	206,120	1	186,065	1	**$3,767,572**	16	
- Vertebral	909,456	4	1,147,569	5	311,824	1	317,025	1	**$2,685,873**	12	
- Other	5,236,898	23	3,717,033	16	3,056,987	13	1,696,985	7	**$13,707,904**	59	

Community health care services for fracture management

Community fracture management included the management of fractures by general practitioners (where people were not admitted to hospital); radiological examination of fractures; ongoing management of fractures by GPs or medical specialists post discharge from acute or subacute care; physiotherapy and pharmaceutical management of fractures (analgesia). Each of these service categories on their own represented a small proportion of total direct costs, combined they were $23 million (1% of total direct costs). Wrist fractures were the largest single fracture group, with a total cost of $3.8 million (16% of total community health service costs). Table 20 shows the summary costs for community care relating to fracture management.

The total cost attributed to pharmaceuticals for fracture management (predominantly analgesia) post hospitalisation or for non-admitted fractures was $0.24 million (see Table 21) with females 70 years and older contributing the highest cost, 46% of the total fracture management cost. Fracture management medication use in women accounted for 82% of the total fracture management cost. The largest single fracture category contributing to the cost of these medications was hip fractures for osteoporotic women 70 years and older, which accounted for 16% of the total fracture management cost.

Table 21: Fracture management drug costs ($) by gender, age group and fracture type

	Women (Total Cost)				Men (Total Cost)				All	
	50-69 years	% Total	70+ years	% Total	50-69 years	% Total	70+ years	% Total	Total Cost	% total
Pharmaceutical Management of Fractures	**$88,096**	**36**	**$112,330**	**46**	**$24,903**	**10**	**$19,166**	**8**	**$244,495**	**100**
- Hip	4,647	2	39,786	16	1,128	<0.01	4,473	2	**$50,034**	20
- Wrist	18,452	8	20,209	8	716	<0.01	675	<0.01	**$40,052**	16
- Vertebral	3,990	2	8,045	3	1,279	1	1,910	1	**$15,224**	6
- Other	61,007	25	44,290	18	21,780	9	12,108	5	**$139,185**	57

Aged care and community services

Nursing home

The total nursing home cost due to osteoporosis in 2012 was estimated at $77.3 million which is 2.7% of the total direct cost.[11] Females contributed the greatest cost which was 77% of the total nursing home costs and 2.4% of the total direct costs (refer to Table 22). Relating to the fracture type, hip fractures contributed the greatest cost to nursing home care, accounting for 85% of the total nursing home costs (23% and 62% of the total nursing home costs for males and females respectively).

Table 22: Nursing home costs by fracture type and gender for adults aged 70 years and over

Fracture Type	Women (Total Cost)		Men (Total Cost)		All		% Total Direct Costs
	Total Cost	% Total	Total Cost	% Total	Total Cost	% Total	
Hip	$48,263,317	62	$17,724,884	23	**$65,988,201**	85	2.7
Wrist	$2,311,772	3	$2,715	<0.01	**$2,314,486**	3	0.1
Vertebral	$3,475,854	4	$8,609	<0.01	**$3,484,464**	5	0.1
Other	$5,463,988	7	$31,701	<0.01	**$5,495,689**	7	0.2
Sub-total	**$59,514,931**	**77**	**$17,767,909**	**23**	**$77,282,840**	**100**	**3.2**

[11] Total direct costs are $2.4 billion; these include all costs except the indirect costs.

Community non-health services (home help, meals on wheels)

Home help

The total cost of home help in 2012 was estimated at $33.4 million, which is 1.4% of the total direct costs (see Table 23). More than three quarters (76%) of the home help cost was in the older age group of 70 years and older, women accounted for 89% of all home help costs. Osteoporosis accounted for 54% of the total home help cost, women 70 years and older with osteoporosis accounting for the largest cost which was 40% of the total home help cost. Considering fracture type, vertebral fractures had the highest cost of home help (37%), followed by other fracture (33%), hip (26%) and wrist (4%).

Meals on wheels

Similar to nursing home, meals on wheels costs were only estimated for those aged 70 years and above. The total cost of meals on wheels was estimated at $14 million, and this comprised 0.6% of the total direct costs. Females accounted for 67% of the total meals on wheels cost with females with osteoporosis being the most costly contributing 41% of the total cost of meals on wheels (Table 24). Osteoporosis accounted for 52% of the total meals on wheels cost. Vertebral fractures were the most costly with 47% of the total cost for meals on wheels followed by other fractures (33%), hip (18%) and wrist (2%).

*Table 23: **Home help costs by fracture type, gender and age groups***

	Women (Total Cost)				Men (Total Cost)				All	
	50-69 years	% total	70+ years	% total	50-69 years	% total	70+ years	% total	Total Cost	% Total Direct
Hip	$76,857	0.2	$5,980,111	17.9	-	-	$2,494,791	7.5	**$8,551,760**	0.3
Wrist	$108,062	0.3	$1,312,525	3.9	-	-	$28,015	0.1	**$1,448,602**	0.1
Vertebral	$2,638,752	7.9	$9,389,350	28.1	-	-	$213,248	0.6	**$12,241,350**	0.5
Other	$4,872,667	14.6	$5,346,614	16.0	$173,589	0.5	$742,270	2.2	**$11,135,140**	0.5
Sub-total	**$7,696,338**	**23.1**	**$22,028,600**	**66.0**	**$173,589**	**0.5**	**$3,478,325**	**10.4**	**$33,376,852**	**1.4**

*Table 24: **Meals on wheels costs by fracture type and gender for adults 70 years and older***

	Women (Total Cost)		Men (Total Cost)		All	% Total Direct
Fracture Type	Total Cost	%total	Total Cost	%total	Total Cost	**Costs**
Hip	$2,439,899	17.5	-	-	**$2,439,899**	0.1
Wrist	$309,416	2.2	-	-	**$309,416**	<0.1
Vertebral	$6,609,719	47.3	-	-	**$6,609,719**	0.3
Other	-	-	$4,619,957	33.0	**$4,619,957**	0.2
Sub-total	**$9,359,035**	**67.0**	**$4,619,957**	**33.0**	**$13,978,991**	**0.6**

Costs by fracture type

Direct and indirect cost data are also presented for all fractures as well as by fracture type (hip, wrist, vertebral, and 'other'), by gender and age groups in Tables 25, 26, 27, 28 and 29. The direct total cost for fractures includes all health care and community services (directly related to fracture care), as well as costs attributable to nursing home or residential care. Community fracture management includes care delivered by GPs or medical specialists (which may be instead of or in addition to hospitalisation), physiotherapy and radiology. Pharmaceuticals/supplements include those directly attributable to the fracture outside the hospital setting (analgesia) and vitamin D and calcium supplements. Other bone medications were considered attributable to the management of osteoporosis or osteopenia rather than the fracture, hence costs have been considered separately. Similarly vitamin D testing and DXA were considered part of the costs attributable to osteoporosis or osteopenia rather than specific to the fracture. Informal care and productivity losses due to hospitalisation or rehabilitation following a fracture are shown separately, as well as the total direct and indirect cost for each fracture type.

Table 25: Total cost of all fractures by gender, age group and sector

All Fractures	Women Ages 50-69 years Total Cost	% Direct Total Cost	Age 70+ years Total Cost	% Direct Total Cost	Men Ages 50-69 years Total Cost	% Direct Total Cost	Age 70+ years Total Cost	% Direct Total Cost	All Total Cost	% Direct Total Cost
Hospital Total	$240,320,269	14.9	$610,741,469	37.8	$114,409,043	7.1	$215,407,040	13.3	$1,180,877,821	73.0
Ambulance	$10,603,507	0.7	$23,469,688	1.5	$6,275,348	0.4	$9,777,031	0.6	$50,125,574	3.1
Community Fracture Mgt (incl GP, Physio, Med Spec, X-ray)	$8,190,646	0.5	$8,139,758	0.5	$3,934,859	0.2	$2,569,086	0.2	$22,834,349	1.4
Rehabilitation	$54,347,995	3.4	$112,773,917	7.0	$25,406,393	1.6	$36,302,949	2.2	$228,831,254	14.1
Nursing Home	$-		$59,514,931	3.7	$-		$17,767,909	1.1	$77,282,840	4.8
Community Services (home help and MOW)	$7,696,338	0.5	$31,387,635	1.9	$173,589	<0.01	$8,098,282	0.5	$47,355,844	2.9
Pharmaceuticals – Fracture Management	$88,096	<0.01	$112,330	<0.01	$24,903	<0.01	$19,166	<0.01	$244,495	<0.01
Supplements – Vitamin D and Calcium	$3,187,825	0.2	$4,089,705	0.3	$1,596,311	0.1	$1,394,991	0.1	$10,268,832	0.6
Total Direct Health Care Cost (excludes informal care)	**$324,434,677**	**20.1**	**$850,229,433**	**52.6**	**$151,820,446**	**9.4**	**$291,336,453**	**18.0**	**$1,617,821,009**	**100.0**
Informal care	$31,603,792		$74,392,420		$17,253,390		$18,502,080		$141,751,682	
Total Direct Cost (includes informal care)	$356,038,469		$924,621,853		$169,073,836		$309,838,532		$1,759,572,690	
Productivity Loss due to Fracture (Indirect)	$29,440,970		$89,578,483		$14,272,389		$31,881,236		$165,173,079	
Total Cost (Direct and Indirect)	**$385,479,438**		**$1,014,200,337**		**$183,346,226**		**$341,719,768**		**$1,924,745,769**	

The direct total cost of all fractures (without informal care) was $1.618 billion, when both informal care and productivity losses were included the total cost was $1.925 billion (Table 25). Seventy three per cent of the total direct cost of all fractures is for hospital care, and 14% is for rehabilitation. Fractures in women aged 70 years and over represent almost 53% of the direct costs of fracture management.

The total direct cost of hip fractures was $695 million representing 43% of total direct costs of all fractures (Table 26). Hospital care represented 73% of direct costs for hip fractures, of which 48% of the total direct costs was hospital care for women aged 70 years and over. Informal care and lost productivity due to hip fractures was $100 million, predominantly attributed to women aged 70 years and over.

Wrist fractures represented only 7% ($114,791,953) of the total direct costs of all fractures (Table 27). Acute hospital care for wrist fractures represented 71% and rehabilitation 18% of the total direct costs for wrist fracture management. The total cost of wrist fractures for women (in both age groups) was $105 million (91% of the total direct costs). Informal care and lost productivity due to wrist fractures was $16 million.

Table 26: Total cost of hip fractures by gender, age group and sector

	Women				Men				All	
	Ages 50-69 years		Age 70+ years		Ages 50-69 years		Age 70+ years			
Hip Fractures	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost
Hospital Total	$27,638,279	4.0	$333,888,431	48.0	$21,948,381	3.2	$122,686,521	17.6	$506,161,616	72.8
Ambulance	$989,281	0.1	$9,421,742	1.4	$871,853	0.1	$3,720,613	0.5	$15,003,489	2.2
Community Fracture Mgt (incl GP, Physio, Med Spec, X-ray)	$483,760	0.1	$1,616,294	0.2	$383,704	0.1	$383,704	0.1	$2,867,463	0.4
Rehabilitation	$7,655,791	1.1	$57,795,822	8.3	$6,072,340	0.9	$21,225,732	3.1	$92,749,686	13.3
Nursing Home	$-		$48,263,317	6.9	$-		$17,724,884	2.5	$65,988,201	9.5
Community Services (home help and MOW)	$76,857	<0.01	$8,420,011	1.2	$-		$2,494,791	0.4	$10,991,659	1.6
Pharmaceuticals – Fracture Management	$4,647	<0.01	$39,786	<0.01	$1,128	<0.01	$4,473	<0.01	$50,034	<0.01
Supplements – Vitamin D and Calcium	$117,885	<0.01	$1,009,375	0.1	$93,503	<0.01	$370,697	0.1	$1,591,460	0.2
Total Direct Health Care Cost (excludes informal care)	**$36,966,500**	**5.3**	**$460,454,777**	**66.2**	**$29,370,909**	**4.2**	**$168,611,415**	**24.2**	**$695,403,602**	**100.0**
Informal care	$194,449		$33,596,053		$61,692		$1,947,297		$35,799,492	
Total Direct Cost (includes informal care)	$37,160,949		$494,050,831		$29,432,602		$170,558,712		$731,203,094	
Productivity Loss due to Fracture (Indirect)	$3,742,896		$41,532,665		$3,100,708		$15,657,648		$64,033,917	
Total Cost (Direct and Indirect)	**$40,903,845**		**$535,583,495**		**$32,533,310**		**$186,216,360**		**$795,237,010**	

Table 27: Total cost of wrist fractures by gender, age group and sector

	Women				Men				All	
	Ages 50-69 years		Age 70+ years		Ages 50-69 years		Age 70+ years			
Wrist Fractures	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost
Hospital Total	$30,385,616	26.5	$43,535,386	37.9	$3,542,828	3.1	$4,031,746	3.5	$81,495,576	71.0
Ambulance	$812,881	0.7	$2,020,443	1.8	$100,407	0.1	$267,031	0.2	$3,200,761	2.8
Community Fracture Mgt (incl GP, Physio, Med Spec, X-ray)	$1,625,530	1.4	$1,711,196	1.5	$205,404	0.2	$185,391	0.2	$3,727,520	3.2
Rehabilitation	$8,335,877	7.3	$10,531,509	9.2	$961,001	0.8	$951,248	0.8	$20,779,636	18.1
Nursing Home	$-		$2,311,772	2.0	$-		$2,715	<0.01	$2,314,486	2.0
Community Services (home help and MOW)	$108,062	0.1	$1,621,942	1.4	$-		$28,015	<0.01	$1,758,019	1.5
Pharmaceuticals – Fracture Management	$18,452	<0.01	$20,209	<0.01	$716	<0.01	$675	<0.01	$40,052	<0.01
Supplements – Vitamin D and Calcium	$627,040	0.5	$686,740	0.6	$83,472	0.1	$78,652	0.1	$1,475,904	1.3
Total Direct Health Care Cost (excludes informal care)	**$41,913,458**	**36.5**	**$62,439,195**	**54.4**	**$4,893,828**	**4.3**	**$5,545,472**	**4.8**	**$114,791,953**	**100.0**
Informal care	$2,685,992		$4,618,432		$26,041		$-		$7,330,465	
Total Direct Cost (includes informal care)	$44,599,451		$67,057,628		$4,919,868		$5,545,472		$122,122,418	
Productivity Loss due to Fracture (Indirect)	$3,170,009		$5,014,982		$365,454		$452,973		$9,003,419	
Total Cost (Direct and Indirect)	**$47,769,460**		**$72,072,610**		**$5,285,322**		**$5,998,445**		**$131,125,837**	

The direct costs of managing vertebral fractures in 2012 were $165 million, with informal care of $30 million included the direct costs were almost $195 million (Table 28). The largest single group were women aged 70 years and over, with a total cost of $106 million (65% of the total).

The total cost of 'other' fractures was almost $643 million (Table 29). The total cost of 'other' fractures for women in both age groups was 68% of total direct costs. With informal care and lost productivity included the total cost of 'other' fractures was $785 million, representing approximately 41% of the total cost of all fractures.

***Table 28:** Total cost of vertebral fractures by gender, age group and sector*

	Women				Men				All	
	Ages 50-69 years		Age 70+ years		Ages 50-69 years		Age 70+ years			
Vertebral Fractures	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost
Hospital Total	$17,103,126	10.4	$64,168,336	38.9	$8,384,903	5.1	$12,732,375	7.7	$102,388,740	62.1
Ambulance	$2,977,254	1.8	$4,883,634	3.0	$897,686	0.5	$941,013	0.6	$9,699,587	5.9
Community Fracture Mgt (incl GP, Physio, Med Spec, X-ray)	$905,465	0.5	$1,139,524	0.7	$310,545	0.2	$315,114	0.2	$2,670,649	1.6
Rehabilitation	$4,678,371	2.8	$15,834,605	9.6	$2,468,915	1.5	$3,016,969	1.8	$25,998,860	15.8
Nursing Home	$-		$3,475,854	2.1	$-		$8,609	<0.01	$3,484,464	2.1
Community Services (home help and MOW)	$2,638,752	1.6	$15,999,069	9.7	$-		$213,248	0.1	$18,851,069	11.4
Pharmaceuticals – Fracture Management	$3,990	<0.01	$8,045	<0.01	$1,279	<0.01	$1,910	<0.01	$15,224	<0.01
Supplements – Vitamin D and Calcium	$480,609	0.3	$969,007	0.6	$167,040	0.1	$249,452	0.2	$1,866,106	1.1
Total Direct Health Care Cost (excludes informal care)	**$28,787,567**	**17.4**	**$106,478,073**	**64.5**	**$12,230,368**	**7.4**	**$17,478,690**	**10.6**	**$164,974,699**	**100.0**
Informal care	$7,687,288		$16,324,560		$3,740,857		$1,757,141		$29,509,846	
Total Direct Cost (includes informal care)	$36,474,855		$122,802,633		$15,971,225		$19,235,831		$194,484,545	
Productivity Loss due to Fracture (Indirect)	$3,019,300		$11,663,001		$1,593,374		$2,222,153		$18,497,828	
Total Cost (Direct and Indirect)	**$39,494,155**		**$134,465,634**		**$17,564,599**		**$21,457,984**		**$212,982,373**	

Table 29: Total cost of 'other' fractures by gender, age group and sector

	Women				Men				All	
	Ages 50-69 years		Age 70+ years		Ages 50-69 years		Age 70+ years			
Other Fractures	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost	Total Cost	% Direct Total Cost
Hospital Total	$165,193,248	25.7	$169,149,317	26.3	$80,532,931	12.5	$75,956,397	11.8	$490,831,892	76.4
Ambulance	$5,824,090	0.9	$7,143,870	1.1	$4,405,403	0.7	$4,848,375	0.8	$22,221,738	3.5
Community Fracture Mgt (incl GP, Physio, Med Spec, X-ray)	$5,175,891	0.8	$3,672,744	0.6	$3,035,207	0.5	$1,684,877	0.3	$13,568,718	2.1
Rehabilitation	$33,677,956	5.2	$28,611,981	4.5	$15,904,136	2.5	$11,109,000	1.7	$89,303,074	13.9
Nursing Home	$-		$5,463,988	0.9	$-		$31,701	<0.01	$5,495,689	0.9
Community Services (home help and MOW)	$4,872,667	0.8	$5,346,614	0.8	$173,589	<0.01	$5,362,227	0.8	$15,755,096	2.5
Pharmaceuticals – Fracture Management	$61,007	<0.01	$44,290	<0.01	$21,780	<0.01	$12,108	<0.01	$139,185	<0.01
Supplements – Vitamin D and Calcium	$1,962,292	0.3	$1,424,584	0.2	$1,252,296	0.2	$696,190	0.1	$5,335,362	0.8
Total Direct Health Care Cost (excludes informal care)	**$216,767,151**	**33.7**	**$220,857,387**	**34.4**	**$105,325,341**	**16.4**	**$99,700,875**	**15.5**	**$642,650,754**	**100.0**
Informal care	$21,036,063		$19,853,375		$13,424,800		$14,797,641		$69,111,879	
Total Direct Cost (includes informal care)	$237,803,214		$240,710,762		$118,750,141		$114,498,517		$711,762,633	
Productivity Loss due to Fracture (Indirect)	$19,508,765		$31,367,835		$9,212,853		$13,548,462		$73,637,915	
Total Cost (Direct and Indirect)	**$257,311,979**		**$272,078,597**		**$127,962,994**		**$128,046,979**		**$785,400,548**	

Mean costs of low trauma fractures

The average annual direct (health care and non-health care) and indirect costs and average total cost for each fracture by age and gender are shown in Table 30. The denominator in the calculations for the mean annual cost was based on the number in the fracture population at the beginning of the period, therefore includes those who subsequently died as a result of the fracture. The total costs in the numerator included the direct health care costs, without Nursing Home (attributed to everyone with a fracture), as well as Nursing Home and direct non-health and indirect costs (attributed to those with a fracture and alive at the end of the period). Average direct health care costs for fractures included acute hospital admitted and non-admitted care, subacute/rehabilitation, ambulance, community health care services following a fracture, pharmaceuticals for fracture management and supplements for osteoporosis prevention. A separate average annual direct health care cost for each fracture by age and gender was also determined which included nursing home costs (in the year of the fracture). The average direct (non-health care) total cost for each fracture type by age and gender includes the cost of community non-health care services following fractures. The average indirect cost includes productivity loss that occurred as a result of admission to acute and subacute (rehabilitation) care.

Hip fractures have the highest average total direct cost for both males and females, ranging from $23,243 to $33,576 and is highest in the 70 years and older age-group for both genders. Wrist fractures in males aged 50-69 years (mean cost $4,386) had the lowest average annual direct total cost. When productivity losses are considered the fracture group with the highest total cost were women aged 70 years and older with a hip fracture (mean annual total cost $36,398).

Table 30: Mean annual direct health care cost of low trauma fractures by gender and age group

Fracture Type	Cost Category	Women 50-69 years (2012$)	Women 70+ years (2012$)	Men 50-69 years (2012$)	Men 70+ years (2012$)
Hip	Average Direct (Health Care) Total Cost without Nursing Home	23,106	27,440	23,194	27,460
	Average Direct (Health Care) Total Cost with Nursing Home	23,106	30,720	23,194	30,740
	Average Direct (Non-Health Care) Total Cost	170	2,855	49	822
	Average Direct Total Cost	23,276	33,576	23,243	31,562
	Average Indirect Cost (Productivity Loss)	2,344	2,823	2,449	2,897
	Average Total Cost (Direct and Indirect)	25,621	36,398	25,691	34,459
Wrist	Average Direct (Health Care) Total Cost without Nursing Home	4,957	6,180	4,362	5,119
	Average Direct (Health Care) Total Cost with Nursing Home	4,957	6,425	4,362	5,121
	Average Direct (Non-Health Care) Total Cost	331	659	23	26
	Average Direct Total Cost	5,289	7,084	4,386	5,147
	Average Indirect Cost (Productivity Loss)	376	530	326	420
	Average Total Cost (Direct and Indirect)	5,664	7,614	4,711	5,568
Vertebral	Average Direct (Health Care) Total Cost without Nursing Home	4,051	6,501	5,441	5,050
	Average Direct (Health Care) Total Cost with Nursing Home	4,051	6,761	5,441	5,053
	Average Direct (Non-Health Care) Total Cost	1,600	2,415	1,664	577
	Average Direct Total Cost	5,651	9,176	7,105	5,630
	Average Indirect Cost (Productivity Loss)	468	871	709	650
	Average Total Cost (Direct and Indirect)	6,119	10,047	7,814	6,280
Other	Average Direct (Health Care) Total Cost without Nursing Home	8,016	10,729	6,245	10,044
	Average Direct (Health Care) Total Cost with Nursing Home	8,016	11,008	6,245	10,048
	Average Direct (Non-Health Care) Total Cost	980	1,287	808	2,147
	Average Direct Total Cost	8,996	12,295	7,052	12,195
	Average Indirect Cost (Productivity Loss)	738	1,602	547	1,443
	Average Total Cost (Direct and Indirect)	9,734	13,898	7,600	13,638

Health care services for osteoporosis and osteopenia management

Medical services

The total cost of general practitioner services for the management of osteoporosis in 2012 was estimated at $404.9 million, representing 49% of the total community health care costs and 17% of total direct costs. GP costs for people aged 50-69 were $256 million, representing 63% of total GP costs (see Table 31). The cost attributed to females for GP services was $223.9 million, accounting for 55% of total GP costs (Table 31). Considering those who fractured, their GP costs represented only 2.9% of the total GP costs.

Diagnostic imaging

According to Medicare data, there were 235,724 DXA scans (Item numbers: 12306, 12309, 12321 and 12323) in 2011/2012 for a total cost of $20.1 million. Assuming that the gap paid by the individual is 15%, the total cost of DXA scans in 2011/2012 was estimated at $23.6 million, which is 2.8% and 1% of the total community health care cost and total direct costs respectively (see Table 31).

Pathology

The total cost associated with routine vitamin D pathology tests was estimated at $92.5 million, 11% of the total community health care costs and 3.8% of the total direct costs. Sixty three per cent ($58.6 million) of the vitamin D costs were associated with 50-69 year olds and 55% ($51.1 million) with females (see Table 31). The cost associated with routine pathology test was estimated at $129.3 million, which is 15.5% of the total community health care costs and 5.3% of total direct costs (see Table 31).

Generally, health care services for osteoporosis and osteopenia management accounted for 26% of the total direct costs while the total community health care cost represented 33.9% of the total direct costs.

Table 31: Community health care costs for the management of osteoporosis/osteopenia by gender, age group and with or without fracture

	Women						Men						All	
	50-69 years		%	70+ years		%	50-69 years		%	70+ years		%		% Total Direct
	Fracture	No Fracture	Total	Fracture	No Fracture	Total	Fracture	No Fracture	Total	Fracture	No Fracture	Total	Total Cost	Cost
General Practitioner	3,642,556	129,772,316	16.1	4,673,086	85,845,972	10.9	1,824,060	121,067,318	14.8	1,593,981	56,476,696	7.0	404,895,984	16.5
Routine Vitamin D Blood Test	832,408	29,655,951	3.7	1,028,937	19,617,774	2.5	416,839	27,666,659	3.4	364,261	12,906,221	1.6	92,489,050	3.8
Routine Pathology Test	1,163,878	41,465,171	5.1	1,438,667	27,429,717	3.5	582,828	38,683,729	4.7	509,313	18,045,573	2.2	129,318,877	5.3
Sub-total	**5,638,842**	**200,893,439**	**25**	**7,140,689**	**132,893,464**	**17**	**2,823,727**	**187,417,706**	**23**	**2,467,555**	**87,428,490**	**11**	**626,703,911**	**25.6**
DXA Scan (Medicare+gap) cost 2011/2012												2.8	23,625,769	1.0
Pharmaceutical-Osteoporosis treatment PBS costs 2011/2012												21.6	23,625,769	7.3
Total												**100.0**	**829,645,097**	**33.9**

Pharmaceuticals for osteoporosis/osteopenia prevention and treatment

Osteoporosis prevention – calcium and vitamin D supplements

The total cost associated with calcium and vitamin D supplementation for osteoporosis prevention in 2012 was estimated at $10.3 million (0.4% total direct costs) for those who fracture (see Table 32) and $310.8 million for individuals who had low bone density but with no fracture. The overall cost was $321 million, 13% of the total direct costs (see Table 33). Considering those who fractured, 24% of this cost was accounted for by females 70 years and older with osteoporosis, while males from the same age group and BMD accounted for the least cost (5%). Overall, 71% of the cost was attributed to females. In terms of fracture type, hip, wrist and vertebral fractures represented 15%, 14% and 18% of the total cost respectively. 'Other' fractures made up the highest cost of $5.3 million, which was 52% of the total cost of supplements for osteoporosis prevention, for individuals that fractured. The costs associated with individuals that had no fracture represented 96% of the total costs of supplements for osteoporosis management with both males and females contributing 48% of this cost.

Osteoporosis management/treatment – bone medications

Pharmaceutical costs relating to osteoporosis management such as bisphosphonates were obtained from the Medicare Australia Statistics website using the Pharmaceutical Benefits Schedule (PBS) Item Reports. The PBS cost in 2011/2012 for pharmaceuticals relating to osteoporosis management excluding hormonal therapy was $179.3 million.[12] The cost is 21.6% and 7.3% of the total community health care costs and total direct costs respectively, representing the most costly component of the pharmaceutical costs (Table 31).

Table 32: Calcium and vitamin D supplement costs ($) by fracture type, gender and age groups

	Women			Men			All	
	50-69 years	70+ years	% Total	50-69 years	70+ years	% Total	Total Cost	% Total Cost
Hip	117,885	1,009,375	11	93,503	370,697	5	1,591,460	15
Wrist	627,040	686,740	13	83,472	78,652	2	1,475,904	14
Vertebral	480,609	969,007	14	167,040	249,452	4	1,866,106	18
Other	1,962,292	1,424,584	33	1,252,296	696,190	19	5,335,362	52
Total	**3,187,825**	**4,089,705**	**71**	**1,596,311**	**1,394,991**	**29**	**10,268,832**	**100**

Table 33: Calcium and vitamin D supplement costs ($) by gender, age groups and with or without fracture

	Women			Men			All	
	50-69 years	70+ years	% Total	50-69 years	70+ years	% Total	Total Cost	% Total Direct Cost
No fracture	113,571,752	41,833,855	48	105,953,472	49,426,237	48	310,785,316	13
Fracture	3,187,825	4,089,705	2	1,596,311	1,394,991	1	10,268,832	<0.01
Total	**116,759,577**	**45,923,560**	**51**	**107,549,782**	**50,821,228**	**49**	**321,054,148**	**13**

[12] The PBS data could not be identified according to BMD, gender, age group or fracture, however authority restrictions suggest that those with osteoporosis aged 70 years or over and with a fracture are more likely to be prescribed osteoporosis (bone active) pharmaceuticals.

Direct non-health care costs

Informal community care

The total cost of informal community care due to osteoporosis in 2012 was estimated at $141.8 million, representing 5.8% of the total direct costs (see Table 34). Females accounted for most of the cost (74%), with females aged 70 years and older with osteoporosis having the largest cost at $45.6 million. This was almost one third of the total informal community care cost and 2% of total direct costs. On the other hand, males aged 70 years and older with osteoporosis had the least cost which was 4% of the total informal community care cost. Considering the fracture type, the 'other' fractures contributed the highest informal care cost (49%), followed by hip (25%), vertebral (21%) and wrist (5%) fractures.

Indirect costs

Production loss

The cost associated with time lost from work due to hospitalisation for fractures due to osteoporosis in acute and sub-acute care in 2012 was estimated at $165.2 million, which is 6.0% of total direct and indirect costs (See Table 35). Similar to informal community care costs, older females aged 70 years and over with osteoporosis contributed the highest cost (54% of total production loss) while younger males aged 50-69 years old with osteoporosis had the least production loss (9% of the total production loss). Higher production loss was mostly associated with 'other' fractures and hip fractures (45% and 39% of total production loss respectively).

Table 34: Informal community care cost by fracture type, gender, BMD categories and age groups

Fracture Type	Women (Total Cost)						Men (Total Cost)						All		
	50-69 years		%	70+ years		%	50-69 years		%	70+ years		%			% Total Direct & Indirect Cost
	Osteoporosis	Osteopenia	Total	Osteoporosis	Osteopenia	Total	Osteoporosis	Osteopenia	Total	Osteoporosis	Osteopenia	Total	Total Cost	% Total Cost	
Hip	82,101	112,348	<0.01	20,589,586	13,006,467	24	19,690	42,003	<0.01	653,677	1,293,620	1	35,799,492	25.3	1.3
Wrist	1,134,088	1,551,904	2	2,830,440	1,787,992	3	8,311	17,729	<0.01	-	-	-	7,330,465	5.2	0.3
Vertebral	3,245,752	4,441,536	5	10,004,625	6,319,934	12	1,193,930	2,546,927	3	589,845	1,167,296	1	29,509,846	20.8	1.1
Other	8,881,916	12,154,147	15	12,224,841	7,628,534	14	4,284,651	9,140,149	9	4,967,336	9,830,305	10	69,111,879	48.8	2.5
Sub-total	**13,343,857**	**18,259,935**	**22**	**45,649,492**	**28,742,928**	**52**	**5,506,581**	**11,746,809**	**12**	**6,210,858**	**12,291,222**	**13**	**141,751,682**	**100.0**	**5.1**

Table 35: Production loss due to hospitalisation by fracture type, gender and age groups

	Women			Men			All		
	50-69 years	70+ years	% Total	50-69 years	70+ years	% Total	Total Costs	% Total Costs	% Total Direct & Indirect Costs
Hip	3,742,896	41,532,665	27	3,100,708	15,657,648	11	64,033,917	38.8	2.3
Wrist	3,170,009	5,014,982	5	365,454	452,973	<0.01	9,003,419	5.5	0.3
Vertebral	3,019,300	11,663,001	9	1,593,374	2,222,153	2	18,497,827	11.2	0.7
Other	19,508,765	31,367,835	31	9,212,853	13,548,462	14	73,637,914	44.6	2.7
Sub-total	**29,440,969**	**89,578,483**	**72**	**14,272,389**	**31,881,236**	**28**	**165,173,077**	**100.0**	**6.0**

Sensitivity Analysis

To undertake a sensitivity analysis the total number of hip fractures in both males and females was changed by 25% (both increased and decreased) to ±5,745 hip fractures to estimate the effect on the total cost of all fractures. The impact of this 25% change on the number of hip fractures was a 10% change in the total direct cost of all fractures. The total direct costs associated with the 25% increase in hip fractures were $1.942 billion, and $1.577 billion when decreased by 25% (Table 36). The change in the number of hip fractures caused the total cost (direct and indirect) to change by 7%. Although the number of actual fractures was relatively small, the impact on costs was substantial ($180 million) in 2012.

Table 36: Impact on total cost of a 25% change in the total number of hip fractures

	Change in Total Cost ($)				
	2012 Results	Hip Fractures Increase by 25%		Hip Fractures Decrease by 25%	
	2012$	2012$	%	2012$	%
Total Direct Fracture Cost (including informal care)	1,759,572,690	1,941,974,095	10	1,577,176,063	-10
TOTAL DIRECT COSTS	2,589,217,788	2,772,304,077	7	2,406,136,360	-7
TOTAL DIRECT and INDIRECT COST	2,754,390,866	2,937,477,154	7	2,571,309,437	-7

Burden of Osteoporosis and Osteopenia in Australia from 2013 to 2022 Population Trends

Table 37 shows the projected total population with osteoporosis and osteopenia by gender and age group from 2013 to 2022. Based on current prevalence rates it is predicted that by 2022, 6.2 million people in the population aged 50 years and over will have osteoporosis or osteopenia, with women representing 55% of the total population (n=3,437,828). This represents a percentage increase in osteoporosis and osteopenia of 31% over the period from 2012 to 2022. Figure 3 shows the predicted trend in population growth for osteoporosis and osteopenia by age group and gender over the period from 2012 to 2022. The largest single percentage increase is in men over 50 years with osteoporosis, representing a change of 41% over the same period. As was the case in 2012, in absolute terms the largest single population group by 2022 will be men aged 50-69 years with osteopenia (n=1,611,761), followed by women aged 50-69 years with osteopenia (n=1,490,078). Men in both age groups with osteoporosis represent the smallest populations with 94,867 mean aged 50-69 years and 190,224 mean aged 70 years and over predicted to have osteoporosis by 2022.

***Figure 3:** Predicted population growth of osteoporosis and osteopenia in men and women aged 50-69 years and 70 years and over, 2012-2022*

Table 37: Projected Australian population by gender, age group and BMD category, 2013-2022

	Women					Men					All
	50-69 years		70+ years		Total	50-69 years		70+ years		Total	
Year	Osteoporosis	Osteopenia	Osteoporosis	Osteopenia	All Women	Osteoporosis	Osteopenia	Osteoporosis	Osteopenia	All Men	Total Women and Men
2012	328,447	1,233,342	513,874	548,019	2,623,682	79,960	1,358,500	122,019	558,278	2,118,758	4,742,441
2013	348,963	1,310,381	548,153	584,577	2,792,074	84,246	1,431,304	131,964	603,781	2,251,295	5,043,370
2014	356,313	1,337,979	564,880	602,415	2,861,588	85,889	1,459,217	137,027	626,943	2,309,075	5,170,662
2015	362,610	1,361,626	582,805	621,531	2,928,571	87,261	1,482,529	142,428	651,657	2,363,875	5,292,446
2016	368,313	1,383,043	601,731	641,714	2,994,801	88,460	1,502,898	148,243	678,262	2,417,863	5,412,664
2017	371,410	1,394,672	628,635	670,406	3,065,124	89,087	1,513,565	156,172	714,540	2,473,365	5,538,488
2018	375,431	1,409,770	653,041	696,434	3,134,676	89,954	1,528,285	163,282	747,069	2,528,589	5,663,265
2019	380,374	1,428,330	676,525	721,478	3,206,707	91,067	1,547,194	169,924	777,458	2,585,643	5,792,350
2020	385,179	1,446,376	701,228	747,823	3,280,607	92,199	1,566,423	176,785	808,849	2,644,256	5,924,863
2021	391,139	1,468,753	725,969	774,208	3,360,069	93,568	1,589,693	183,534	839,727	2,706,522	6,066,591
2022	396,818	1,490,078	750,531	800,402	3,437,828	94,867	1,611,761	190,224	870,338	2,767,190	6,205,018

Osteoporosis (Bone Active) Medication

Table 38 shows the population numbers assumed to be taking osteoporosis (bone active) pharmaceuticals each year for the 10-year projection model from 2013 to 2022. This was based on a starting population of approximately 500,000 people from 2012, including an assumed 'medication' prevalence rate of 35% of the population with osteoporosis, and new people commencing medication following a fracture (with a 40% non-adherence rate after one year). The population numbers shown in Table 38 suggest an average annual growth rate in osteoporosis medication use of 2.6%, which would mean a 26% change in the total population taking medications from 2013 to 2022. The total population assumed taking osteoporosis (bone active) medications in 2022 was 818,600 people, representing only 13% of the total population with osteoporosis or osteopenia in 2022.

Table 38: Population numbers and annual percentage change assumed on osteoporosis medication by gender and age group, 2013 to 2022

	Women			Men			All	
Year	50-69 years	70+ years	Total all Women	50-69 years	70+ years	Total all Men	Total Women and Men	Annual % change
2013	202,224	292,344	494,568	70,888	83,333	154,221	648,789	
2014	204,274	295,939	500,213	71,389	85,726	157,115	657,328	1.3
2015	207,954	305,171	513,124	72,575	89,017	161,592	674,716	2.6
2016	211,303	315,099	526,403	73,617	92,646	166,263	692,666	2.7
2017	213,375	328,558	541,933	74,278	97,350	171,627	713,561	3.0
2018	215,553	341,725	557,278	74,931	101,968	176,899	734,177	2.9
2019	218,303	354,125	572,427	75,805	106,209	182,014	754,441	2.8
2020	221,093	367,000	588,094	76,750	110,496	187,246	775,340	2.8
2021	224,388	380,029	604,417	77,836	114,767	192,602	797,020	2.8
2022	227,701	392,966	620,666	78,943	118,989	197,932	818,598	2.7

Fractures Numbers and Costs 2013-2022

The predicted number of fractures and associated costs each year were determined for each fracture type and by gender and age group from 2013 to 2022. These are shown separately for all fractures (Tables 39 and 40) and by each fracture type in Tables 41 and 42 (hip), Tables 43 and 44 (wrist), Tables 45 and 46 (vertebral) and Tables 47 and 48 ('other' fractures). These numbers are based on the predicted populations with osteoporosis and osteopenia and the assumed number of the population taking osteoporosis (bone active) medications. The same assumptions regarding population rates and fracture distribution have been attributed as for 2012. Costs are reported as direct, indirect and total for each fracture type, using the average annual cost of a fracture from the 2012 burden of disease results. Average costs were attributed by gender, age group and fracture type. All costs are reported in 2012 AUD for comparability with the 2012 burden of disease results.

All fractures

The annual total burden of fractures related to osteoporosis and osteopenia for 2013 to 2022 are shown in Tables 39 (population) and 40 (total cost). The total number of fractures incudes both new (or first) fractures and re-fractures[13] (that occur following a previous fracture as the model progresses over time). The total number of fractures is likely to increase from 144,312 in 2013 to 183,105 (representing an increase of 27% over this 10-year period). New fractures are predicted to represent 94% of the total fracture burden and re-fractures 6% by 2022. The results show that the total number of fractures was predicted to grow by 26% in women and 28% in men over the 10-year period.

The annual total cost of all fractures shown in Table 40 includes direct and indirect costs of both new fractures and re-fractures from 2013 to 2022. The total cost relating to fractures in 2022 is predicted to be $2.591 billion (2012AUD). This represents an increase of 31% from over the period 2013 to 2022 (in constant dollars). Although women aged 70 years and over experience less than half of the total fractures (43%), they continue to have the highest fracture-related costs (54% of total costs), and predicted to increase by 36% to $1.4 billion in 2022.

***Table 39:** Annual number of all fractures (new fractures and re-fractures) by gender, age group and total, 2013-2022*

		Number of Fractures				
		Women		Men		Total
Year	All Fractures	50-69 years	70+ years	50-69 years	70+ years	All Fractures
2013	New Fractures	41,656	53,647	20,969	19,444	135,716
	Re-fractures	1,736	3,999	1,502	1,360	8,596
	Total all Fractures (2013)	**43,392**	**57,645**	**22,471**	**20,804**	**144,312**
2014	New Fractures	42,477	55,221	21,343	20,139	139,179
	Re-fractures	1,737	3,914	1,618	1,427	8,695
	Total all Fractures (2014)	**44,214**	**59,134**	**22,961**	**21,566**	**147,875**
2015	New Fractures	43,218	56,998	21,675	20,936	142,828
	Re-fractures	1,759	3,973	1,666	1,458	8,856
	Total all Fractures (2015)	**44,977**	**60,972**	**23,341**	**22,394**	**151,684**
2016	New Fractures	43,891	58,856	21,967	21,794	146,507
	Re-fractures	1,798	4,130	1,701	1,533	9,163
	Total all Fractures (2016)	**45,689**	**62,986**	**23,669**	**23,327**	**155,670**
2017	New Fractures	44,229	61,586	22,111	22,980	150,906
	Re-fractures	1,826	4,264	1,725	1,596	9,411
	Total all Fractures (2017)	**46,055**	**65,850**	**23,837**	**24,576**	**160,317**
2018	New Fractures	44,719	63,925	22,331	24,012	154,987
	Re-fractures	1,840	4,460	1,738	1,682	9,720
	Total all Fractures (2018)	**46,559**	**68,384**	**24,069**	**25,694**	**164,707**
2019	New Fractures	45,318	66,200	22,612	24,981	159,110
	Re-fractures	1,861	4,630	1,755	1,758	10,004
	Total all Fractures (2019)	**47,178**	**70,830**	**24,367**	**26,738**	**169,114**
2020	New Fractures	45,887	68,623	22,893	25,989	163,393
	Re-fractures	1,885	4,796	1,777	1,829	10,287
	Total all Fractures (2020)	**47,773**	**73,419**	**24,670**	**27,818**	**173,679**
2021	New Fractures	46,610	71,033	23,238	26,977	167,857
	Re-fractures	1,909	4,971	1,799	1,903	10,582
	Total all Fractures (2021)	**48,519**	**76,004**	**25,036**	**28,880**	**178,439**
2022	New Fractures	47,282	73,422	23,559	27,957	172,219
	Re-fractures	1,939	5,146	1,825	1,975	10,885
	Total all Fractures (2022)	**49,221**	**78,568**	**25,384**	**29,932**	**183,105**

[13] Re-fractures were not included in the 2012 annual burden but have been carried forward from the 2012 fracture cohort and new fractures added each year.

Table 40: Annual total cost of all fractures (direct and indirect costs) by gender, age group and total, 2013-2022 (2012$)

Year	All Fractures	Total Cost of All Fractures (2012$) Women 50-69 years	Women 70+ years	Men 50-69 years	Men 70+ years	Total All Fractures ($)
2013	Total Direct Costs	359,903,383	937,397,550	177,507,592	334,838,040	1,809,646,565
	Total Indirect Costs	29,782,804	90,514,219	15,018,851	34,409,801	169,725,676
	Total Cost – All Fractures	**389,686,188**	**1,027,911,769**	**192,526,443**	**369,247,841**	**1,979,372,241**
2014	Total Direct Costs	366,729,314	961,442,779	181,312,301	347,114,460	1,856,598,854
	Total Indirect Costs	30,346,755	92,852,130	15,336,052	35,672,245	174,207,182
	Total Cost – All Fractures	**397,076,068**	**1,054,294,909**	**196,648,353**	**382,786,704**	**2,030,806,035**
2015	Total Direct Costs	373,061,650	991,201,577	184,268,254	360,416,646	1,908,948,128
	Total Indirect Costs	30,870,506	95,731,785	15,584,174	37,040,684	179,227,149
	Total Cost – All Fractures	**403,932,156**	**1,086,933,362**	**199,852,428**	**397,457,330**	**2,088,175,277**
2016	Total Direct Costs	378,961,822	1,023,920,579	186,848,610	375,419,322	1,965,150,334
	Total Indirect Costs	31,358,781	98,892,072	15,801,995	38,582,610	184,635,458
	Total Cost – All Fractures	**410,320,603**	**1,122,812,652**	**202,650,605**	**414,001,932**	**2,149,785,792**
2017	Total Direct Costs	381,999,270	1,070,418,837	188,174,359	395,509,799	2,036,102,265
	Total Indirect Costs	31,610,291	103,386,941	15,914,159	40,647,953	191,559,345
	Total Cost – All Fractures	**413,609,561**	**1,173,805,778**	**204,088,519**	**436,157,752**	**2,227,661,609**
2018	Total Direct Costs	386,184,208	1,111,659,170	190,007,683	413,513,184	2,101,364,245
	Total Indirect Costs	31,956,518	107,367,688	16,069,033	42,497,740	197,890,978
	Total Cost – All Fractures	**418,140,726**	**1,219,026,858**	**206,076,716**	**456,010,924**	**2,299,255,223**
2019	Total Direct Costs	391,317,058	1,151,436,929	192,358,204	430,325,056	2,165,437,247
	Total Indirect Costs	32,381,205	111,208,739	16,267,737	44,225,331	204,083,012
	Total Cost – All Fractures	**423,698,263**	**1,262,645,669**	**208,625,940**	**474,550,387**	**2,369,520,260**
2020	Total Direct Costs	396,249,829	1,193,507,459	194,747,172	447,696,583	2,232,201,043
	Total Indirect Costs	32,789,408	115,272,373	16,469,795	46,010,672	210,542,247
	Total Cost – All Fractures	**429,039,236**	**1,308,779,832**	**211,216,967**	**493,707,255**	**2,442,743,291**
2021	Total Direct Costs	402,440,903	1,235,533,008	197,640,391	464,783,876	2,300,398,178
	Total Indirect Costs	33,301,644	119,330,849	16,714,409	47,766,657	217,113,559
	Total Cost – All Fractures	**435,742,547**	**1,354,863,857**	**214,354,800**	**512,550,533**	**2,517,511,737**
2022	Total Direct Costs	408,263,423	1,277,227,849	200,382,437	481,723,338	2,367,597,047
	Total Indirect Costs	33,783,484	123,357,333	16,946,357	49,507,478	223,594,652
	Total Cost – All Fractures	**442,046,907**	**1,400,585,182**	**217,328,794**	**531,230,816**	**2,591,191,699**

Hip fractures

Table 41 shows the annual predicted number of hip fractures by age group and gender. By 2022 there are expected to be 32,413 hip fractures in that year attributable to osteoporosis and osteopenia. This represents a percentage increase of 35% over the period 2013 to 2022. Sixty three per cent of hip fractures are likely to occur in women aged over 70 years (n=20,535), and each year the number of hip fractures in this group is likely to increase by an average of 3.3% in women and 3.6% in men aged 70 years and over.

The total annual cost of hip fractures is likely to increase by 36% from $829 million in 2013 to $1.27 billion in 2022 (Table 42). Women aged 70 years and over represent approximately 66% of the total annual cost of hip fractures. Eight per cent of the total annual cost is indirect costs due to lost productivity. Younger men aged 50-69 years represent only 4% of the total annual cost of hip fractures.

Table 41: Annual number of hip fractures (new fracture and re-fractures) by gender, age group and total, 2013-2022

		Number of Fractures				
		Women		Men		Total
Year	Hip Fractures	50-69 years	70+ years	50-69 years	70+ years	Hip Fractures
2013	New Fractures	1,576	13,999	1,253	5,491	22,319
	Re-fractures	77	1,084	107	404	1,671
	Total Hip Fractures (2013)	**1,653**	**15,082**	**1,360**	**5,895**	**23,990**
2014	New Fractures	1,608	14,418	1,276	5,690	22,991
	Re-fractures	75	1,045	110	420	1,649
	Total Hip Fractures (2014)	**1,683**	**15,462**	**1,385**	**6,110**	**24,640**
2015	New Fractures	1,636	14,881	1,296	5,915	23,729
	Re-fractures	75	1,056	110	427	1,668
	Total Hip Fractures (2015)	**1,711**	**15,937**	**1,406**	**6,342**	**25,396**
2016	New Fractures	1,662	15,366	1,313	6,157	24,499
	Re-fractures	77	1,097	112	449	1,734
	Total Hip Fractures (2016)	**1,738**	**16,463**	**1,425**	**6,606**	**26,232**
2017	New Fractures	1,675	16,076	1,322	6,492	25,565
	Re-fractures	78	1,132	113	467	1,790
	Total Hip Fractures (2017)	**1,753**	**17,208**	**1,435**	**6,959**	**27,355**
2018	New Fractures	1,693	16,688	1,335	6,784	26,500
	Re-fractures	78	1,184	114	492	1,869
	Total Hip Fractures (2018)	**1,772**	**17,873**	**1,449**	**7,276**	**28,370**
2019	New Fractures	1,716	17,283	1,352	7,058	27,408
	Re-fractures	79	1,230	115	515	1,939
	Total Hip Fractures (2019)	**1,795**	**18,513**	**1,467**	**7,572**	**29,347**
2020	New Fractures	1,738	17,915	1,369	7,343	28,364
	Re-fractures	80	1,273	117	535	2,006
	Total Hip Fractures (2020)	**1,818**	**19,189**	**1,485**	**7,878**	**30,370**
2021	New Fractures	1,765	18,545	1,389	7,622	29,320
	Re-fractures	81	1,320	118	557	2,076
	Total Hip Fractures (2021)	**1,846**	**19,865**	**1,507**	**8,179**	**31,397**
2022	New Fractures	1,790	19,169	1,408	7,899	30,266
	Re-fractures	83	1,366	120	578	2,147
	Total Hip Fractures (2022)	**1,873**	**20,535**	**1,528**	**8,477**	**32,413**

Table 42: Annual total cost of hip fractures (direct and indirect costs) by gender, age group and total, 2013-2022 (2012$)

		Total Cost of Hip Fractures (2012$)				
		Women		Men		Total
Year	Hip Fractures	50-69 years	70+ years	50-69 years	70+ years	All Hip Fractures ($)
2013	Total Direct Costs	38,472,038	506,399,138	31,600,960	186,062,848	762,534,983
	Total Indirect Costs	3,874,950	42,570,732	3,329,144	17,080,960	66,855,786
	Total Hip Fracture Cost	**42,346,989**	**548,969,870**	**34,930,103**	**203,143,807**	**829,390,770**
2014	Total Direct Costs	39,167,734	519,158,793	32,197,484	192,841,337	783,365,348
	Total Indirect Costs	3,945,022	43,643,380	3,391,987	17,703,239	68,683,628
	Total Hip Fracture Cost	**43,112,756**	**562,802,173**	**35,589,471**	**210,544,577**	**852,048,976**
2015	Total Direct Costs	39,833,332	535,101,875	32,674,160	200,174,544	807,783,912
	Total Indirect Costs	4,012,062	44,983,644	3,442,205	18,376,443	70,814,354
	Total Hip Fracture Cost	**43,845,394**	**580,085,519**	**36,116,365**	**218,550,988**	878,598,266
2016	Total Direct Costs	40,464,947	552,752,685	33,120,964	208,503,727	834,842,323
	Total Indirect Costs	4,075,678	46,467,470	3,489,275	19,141,080	73,173,503
	Total Hip Fracture Cost	**44,540,625**	**599,220,154**	**36,610,240**	**227,644,807**	908,015,826
2017	Total Direct Costs	40,795,980	577,780,709	33,356,287	219,637,854	871,570,831
	Total Indirect Costs	4,109,021	48,571,465	3,514,066	20,163,216	76,357,768
	Total Hip Fracture Cost	**44,905,001**	**626,352,174**	**36,870,354**	**239,801,070**	947,928,598
2018	Total Direct Costs	41,239,845	600,085,862	33,677,593	229,654,832	904,658,131
	Total Indirect Costs	4,153,727	50,446,560	3,547,916	21,082,796	79,230,999
	Total Hip Fracture Cost	**45,393,572**	**650,532,422**	**37,225,509**	**250,737,628**	**983,889,130**
2019	Total Direct Costs	41,785,811	621,574,104	34,092,435	238,999,840	936,452,190
	Total Indirect Costs	4,208,718	52,252,981	3,591,619	21,940,687	81,994,005
	Total Hip Fracture Cost	**45,994,529**	**673,827,085**	**37,684,055**	**260,940,527**	**1,018,446,195**
2020	Total Direct Costs	42,313,315	644,278,294	34,516,310	248,646,447	969,754,366
	Total Indirect Costs	4,261,848	54,161,622	3,636,274	22,826,266	84,886,010
	Total Hip Fracture Cost	**46,575,163**	**698,439,916**	**38,152,584**	**271,472,713**	**1,054,640,376**
2021	Total Direct Costs	42,971,547	666,973,024	35,027,792	258,140,918	1,003,113,281
	Total Indirect Costs	4,328,146	56,069,467	3,690,159	23,697,878	87,785,650
	Total Hip Fracture Cost	**47,299,694**	**723,042,491**	**38,717,951**	**281,838,796**	**1,090,898,931**
2022	Total Direct Costs	43,594,503	689,490,426	35,514,872	267,552,158	1,036,151,960
	Total Indirect Costs	4,390,891	57,962,406	3,741,472	24,561,850	90,656,619
	Total Hip Fracture Cost	**47,985,394**	**747,452,832**	**39,256,344**	**292,114,008**	**1,126,808,578**

Wrist fractures

Table 43 shows the predicted annual number of wrist fractures by gender and age group from 2013 to 2022. The total increase from 2013 to 2022 was predicted to be 26%, with an average annual increase of 2.6% in women and 2.8% in men. Women aged 70 years and over are predicted to represent approximately 50% of all wrist fractures attributable to osteoporosis and osteopenia in 2022.

The annual total cost of wrist fractures is predicted to increase from $130 million to $160 million in 2022 in AUD 2012 (Table 44). Women in both age groups represent 58% of the total cost and this is predicted to be relatively constant over the 10 year period (2012 to 2022).

***Table 43:** Annual number of wrist fractures (new fractures and re-fractures) by gender, age group and total, 2013-2022*

		Number of Fractures				
		Women		Men		Total
Year	Wrist Fractures	50-69 years	70+ years	50-69 years	70+ years	Wrist Fractures
2013	New Fractures	8,136	8,703	1,091	1,076	19,006
	Re-fractures	317	571	74	66	1,029
	Total Wrist Fractures (2013)	**8,453**	**9,274**	**1,165**	**1,142**	**20,034**
2014	New Fractures	8,294	8,950	1,111	1,114	19,468
	Re-fractures	323	585	81	72	1,063
	Total Wrist Fractures (2014)	**8,617**	**9,536**	**1,192**	**1,186**	**20,531**
2015	New Fractures	8,438	9,239	1,128	1,158	19,962
	Re-fractures	328	598	84	75	1,086
	Total Wrist Fractures (2015)	**8,766**	**9,837**	**1,212**	**1,232**	**21,048**
2016	New Fractures	8,569	9,540	1,143	1,205	20,457
	Re-fractures	336	622	86	79	1,122
	Total Wrist Fractures (2016)	**8,905**	**10,162**	**1,229**	**1,284**	**21,580**
2017	New Fractures	8,635	9,985	1,151	1,271	21,041
	Re-fractures	341	642	87	82	1,152
	Total Wrist Fractures (2017)	**8,976**	**10,628**	**1,238**	**1,353**	**22,194**
2018	New Fractures	8,731	10,363	1,162	1,328	21,584
	Re-fractures	344	671	88	86	1,189
	Total Wrist Fractures (2018)	**9,074**	**11,034**	**1,250**	**1,414**	**22,773**
2019	New Fractures	8,848	10,731	1,177	1,381	22,137
	Re-fractures	347	697	89	90	1,224
	Total Wrist Fractures (2019)	**9,195**	**11,428**	**1,266**	**1,471**	**23,360**
2020	New Fractures	8,959	11,124	1,191	1,437	22,711
	Re-fractures	352	722	90	94	1,258
	Total Wrist Fractures (2020)	**9,311**	**11,846**	**1,281**	**1,531**	**23,969**
2021	New Fractures	9,100	11,514	1,209	1,492	23,315
	Re-fractures	356	749	91	97	1,294
	Total Wrist Fractures (2021)	**9,457**	**12,263**	**1,300**	**1,589**	**24,609**
2022	New Fractures	9,231	11,901	1,226	1,546	23,904
	Re-fractures	362	775	92	101	1,331
	Total Wrist Fractures (2022)	**9,593**	**12,676**	**1,318**	**1,647**	**25,235**

Table 44: Annual total cost of wrist fractures (direct and indirect costs) by gender, age group and total, 2013-2022 (2012$)

		Total Cost of Wrist Fractures (2012$)				
		Women		Men		Total
Year	Wrist Fractures	50-69 years	70+ years	50-69 years	70+ years	All Wrist Fractures ($)
2013	Total Direct Costs	44,703,582	65,696,378	5,110,857	5,878,103	121,388,920
	Total Indirect Costs	3,177,410	4,913,180	379,641	480,144	8,950,375
	Total Wrist Fracture Cost	**47,880,992**	**70,609,558**	**5,490,499**	**6,358,247**	**130,339,295**
2014	Total Direct Costs	45,570,673	67,548,372	5,228,016	6,104,964	124,452,025
	Total Indirect Costs	3,239,041	5,051,683	388,344	498,674	9,177,742
	Total Wrist Fracture Cost	**48,809,714**	**72,600,055**	**5,616,360**	**6,603,638**	**133,629,767**
2015	Total Direct Costs	46,361,134	69,683,313	5,316,165	6,342,845	127,703,456
	Total Indirect Costs	3,295,224	5,211,347	394,892	518,105	9,419,569
	Total Wrist Fracture Cost	**49,656,358**	**74,894,660**	**5,711,056**	**6,860,951**	**137,123,025**
2016	Total Direct Costs	47,093,574	71,985,053	5,391,230	6,607,012	131,076,869
	Total Indirect Costs	3,347,284	5,383,486	400,468	539,683	9,670,921
	Total Wrist Fracture Cost	**50,440,858**	**77,368,539**	**5,791,698**	**7,146,695**	**140,747,790**
2017	Total Direct Costs	47,468,258	75,283,627	5,429,408	6,962,048	135,143,341
	Total Indirect Costs	3,373,916	5,630,173	403,304	568,684	9,976,077
	Total Wrist Fracture Cost	**50,842,174**	**80,913,800**	**5,832,712**	**7,530,732**	**145,119,418**
2018	Total Direct Costs	47,989,592	78,165,679	5,482,578	7,277,790	138,915,639
	Total Indirect Costs	3,410,971	5,845,711	407,253	594,475	10,258,410
	Total Wrist Fracture Cost	**51,400,563**	**84,011,390**	**5,889,831**	**7,872,265**	**149,174,049**
2019	Total Direct Costs	48,628,304	80,956,668	5,550,526	7,573,193	142,708,691
	Total Indirect Costs	3,456,369	6,054,438	412,300	618,604	10,541,712
	Total Wrist Fracture Cost	**52,084,673**	**87,011,106**	**5,962,826**	**8,191,797**	**153,250,403**
2020	Total Direct Costs	49,240,964	83,917,247	5,619,424	7,878,994	146,656,629
	Total Indirect Costs	3,499,915	6,275,849	417,418	643,583	10,836,765
	Total Wrist Fracture Cost	**52,740,879**	**90,193,096**	**6,036,842**	**8,522,577**	**157,493,394**
2021	Total Direct Costs	50,011,510	86,868,611	5,703,012	8,179,444	150,762,577
	Total Indirect Costs	3,554,683	6,496,570	423,627	668,125	11,143,006
	Total Wrist Fracture Cost	**53,566,194**	**93,365,180**	**6,126,639**	**8,847,570**	**161,905,583**
2022	Total Direct Costs	50,734,549	89,796,364	5,782,049	8,477,365	154,790,327
	Total Indirect Costs	3,606,075	6,715,525	429,498	692,460	11,443,559
	Total Wrist Fracture Cost	**54,340,624**	**96,511,889**	**6,211,547**	**9,169,825**	**166,233,886**

Vertebral fractures

Table 45 shows the predicted number of vertebral fractures in men and women aged 50 years and over from 2013 to 2022. By 2022 there are predicted to be 35,044 vertebral fractures, representing an average annual increase in vertebral fractures of 2.8% in women and 3.1% in men over the same period. Women aged 70 years and over represent the largest single population group with 19,147 vertebral fractures predicted by 2022, which is 55% of the total number of vertebral fractures. Overall 77% of all vertebral fractures will occur in women aged 50 years and over by 2022.

The total annual costs of vertebral fractures are shown in Table 46. The costs of vertebral fractures are predicted to increase by 30% to $295 million between 2013 and 2022. The annual increase in costs is likely to be 31% for women and 39% for men aged 50 years and over, for the next 10 years from 2013 to 2022. Vertebral fractures in women aged 50 years and over are likely to be almost $240 million by 2022, 81% of the total costs attributable to vertebral fractures.

Table 45: Annual number of vertebral fractures (new fractures and re-fractures) by gender, age group and total, 2013-2022

		Number of Fractures				
		Women		Men		Total
Year	Vertebral Fractures	50-69 years	70+ years	50-69 years	70+ years	Vertebral Fractures
2013	New Fractures	6,443	12,946	2,242	3,503	25,134
	Re-fractures	349	1,158	212	302	2,021
	Total Vertebral Fractures (2013)	**6,792**	**14,104**	**2,455**	**3,805**	**27,155**
2014	New Fractures	6,579	13,343	2,284	3,631	25,836
	Re-fractures	327	1,077	208	306	1,917
	Total Vertebral Fractures (2014)	**6,905**	**14,420**	**2,492**	**3,937**	**27,754**
2015	New Fractures	6,694	13,772	2,320	3,774	26,561
	Re-fractures	328	1,087	209	311	1,935
	Total Vertebral Fractures (2015)	**7,022**	**14,859**	**2,529**	**4,086**	**28,496**
2016	New Fractures	6,799	14,221	2,351	3,929	27,299
	Re-fractures	335	1,130	212	327	2,005
	Total Vertebral Fractures (2016)	**7,134**	**15,351**	**2,564**	**4,256**	**29,304**
2017	New Fractures	6,853	14,874	2,367	4,142	28,236
	Re-fractures	340	1,167	215	341	2,063
	Total Vertebral Fractures (2017)	**7,193**	**16,041**	**2,582**	**4,482**	**30,298**
2018	New Fractures	6,928	15,442	2,390	4,328	29,089
	Re-fractures	343	1,221	216	359	2,140
	Total Vertebral Fractures (2018)	**7,271**	**16,663**	**2,607**	**4,688**	**31,229**
2019	New Fractures	7,020	15,993	2,420	4,503	29,937
	Re-fractures	347	1,267	218	375	2,208
	Total Vertebral Fractures (2019)	**7,367**	**17,261**	**2,639**	**4,879**	**32,145**
2020	New Fractures	7,109	16,578	2,450	4,685	30,823
	Re-fractures	351	1,312	221	390	2,276
	Total Vertebral Fractures (2020)	**7,460**	**17,891**	**2,672**	**5,076**	**33,098**
2021	New Fractures	7,220	17,161	2,487	4,863	31,732
	Re-fractures	356	1,360	224	406	2,346
	Total Vertebral Fractures (2021)	**7,576**	**18,522**	**2,711**	**5,270**	**34,078**
2022	New Fractures	7,324	17,739	2,522	5,040	32,625
	Re-fractures	362	1,408	227	422	2,419
	Total Vertebral Fractures (2022)	**7,686**	**19,147**	**2,749**	**5,462**	**35,044**

Table 46: Annual total cost of vertebral fractures (direct and indirect costs) by gender, age group and total, 2013-2022 (2012$)

		Total Cost of Vertebral Fractures (2012$)				
		Women		Men		Total
Year	Vertebral Fractures	50-69 years	70+ years	50-69 years	70+ years	All Vertebral Fractures ($)
2013	Total Direct Costs	38,383,939	129,413,073	17,439,693	21,420,323	206,657,029
	Total Indirect Costs	3,177,329	12,290,817	1,739,876	2,474,508	19,682,531
	Total Vertebral Fracture Cost	**41,561,268**	**141,703,891**	**19,179,570**	**23,894,832**	**226,339,560**
2014	Total Direct Costs	39,024,056	132,315,238	17,703,276	22,163,395	211,205,966
	Total Indirect Costs	3,230,316	12,566,446	1,766,173	2,560,349	20,123,285
	Total Vertebral Fracture Cost	**42,254,373**	**144,881,684**	**19,469,449**	**24,723,744**	**231,329,250**
2015	Total Direct Costs	39,685,847	136,345,660	17,966,920	23,000,103	216,998,530
	Total Indirect Costs	3,285,098	12,949,230	1,792,475	2,657,007	20,683,810
	Total Vertebral Fracture Cost	**42,970,944**	**149,294,890**	**19,759,395**	**25,657,110**	**237,682,339**
2016	Total Direct Costs	40,316,951	140,853,778	18,213,668	23,960,590	223,344,987
	Total Indirect Costs	3,337,339	13,377,382	1,817,092	2,767,964	21,299,777
	Total Vertebral Fracture Cost	**43,654,291**	**154,231,160**	**20,030,760**	**26,728,554**	**244,644,764**
2017	Total Direct Costs	40,651,112	147,187,261	18,344,474	25,234,502	231,417,349
	Total Indirect Costs	3,365,000	13,978,895	1,830,142	2,915,128	22,089,165
	Total Vertebral Fracture Cost	**44,016,112**	**161,166,156**	**20,174,616**	**28,149,630**	**253,506,515**
2018	Total Direct Costs	41,091,241	152,898,201	18,520,016	26,389,839	238,899,298
	Total Indirect Costs	3,401,433	14,521,283	1,847,655	3,048,594	22,818,965
	Total Vertebral Fracture Cost	**44,492,674**	**167,419,484**	**20,367,671**	**29,438,433**	**261,718,263**
2019	Total Direct Costs	41,633,986	158,381,062	18,747,735	27,465,490	246,228,273
	Total Indirect Costs	3,446,360	15,042,010	1,870,373	3,172,855	23,531,599
	Total Vertebral Fracture Cost	**45,080,346**	**173,423,072**	**20,618,108**	**30,638,346**	**269,759,871**
2020	Total Direct Costs	42,160,120	164,162,284	18,981,011	28,573,879	253,877,294
	Total Indirect Costs	3,489,912	15,591,073	1,893,646	3,300,898	24,275,529
	Total Vertebral Fracture Cost	**45,650,032**	**179,753,357**	**20,874,657**	**31,874,777**	**278,152,824**
2021	Total Direct Costs	42,814,083	169,950,440	19,261,674	29,666,104	261,692,301
	Total Indirect Costs	3,544,046	16,140,795	1,921,647	3,427,073	25,033,560
	Total Vertebral Fracture Cost	**46,358,129**	**186,091,234**	**21,183,320**	**33,093,177**	**286,725,861**
2022	Total Direct Costs	43,435,643	175,693,573	19,529,958	30,748,436	269,407,610
	Total Indirect Costs	3,595,497	16,686,240	1,948,412	3,552,106	25,782,255
	Total Vertebral Fracture Cost	**47,031,140**	**192,379,813**	**21,478,370**	**34,300,543**	**295,189,865**

'Other' fractures

Table 47 shows the annual trend in 'other' fractures likely to be attributable to osteoporosis or osteopenia. The number of 'other' fractures is predicted to increase to 90,413 by 2022 (an increase of 24% from 2013). These 'other' fractures represent almost 50% of the fracture burden associated with these conditions. Although women experience the largest number (n=56,000), 'other' fractures in men aged 50-69 years are predicted to represent 22% by 2022. The predicted average annual growth rate in these fractures is 2.4% in women and 2.5% in men.

Table 48 shows the total cost of this low trauma fracture group likely to be attributable to osteoporosis/osteopenia. Although 'other' fractures represent almost 50% of all fracture numbers, they represent just 39% of the total costs of all fractures. From 2013 to 2022 the number of these fractures is predicted to increase by 36%, with the cost increasing to just over $1 billion. Most of these fractures occur in women in both age groups (65% of the total).

Table 47: Annual number of 'other' fractures (new fractures and re-fractures) by gender, age group and total, 2013-2022

		Number of Fractures				
		Women		Men		Total
Year	Other Fractures	50-69 years	70+ years	50-69 years	70+ years	Other Fractures
2013	New Fractures	25,502	17,999	16,383	9,374	69,258
	Re-fractures	993	1,186	1,109	587	3,875
	Total Other Fractures (2013)	**26,495**	**19,185**	**17,491**	**9,961**	**73,133**
2014	New Fractures	25,997	18,510	16,672	9,705	70,884
	Re-fractures	1,012	1,207	1,220	628	4,067
	Total Other Fractures (2014)	**27,009**	**19,716**	**17,892**	**10,333**	**74,950**
2015	New Fractures	26,450	19,106	16,931	10,089	72,577
	Re-fractures	1,027	1,232	1,263	645	4,167
	Total Other Fractures (2015)	**27,477**	**20,339**	**18,194**	**10,734**	**76,744**
2016	New Fractures	26,861	19,729	17,160	10,502	74,252
	Re-fractures	1,050	1,281	1,291	679	4,301
	Total Other Fractures (2016)	**27,911**	**21,010**	**18,451**	**11,181**	**78,553**
2017	New Fractures	27,066	20,650	17,272	11,076	76,064
	Re-fractures	1,067	1,323	1,310	706	4,406
	Total Other Fractures (2017)	**28,133**	**21,973**	**18,582**	**11,782**	**80,470**
2018	New Fractures	27,367	21,432	17,444	11,572	77,814
	Re-fractures	1,076	1,383	1,320	744	4,522
	Total Other Fractures (2018)	**28,442**	**22,814**	**18,764**	**12,316**	**82,336**
2019	New Fractures	27,734	22,193	17,663	12,038	79,628
	Re-fractures	1,087	1,436	1,333	778	4,634
	Total Other Fractures (2019)	**28,821**	**23,629**	**18,996**	**12,816**	**84,262**
2020	New Fractures	28,082	23,006	17,883	12,524	81,495
	Re-fractures	1,102	1,487	1,349	810	4,747
	Total Other Fractures (2020)	**29,184**	**24,493**	**19,232**	**13,334**	**86,242**
2021	New Fractures	28,525	23,813	18,152	13,000	83,490
	Re-fractures	1,116	1,542	1,366	842	4,865
	Total Other Fractures (2021)	**29,641**	**25,354**	**19,518**	**13,842**	**88,355**
2022	New Fractures	28,936	24,613	18,403	13,472	85,423
	Re-fractures	1,133	1,596	1,386	874	4,989
	Total Other Fractures (2022)	**30,069**	**26,209**	**19,788**	**14,346**	**90,413**

Table 48: Annual total cost of 'other' fractures (direct and indirect costs) by gender, age group and total, 2013-2022 (2012$)

		Total Cost of Other Fractures (2012$)				
		Women		Men		Total
Year	Other Fractures	50-69 years	70+ years	50-69 years	70+ years	All Other Fractures ($)
2013	Total Direct Costs	238,343,824	235,888,961	123,356,081	121,476,766	719,065,632
	Total Indirect Costs	19,553,115	30,739,490	9,570,190	14,374,190	74,236,984
	Total Other Fracture Cost	**257,896,939**	**266,628,450**	**132,926,271**	**135,850,956**	**793,302,616**
2014	Total Direct Costs	242,966,849	242,420,376	126,183,526	126,004,764	737,575,515
	Total Indirect Costs	19,932,376	31,590,621	9,789,548	14,909,982	76,222,526
	Total Other Fracture Cost	**262,899,225**	**274,010,997**	**135,973,074**	**140,914,746**	**813,798,041**
2015	Total Direct Costs	247,181,338	250,070,729	128,311,010	130,899,154	756,462,230
	Total Indirect Costs	20,278,122	32,587,564	9,954,602	15,489,129	78,309,417
	Total Other Fracture Cost	**267,459,460**	**282,658,293**	**138,265,612**	**146,388,282**	**834,771,646**
2016	Total Direct Costs	251,086,351	258,329,063	130,122,748	136,347,993	775,886,155
	Total Indirect Costs	20,598,479	33,663,736	10,095,160	16,133,883	80,491,257
	Total Other Fracture Cost	**271,684,830**	**291,992,799**	**140,217,908**	**152,481,876**	**856,377,412**
2017	Total Direct Costs	253,083,919	270,167,240	131,044,189	143,675,395	797,970,743
	Total Indirect Costs	20,762,354	35,206,408	10,166,647	17,000,925	83,136,335
	Total Other Fracture Cost	**273,846,273**	**305,373,648**	**141,210,837**	**160,676,320**	**881,107,078**
2018	Total Direct Costs	255,863,530	280,509,428	132,327,496	150,190,723	818,891,177
	Total Indirect Costs	20,990,387	36,554,134	10,266,209	17,771,875	85,582,604
	Total Other Fracture Cost	**276,853,917**	**317,063,562**	**142,593,705**	**167,962,598**	**904,473,781**
2019	Total Direct Costs	259,268,957	290,525,096	133,967,507	156,286,533	840,048,093
	Total Indirect Costs	21,269,759	37,859,310	10,393,444	18,493,184	88,015,697
	Total Other Fracture Cost	**280,538,716**	**328,384,406**	**144,360,951**	**174,779,717**	**928,063,790**
2020	Total Direct Costs	262,535,430	301,149,634	135,630,428	162,597,262	861,912,754
	Total Indirect Costs	21,537,732	39,243,829	10,522,456	19,239,925	90,543,942
	Total Other Fracture Cost	**284,073,162**	**340,393,463**	**146,152,884**	**181,837,187**	**952,456,696**
2021	Total Direct Costs	266,643,762	311,740,934	137,647,914	168,797,410	884,830,019
	Total Indirect Costs	21,874,769	40,624,017	10,678,976	19,973,580	93,151,343
	Total Other Fracture Cost	**288,518,531**	**352,364,951**	**148,326,890**	**188,770,990**	**977,981,362**
2022	Total Direct Costs	270,498,729	322,247,485	139,555,558	174,945,379	907,247,150
	Total Indirect Costs	22,191,021	41,993,162	10,826,975	20,701,062	95,712,219
	Total Other Fracture Cost	**292,689,749**	**364,240,647**	**150,382,533**	**195,646,440**	**1,002,959,369**

Community Service Costs for Osteoporosis and Osteopenia

The projected total cost for community services in the Australian population aged 50 years and over with osteoporosis or osteopenia is almost $1.25 billion which represents 35% of the total direct costs of osteoporosis and osteopenia in 2022 (Table 49). The total cost of routine pathology and general practitioner attendance represent over half the total cost of community services. The growth in osteoporosis medication is likely to increase by 50% to $275 million by 2022 based on the assumptions made in this model. The costs of DXA and vitamin D tests are 34% and 23% respectively of the total cost by 2022. Ongoing residential care costs following a fracture have been included for the 2012 cohort assumed to go into residential care as a result of the fracture, and following subsequent fractures that occur over the 10 year period of the model.

Table 50 provides an annual summary of all costs attributed to osteoporosis, osteopenia and fractures over the period 2012 to 2022. The results of the 2012 annual burden of disease model are included in Table 50 for comparability. In the 2012 model re-fractures were not included, and only residential care for the fracture population in the year that the fracture occurred was included. All other cost categories can be compared between 2012 and 2022. The total costs are predicted to increase by 30% to $3.62 billion by 2022, or (with residential care and re-fractures included) to $3.84 billion (in 2012$). The direct costs of treating first fractures are predicted to increase to $2.221 billion by 2022, and for treating re-fractures the cost is to reach almost $150 million. Table 51 provides an annual summary of total direct and indirect costs inflated to future dollars using an inflation rate of 3.4%. For the 2012 comparison, the total direct and indirect costs ranged from $2.7 billion (in 2012$) to almost $5 billion (in 2022$). The cost increases to $5.4 billion (in 2022$) with the inclusion of re-fractures and residential care.

Figure 4 shows the increase in direct and total (direct and indirect) costs from 2012 to 2022 with re-fracture costs and residential care included.

Figure 4: Annual change in direct and total costs, 2013 to 2022, 2012$ ($millions)

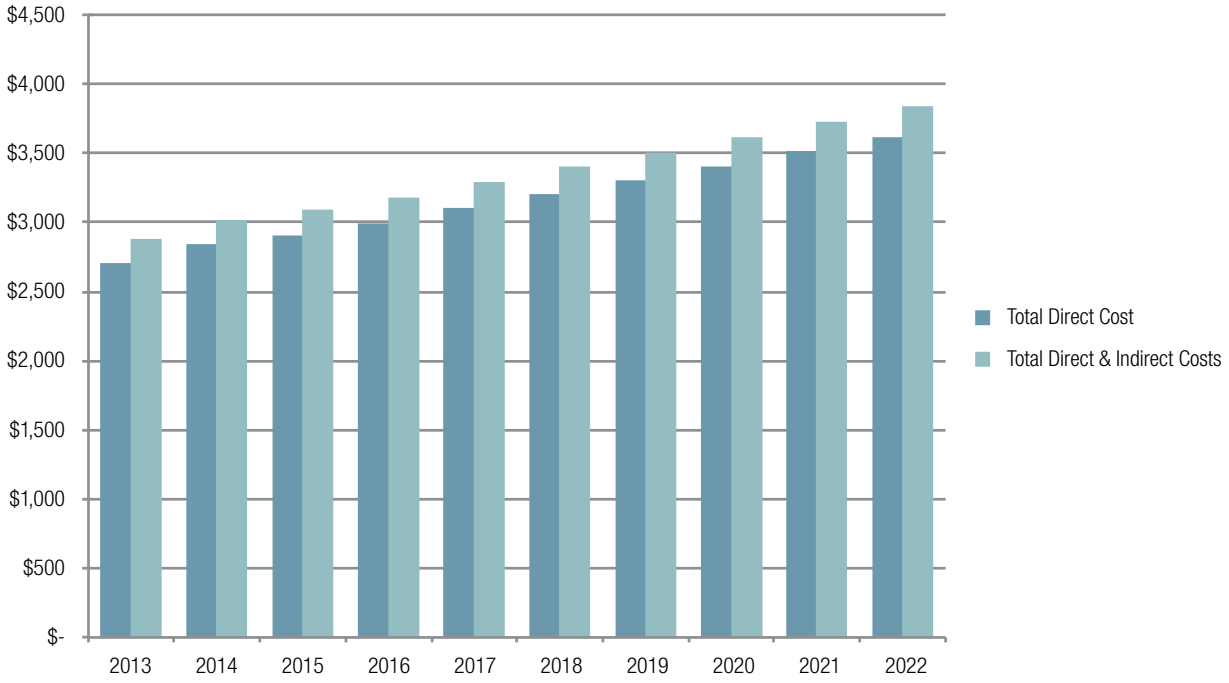


Table 49: Total annual costs of community services for osteoporosis and osteopenia (irrespective of fracture), 2013-2022 (2012$)

Community Health Care Service	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Bisphosphonates	186,673,169	216,894,065	226,507,293	232,543,973	239,652,306	246,561,307	253,384,682	260,432,993	267,744,136	274,991,882
DXA	34,908,103	35,944,475	37,038,573	38,184,173	39,711,593	41,108,895	42,465,875	43,882,791	45,316,095	46,732,225
Vitamin D Test	98,471,790	100,957,180	103,333,781	105,682,261	108,138,986	110,575,259	113,095,626	115,682,944	118,450,187	121,152,981
Routine Pathology Test	137,683,989	141,159,079	144,482,060	147,765,722	151,200,734	154,607,148	158,131,145	161,748,752	165,617,931	169,396,998
Community GP Visits	430,905,494	441,781,383	452,181,217	462,457,997	473,208,450	483,869,403	494,898,352	506,220,269	518,329,524	530,156,759
Nursing Home – previous fracture	13,258,394	25,879,743	37,680,690	48,794,883	59,317,879	69,536,075	79,379,528	88,860,210	98,049,330	106,969,796
All Total Cost	**901,900,939**	**962,615,926**	**1,001,223,615**	**1,035,429,009**	**1,071,229,948**	**1,106,258,086**	**1,141,355,207**	**1,176,827,960**	**1,213,507,202**	**1,249,400,641**

Table 50: Total annual direct and indirect costs for osteoporosis, osteopenia and fractures, 2012-2022 (2012$)

Total Cost (2012$)	2012	2013	2014	2015	2016	2017
Total Direct New Fracture Cost	**$1,759,572,690**	**$1,695,549,074**	**$1,742,267,149**	**$1,792,761,620**	**$1,844,620,850**	**$1,911,960,550**
- Hip fractures	$731,203,094	$709,131,348	$730,749,028	$754,556,645	$779,474,104	$814,371,603
- Wrist fractures	$122,122,418	$114,999,943	$117,864,765	$120,974,834	$124,112,635	$127,986,181
- Vertebral fractures	$194,484,545	$190,851,205	$196,279,042	$201,932,505	$207,730,361	$215,343,382
- Other fractures	$711,762,633	$680,566,577	$697,374,314	$715,297,636	$733,303,750	$754,259,385
Total Direct Non-fracture Costs	**$829,645,097**	**$888,642,545**	**$936,736,182**	**$963,542,925**	**$986,634,126**	**$1,011,912,069**
- Pharmaceuticals – bone health (includes bisphosphonates)	$179,315,417	$186,673,169	$216,894,065	$226,507,293	$232,543,973	$239,652,306
- DXA	$23,625,769	$34,908,103	$35,944,475	$37,038,573	$38,184,173	$39,711,593
- Routine medical and pathology (includes Vitamin D tests)	$626,703,911	$667,061,273	$683,897,642	$699,997,058	$715,905,980	$732,548,170
TOTAL DIRECT COSTS (for 2012 comparison)	**$2,589,217,788**	**$2,584,191,619**	**$2,679,003,331**	**$2,756,304,545**	**$2,831,254,976**	**$2,923,872,619**
Total Direct Re-fracture Cost	-	$114,097,490	$114,331,704	$116,186,508	$120,529,484	$124,141,714
- Hip fractures	-	$53,403,635	$52,616,320	$53,227,267	$55,368,219	$57,199,227
- Wrist fractures	-	$6,388,977	$6,587,259	$6,728,622	$6,964,234	$7,157,161
- Vertebral fractures	-	$15,805,824	$14,926,924	$15,066,025	$15,614,626	$16,073,968
- Other fractures	-	$38,499,055	$40,201,201	$41,164,594	$42,582,405	$43,711,358
Direct Non-fracture Costs (Residential Care only)	-	**$13,258,394**	**$25,879,743**	**$37,680,690**	**$48,794,883**	**$59,317,879**
TOTAL DIRECT COSTS (with re-fractures and residential care)*	-	**$2,711,547,504**	**$2,819,214,779**	**$2,910,171,743**	**$3,000,579,343**	**$3,107,332,212**
Total Indirect Cost (Productivity Loss due to New Fractures)	**$165,173,079**	**$158,974,217**	**$163,418,172**	**$168,259,841**	**$173,250,941**	**$179,826,980**
- Hip fractures	$64,033,917	$62,185,079	$64,074,760	$66,151,942	$68,324,321	$71,349,052
- Wrist fractures	$9,003,419	$8,476,597	$8,689,056	$8,920,338	$9,154,080	$9,444,800
- Vertebral fractures	$18,497,828	$18,163,263	$18,685,641	$19,232,446	$19,794,820	$20,539,305
- Other fractures	$73,637,915	$70,149,277	$71,968,715	$73,955,115	$75,977,720	$78,493,823
TOTAL DIRECT and INDIRECT COST (for 2012 comparison)	**$2,754,390,866**	**$2,743,165,836**	**$2,842,421,504**	**$2,924,564,386**	**$3,004,505,917**	**$3,103,699,599**
Total Indirect Cost (Productivity Loss due to Re-fractures)	-	**$10,751,460**	**$10,789,009**	**$10,967,308**	**$11,384,518**	**$11,732,365**
- Hip fractures	-	$4,670,707	$4,608,868	$4,662,412	$4,849,182	$5,008,715
- Wrist fractures	-	$473,778	$488,687	$499,231	$516,841	$531,277
- Vertebral fractures	-	$1,519,268	$1,437,644	$1,451,363	$1,504,957	$1,549,860
- Other fractures	-	$4,087,707	$4,253,811	$4,354,302	$4,513,537	$4,642,512
TOTAL DIRECT and INDIRECT COST (with re-fractures and residential care)*	-	**$2,881,273,180**	**$2,993,421,961**	**$3,089,398,892**	**$3,185,214,802**	**$3,298,891,557**

** Total direct cost (with re-fracture costs and residential care is not comparable with 2012 costs)*

Table 51: Inflated total annual direct and indirect costs for osteoporosis, osteopenia and fractures, 2012-2022 ($current)

Total Cost ($)	2012	2013	2014	2015	2016	2017
TOTAL DIRECT and INDIRECT COST (for 2012 comparison)	$2,754,390,866	$2,836,433,474	$3,038,992,005	$3,233,127,289	$3,434,434,346	$3,668,448,055
TOTAL DIRECT and INDIRECT COST (with re-fractures and residential care)*	-	$2,979,236,468	$3,200,435,050	$3,415,353,040	$3,641,001,688	$3,899,157,096

** Total direct cost (with re-fracture costs and residential care is not comparable with 2012 costs)*
Inflation rate=3.4% for each year

Table 50: continued

2018	2019	2020	2021	2022
$1,972,422,764	**$2,032,180,554**	**$2,094,729,021**	**$2,158,506,623**	**$2,221,227,955**
$844,874,994	$874,399,801	$905,518,964	$936,576,380	$967,317,819
$131,512,802	$135,078,561	$138,801,413	$142,672,554	$146,459,012
$222,197,826	$228,973,580	$236,079,031	$243,320,412	$250,454,904
$773,837,141	$793,728,612	$814,329,614	$835,937,277	$856,996,220
$1,036,722,011	**$1,061,975,679**	**$1,087,967,749**	**$1,115,457,872**	**$1,142,430,845**
$246,561,307	$253,384,682	$260,432,993	$267,744,136	$274,991,882
$41,108,895	$42,465,875	$43,882,791	$45,316,095	$46,732,225
$749,051,809	$766,125,123	$783,651,965	$802,397,641	$820,706,738
$3,009,144,775	**$3,094,156,233**	**$3,182,696,770**	**$3,273,964,496**	**$3,363,658,800**
$128,941,481	$133,256,694	$137,472,023	$141,891,554	$146,369,092
$59,783,137	$62,052,389	$64,235,403	$66,536,901	$68,834,141
$7,402,837	$7,630,130	$7,855,216	$8,090,023	$8,331,314
$16,701,471	$17,254,693	$17,798,263	$18,371,888	$18,952,706
$45,054,036	$46,319,481	$47,583,140	$48,892,742	$50,250,930
$69,536,075	**$79,379,528**	**$88,860,210**	**$98,049,330**	**$106,969,796**
$3,207,622,331	**$3,306,792,455**	**$3,409,029,002**	**$3,513,905,380**	**$3,616,997,688**
$185,692,556	**$191,466,149**	**$197,517,913**	**$203,662,028**	**$209,711,443**
$73,998,305	$76,564,228	$79,266,519	$81,966,301	$84,637,603
$9,708,660	$9,974,900	$10,253,083	$10,541,718	$10,824,206
$21,207,489	$21,865,903	$22,556,691	$23,258,632	$23,950,655
$80,778,101	$83,061,118	$85,441,621	$87,895,377	$90,298,980
$3,194,837,330	**$3,285,622,382**	**$3,380,214,683**	**$3,477,626,523**	**$3,573,370,243**
$12,198,423	**$12,616,863**	**$13,024,334**	**$13,451,532**	**$13,883,209**
$5,232,694	$5,429,777	$5,619,491	$5,819,350	$6,019,016
$549,750	$566,812	$583,682	$601,288	$619,353
$1,611,476	$1,665,696	$1,718,839	$1,774,928	$1,831,601
$4,804,503	$4,954,579	$5,102,321	$5,255,966	$5,413,239
$3,405,513,309	**$3,510,875,467**	**$3,619,571,250**	**$3,731,018,939**	**$3,840,592,339**

Table 51: continued

2018	2019	2020	2021	2022
$3,904,558,939	$4,152,038,956	$4,416,808,745	$4,698,592,578	$4,992,101,468
$4,162,035,828	$4,436,691,140	$4,729,567,630	$5,040,948,986	$5,365,418,457

Fractures Averted due to Osteoporosis (Bone Active) Pharmaceuticals

Relatively conservative assumptions were made concerning the use of osteoporosis bone active pharmaceuticals in the 2012 population. Yet despite these assumptions, the prediction is that there will be between 13,500 and 17,500 fractures averted annually directly attributable to osteoporosis bone active pharmaceuticals (Table 52). Over the 10 year period the total number of fractures averted is predicted to be 153,400. Women aged 70 years and over are likely to experience the greatest number of averted fractures, from 6,200 in 2013 to 8,670 in 2022.

The annual savings in direct health care costs attributable to averted fractures is predicted to range from $140 million in 2013 to $187 million in 2022 ($2012). Over the 10 year period the total savings is predicted to be $1.6 billion in direct health care costs (Table 52). Just from the hip fractures averted alone the annual savings are predicted to be $61 million ($2012).

Table 52: Number of fractures avoided and associated direct health care cost due to osteoporosis (bone active pharmaceuticals), 2012-2022 (2012$)

Year	Fracture Type	Number of Fractures Avoided				Total Fractures Avoided	Direct Health Care Cost of Fractures Avoided $2012				Total Direct Health Care Cost of Fractures
		Women		Men			Women		Men		
		50-69 years	70+ years	50-69 years	70+ years		50-69 years	70+ years	50-69 years	70+ years	
2013	Hip	96	1,296	81	339	1,812	2,220,276	35,550,489	1,882,210	9,316,465	48,969,441
	Wrist	789	1,319	112	108	2,328	3,913,252	8,150,379	488,668	554,037	13,106,336
	Vertebral	282	869	105	160	1,416	1,142,825	5,652,269	569,492	809,062	8,173,647
	Other	2,473	2,732	1,681	951	7,836	19,824,017	29,307,636	10,496,967	9,548,890	69,177,510
	Total	**3,641**	**6,215**	**1,979**	**1,558**	**13,393**	**27,100,370**	**78,660,773**	**13,437,337**	**20,228,454**	**139,426,933**
2014	Hip	105	1,421	93	383	2,001	2,419,456	38,980,129	2,151,383	10,510,594	54,061,562
	Wrist	801	1,328	108	111	2,347	3,969,494	8,206,505	470,402	566,591	13,212,991
	Vertebral	335	1,059	144	204	1,743	1,358,615	6,885,668	785,909	1,030,592	10,060,783
	Other	2,509	2,743	1,618	961	7,831	20,110,139	29,425,470	10,104,825	9,654,941	69,295,375
	Total	**3,750**	**6,550**	**1,963**	**1,659**	**13,922**	**27,857,703**	**83,497,772**	**13,512,518**	**21,762,718**	**146,630,712**
2015	Hip	107	1,467	95	399	2,068	2,475,672	40,257,314	2,210,320	10,946,962	55,890,268
	Wrist	816	1,366	109	115	2,407	4,047,428	8,444,157	477,497	586,773	13,555,855
	Vertebral	343	1,091	146	212	1,791	1,388,474	7,090,029	792,596	1,068,728	10,339,827
	Other	2,558	2,822	1,643	995	8,018	20,505,010	30,275,186	10,257,258	9,995,715	71,033,170
	Total	**3,824**	**6,746**	**1,993**	**1,720**	**14,283**	**28,416,585**	**86,066,686**	**13,737,670**	**22,598,178**	**150,819,120**
2016	Hip	109	1,514	97	414	2,134	2,519,835	41,538,397	2,245,643	11,378,781	57,682,655
	Wrist	831	1,410	111	119	2,471	4,118,664	8,714,341	485,276	610,086	13,928,367
	Vertebral	349	1,125	148	220	1,842	1,413,492	7,314,308	805,623	1,110,570	10,643,993
	Other	2,603	2,912	1,669	1,035	8,219	20,865,905	31,243,739	10,424,363	10,392,654	72,926,661
	Total	**3,892**	**6,961**	**2,025**	**1,788**	**14,666**	**28,917,896**	**88,810,784**	**13,960,905**	**23,492,090**	**155,181,676**
2017	Hip	111	1,563	98	431	2,203	2,559,624	42,886,952	2,276,602	11,842,750	59,565,928
	Wrist	844	1,456	113	124	2,537	4,183,099	8,997,899	491,916	635,071	14,307,984
	Vertebral	354	1,162	150	229	1,895	1,436,018	7,551,409	816,991	1,155,726	10,960,143
	Other	2,644	3,007	1,692	1,077	8,420	21,192,345	32,260,366	10,566,987	10,818,252	74,837,951
	Total	**3,953**	**7,187**	**2,053**	**1,861**	**15,055**	**29,371,085**	**91,696,625**	**14,152,496**	**24,451,800**	**159,672,007**
2018	Hip	112	1,632	99	454	2,297	2,581,666	44,789,137	2,293,983	12,469,560	62,134,346
	Wrist	851	1,522	113	131	2,617	4,216,781	9,406,905	495,107	669,525	14,788,318
	Vertebral	358	1,212	151	241	1,962	1,449,216	7,877,677	823,973	1,215,373	11,366,239
	Other	2,665	3,143	1,703	1,135	8,647	21,362,995	33,726,705	10,635,530	11,405,115	77,130,345
	Total	**3,985**	**7,510**	**2,067**	**1,961**	**15,523**	**29,610,657**	**95,800,424**	**14,248,593**	**25,759,573**	**165,419,247**
2019	Hip	113	1,696	100	475	2,384	2,609,465	46,534,956	2,315,826	13,041,366	64,501,612
	Wrist	860	1,581	115	137	2,692	4,262,953	9,768,714	500,058	699,690	15,231,414
	Vertebral	361	1,260	153	252	2,026	1,464,488	8,189,678	831,377	1,272,251	11,757,794
	Other	2,694	3,264	1,720	1,187	8,865	21,596,909	35,023,943	10,741,883	11,918,987	79,281,722
	Total	**4,029**	**7,801**	**2,087**	**2,050**	**15,967**	**29,933,815**	**99,517,291**	**14,389,143**	**26,932,293**	**170,772,543**
2020	Hip	114	1,757	101	494	2,467	2,643,645	48,212,574	2,343,912	13,574,775	66,774,906
	Wrist	871	1,637	116	142	2,767	4,319,565	10,118,337	506,382	727,947	15,672,231
	Vertebral	366	1,305	155	262	2,089	1,483,413	8,486,799	841,202	1,324,842	12,136,255
	Other	2,730	3,381	1,742	1,235	9,088	21,883,711	36,277,474	10,877,738	12,400,351	81,439,273
	Total	**4,082**	**8,081**	**2,114**	**2,133**	**16,410**	**30,330,334**	**103,095,184**	**14,569,234**	**28,027,914**	**176,022,666**
2021	Hip	116	1,821	102	514	2,554	2,677,076	49,972,499	2,373,004	14,123,154	69,145,733
	Wrist	882	1,697	118	148	2,845	4,374,018	10,488,184	512,679	757,327	16,132,208
	Vertebral	371	1,353	157	273	2,153	1,502,251	8,796,006	851,688	1,378,348	12,528,293
	Other	2,764	3,505	1,764	1,284	9,317	22,159,584	37,603,487	11,012,996	12,900,841	83,676,906
	Total	**4,134**	**8,376**	**2,140**	**2,220**	**16,869**	**30,712,929**	**106,860,176**	**14,750,366**	**29,159,670**	**181,483,140**
2022	Hip	118	1,885	104	534	2,641	2,718,288	51,737,385	2,407,768	14,663,688	71,527,130
	Wrist	896	1,757	119	154	2,926	4,442,303	10,857,442	520,417	786,139	16,606,301
	Vertebral	376	1,401	159	283	2,220	1,525,030	9,107,710	863,868	1,431,418	12,928,027
	Other	2,808	3,628	1,790	1,333	9,559	22,505,521	38,927,406	11,179,222	13,391,654	86,003,803
	Total	**4,198**	**8,671**	**2,172**	**2,304**	**17,346**	**31,191,142**	**110,629,944**	**14,971,275**	**30,272,899**	**187,065,261**

Discussion

This report demonstrates that the economic costs associated with osteoporosis and osteopenia among Australians aged 50 years and over, is significant, has previously been underestimated and is likely to represent an increasing burden due to the high prevalence of osteoporosis in our ageing population. The total cost associated with osteoporosis, osteopenia and the consequent fractures in 2012 was estimated to be $AUD 2.75 billion. Although there is no previous Australian burden of illness study using similar methodology, the direct health costs of osteoporosis in 2000-2001 was estimated to be $1.9 billion.[37] This earlier report was only able to estimate the burden of hospitalised fractures irrespective of bone density and included all adults aged 20 years and over. By comparison the current report, in line with other international cost of osteoporosis, targets adults from 50 years and older studies.[5,34,63-66] Using Australian epidemiologic and cost data, the current analysis confines the burden of osteoporosis to adults with low bone density and has included direct and indirect costs from both hospitalised and non-hospitalised fractures. The estimates appear consistent with other similar population profiles. A recent burden of illness of osteoporosis in Canada estimates the total cost at $2.3 billion or 1.3% of Canada's health care expenditures.[65] In Sweden fractures account for 1 to 2% of the total health care costs and the annual burden of osteoporosis is estimated at €0.5 billion.[40,41] In 2005 the burden of osteoporosis in the USA was estimated at $US17 billion with more than 2 million incident fractures in adults aged 50 years and older.[63]

As other studies have found, the large burden of disease attributable to osteoporosis is predominantly due to associated fractures. This study found that the burden from fractures represented 64% of the total direct costs. This is without accounting for the impact on disability and quality of life. The flow on effects from fractures include mortality, nursing home residential care, impact on households through lost productivity and informal care requirements, and the ongoing need for community services. This study has attempted to capture all these downstream use of resources (health sector and broader community services). Whilst the unit costs of treating fractures in hospital and subacute care are likely to be high relative to similar fractures from other causes, due to age, frailty and co-morbidities, the total burden of osteoporosis is likely driven by the large population prevalence of osteoporosis and osteopenia. This was emphasised when the number of hip fractures was assumed to change by 25% in the sensitivity analyses, this change impacted total costs by 7% (and by 10% when considering just the cost of all fractures). Whilst this is not insignificant, the increasing burden of osteoporosis and osteopenia will not just be related to fractures.

The community costs of managing osteoporosis and osteopenia (without including the costs of fractures) were $829 million (34% of direct total costs). This was slightly higher than the burden attributable to hip fractures. By 2022 the community costs of managing osteoporosis and osteopenia are predicted to increase by 33% to 1.25 billion, 35% of the total direct cost. This is even with our conservative assumptions concerning the use of anti-osteoporosis pharmaceuticals, medical practitioner visits, DXA and vitamin D tests. If current trends in osteoporosis and osteopenia continue, the total expenditure will be driven by a population effect rather than the effect of any single unit cost or service. This adds support for funding directed towards lifestyle changes to promote bone health among young Australians so that the prevalence of osteopenia in those aged 50 years and over, is reduced compared with the prevalence in 2012.

Cost of Management of Osteoporosis and Osteopenia

Approximately $830 million or 30% of this relates to the cost of management and prevention of further bone loss in Australians with either osteoporosis or osteopenia. This cost of management of osteoporosis is almost two-fold higher in the age group 50 to 69 years compared to those aged 70 years and older ($621 million vs $390 million, respectively), largely driven by high number of osteopenic adults in the younger age group (2.6 million). This cost is equally distributed between women and men aged 50 to 69 years. Similarly there are an equal number of women and men with osteopenia in those aged over 70 years, totalling another one million adults. Despite this the cost of osteoporosis management is 36% higher for women than men in the 70+ year old group driven by increased longevity and a four-fold higher number of older women with osteoporosis compared with men.

The costs contributing to the management of osteoporosis and osteopenia were derived from the PBS reported number of prescriptions for anti-osteoporosis pharmaceuticals, 2.4 GP visits to prescribe these therapies, a standard blood test to assess serum calcium and renal function, once-a-year blood test for vitamin D status, a DXA scan once every three years and calcium and vitamin D supplements in 39% of the population with osteoporosis and osteopenia.

Costs Related to Fracture Treatment and Subsequent Care

In 2012 the annual cost of all treatment and consequences of fracture in the 4.7 million Australians aged 50 years and over with osteoporosis and osteopenia comprised 64% or $2.05 billion of the total cost of the disorder. Eighty percent of this or $1.6 billion, were direct costs of health care and community services utilised as a consequence of the fracture event. As expected hip fracture was the most costly fracture type. This was true both on an average 'per fracture' basis ($27,500) and as the total proportional cost burden of all fractures accounting for 42% of the direct cost of fractures but representing only 16% of all osteoporotic fractures. In the USA hip fractures have been estimated to account for 72% of total

hospital costs and represent only 14% of all fractures[63] while in Canada hip fractures account for 53% of acute care costs and represent 50% of hospitalisations attributable to osteoporotic fractures.[65] In Australia hip fracture cases had the longest LOS in an acute hospital setting (50 to 69 year olds and 70+ year old, respectively: mean LOS in days, Hip: 7 and 11.5 days; Wrist: 1.6 and 2.4 days; Vertebral: 0 and 5.4 days; 'Other' sites: 4.5 and 11.1 days). Mean health care costs were approximately five-fold higher than wrist or vertebral fractures and three-fold higher than the mean cost of fractures grouped as 'other' sites. Hip fractures cost $23,000 and $27,000 in those aged 50 to 69 years and 70 years and over, respectively. In Canada, the mean LOS for hip fracture was 14.5 days although the median LOS was 7 days[63] similar to Australian data.

Fractures at Sites other than Hip, Wrist and Vertebrae

Although hip (43%), wrist (7%) and vertebral fractures (10%) together account for 60% of the direct costs of fracture treatment, the economic burden of osteoporosis would be significantly underestimated by not including the 40% direct costs used in the treatment and management of fractures at other sites. Grouped together 'other' fractures represent 51% of all fractures. In USA, Tarride and colleagues report these 'other' fractures accounted for almost 20% of direct costs[65] and represent 40% of all fractures.[63]

Our results indicate that osteoporosis was responsible for almost 90,000 hospitalisations (acute inpatient) in 2012 at a cost of almost $1.14 billion. This is equivalent to a rate of 12.6 hospitalisations per 1,000 Australians adults aged over 50 years or 18.9 hospitalisations per 1,000 older Australians with low bone density (osteoporosis or osteopenia). The previous Australian estimate was 4.48 per 1,000 adults aged over 20 years.[37] The mean cost of each acute inpatient episode was $12,700.

Irrespective of fracture site, the mean LOS was approximately double that in the older age group (70+ year group: mean LOS in days, 11.5 hip; 2.4 wrist; 5 vertebral and 11 days for fractures at 'other' sites).

Projections 2013 to 2022

The projection analysis shows that the total annual direct and indirect costs for osteoporosis, osteopenia and associated fractures will steadily escalate from $2.9 billion in 2012 to an estimated $3.8 billion in 2022. One of the most notable aspects for the projections analysis is the significant saving on averted fractures and associated costs attributable to osteoporosis medication. Using conservative assumptions regarding the use of osteoporosis pharmaceuticals, it is projected that over the ten year period, over 150,000 fractures could be averted with a predicted annual saving ranging from $140 million in 2013 to $187 million in 2022. Obviously the predicted total saving of $1.6 billion over this period could be significantly increased by improvements in any of the contributing factors such as drug efficacy in reducing fracture rates, medication uptake and persistence rates. Landfeldt and colleagues have estimated that the estimated additional fracture-related costs associated with poor persistence were larger than the current total annual expenditure on all osteoporosis medications in Sweden.[67] Our analysis demonstrates the proportion of total fracture numbers occurring in older adults with osteopenia is 12% higher than in adults with osteoporosis (2012: 74,353 vs 66,469). As was the case in 2012, the predictions analysis demonstrates the largest absolute increase will be in the number of women and men with osteopenia aged 50 to 69 years. Our assumptions on osteoporosis medications have conservatively assumed that adults with osteopenia but without fracture would not be commenced on osteoporosis medication.

In Australia the projected burden of fractures and costs is estimated to increase in the next ten-year period to 2022, by 27% and 31% respectively. This is proportionally more than the projected burden of annual fractures and costs in the USA which has been estimated for a 20-year period (2005 to 2025) to grow by approximately 50%.[63] Men currently account for 29% fractures and about 27% costs in both Australia and the USA. In Australia this proportion will increase slightly to be 30% of fractures and 29% of associated costs.

Strengths of the Analysis

The strengths of the study include:

1. The prevalence of osteoporosis and osteopenia has been taken from an Australian study that measured BMD in a representative age-stratified sample of the population[6] rather than self-reported prevalence from the AHS;
2. The derivation of unit costs was taken from accredited Commonwealth and state government reimbursement fees such as Medicare Scheduled fee and PBS;
3. The costing for hospital utilisation was derived from a 'bottom-up' approach using patient level data rather than using DRG costing;
4. Health and community care service utilisation were derived from a prospective observational study that is currently collecting this data from adults with incident fracture in five states across Australia (AusICUROS);
5. The burden of fractures is not restricted to hip fractures or hospitalised fracture cases but includes all fractures other than fingers, toes, facial and skull. Furthermore, the estimate is conservative since low trauma fractures occurring in adults with BMD in the normal range (T-score above -1) have not been included. The burden attributable to hip fractures has been reduced by incorporating recent reports of a 15% decline in hip fracture rate (not numbers).[5] A decrease in hip fracture rate has been reported in other Australian[11,19,20,68] and international studies.[69,70] It has been proposed that recent increases in adiposity and consequent increase in hip BMD may have contributed to this decline.[20]

Limitations of the Study

Important limitations of the study include the data sources used in the model regarding:

1. Both prevalence of osteoporosis and osteopenia, and fracture incidence are taken from one large region located in south eastern Victoria;
2. We have assumed the age and gender-specific distribution of fracture sites is not different in the group of adults with low bone density compared with all adults irrespective of bone density;
3. Although hip fracture rates appear to have declined over the past ten to twenty years, there is no published Australian data to identify change in fractures occurring at other sites. While some data suggest the decline is restricted to hip fracture incidence there are few if any recent international studies published using reliable data for incidence of non-hip fractures[27,69] while recent Canadian data suggest declines in other major osteoporotic fracture sites;[70]
4. It is likely that there are differences in fracture rates among Indigenous Australians consistent with racial differences identified in the USA between Black Americans, Hispanic and Caucasian Americans,[71] however there is no reliable published Australian data available to incorporate such differences into the analysis. The Australian Indigenous population accounts for less than 1.2% of Australian adults aged 50 years and over;[72]
5. Mortality within the first 12 months following fracture has been extrapolated from the AusICUROS data. This may represent an underestimate as some fracture participants 'lost to follow-up' may have died;
6. The burden of 'other' fractures grouped could be overestimated since AusICUROS recruitment was through a combination of emergency department and inpatient wards. Fractures of a less serious nature may have been managed without visiting an emergency department;
7. The projection results were dependent on ABS population projections in conjunction with projected changes in prescription rates for anti-osteoporotic therapy. Furthermore the anticipated anti-fracture efficacy of this therapy is highly dependent on several important variables including medication compliance. We have used well cited published data to support our assumptions but recognise the highly variable nature of this aspect of the report. Sensitivity analyses have not been done to assess the impact of significant deviations in our assumptions, other than by varying the total number of hip fractures. A report of the burden of osteoporosis in USA by Burge and colleagues has reported that changes in all non-hip fracture rates of ±25% results in 21% change in total fracture rates but only ±7% differences in cost.[63] This is similar to our results when varying the number of hip fractures by ±25%.

Conclusion

The projected increase in the number of older Australians will translate to an increased population at significant risk of falls and fracture. This new information on the current and future costs of osteoporosis in Australia will aid clinicians, government policy makers, researchers and health care organisations and funding bodies to assess the economic importance of osteoporosis in reducing both osteoporosis-related fractures and associated costs, promoting bone health and to identify further resource needs. The high population-at-risk in the age group 50 to 69 years translates to a significant burden of fractures and associated costs in this age group. Although hip, wrist and vertebral fractures and the associated costs account for the most significant burden of osteoporosis and osteopenia, fractures at other sites account for 40% of all fractures and should not be ignored in future planning of resource needs and implementation of osteoporosis prevention and treatment modalities. It is not only a disease affecting women, men account for 25 to 30% of all fractures related to osteoporosis and osteopenia, and their associated costs.

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List of Abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
ALOS	Average Length of Stay
ARDRG	Australian Refined Diagnosis Related Group
AUD	Australian Dollars
AusICUROS	The Australian Study of Cost and Utilities Related to Osteoporotic Fractures
BMD	Bone Mineral Density
BMI	Body Mass Index
BOD	Burden of Disease
COI	Cost if Illness
DALYs	Disability Adjusted Life Years
DRG	Diagnosis Related Group
DXA	Dual-energy X-ray Absorptiometry
ED	Emergency Department
GOS	Geelong Osteoporosis Study
GPs	General Practitioners
HRT	Hormone Replacement Therapy
IHPA	Independent Hospital Pricing Authority
IOF	International Osteoporosis Foundation
MBS	Medicare Benefit Schedule
Med Spec	Medical Specialist
MOW	Meals on wheels
NSAIDs	Non-Steroidal Anti Inflammatory Drugs
OA	Osteoporosis Australia
OPD	Out Patient Department
OTC	Over the counter
PBS	Pharmaceutical Benefit Scheme
Physio	Physiotherapy
RPBS	Repatriation Pharmaceutical Benefits Scheme
SES	Social Economic Status
SERMs	Selective Estrogen Receptor Modulators
WHO	World Health Organisation

Appendix

Appendix A: Utilisation Rates for Service use Following Fractures, by Fracture Type, Age and Gender

Post Fracture Utilisation Rates			50-69 years		70+ years	
			Men	Women	Men	Women
Hospitalisation (AusICUROS)		Hip	1.00	1.00	1.00	1.00
		Wrist	0.39	0.45	0.50	0.63
		Vertebral	0.50	0.33	0.50	0.67
		Other	0.43	0.58	0.67	0.72
Ambulance Paramedic (AusICUROS)		Hip	1.00	0.90	1.00	0.93
		Wrist	0.13	0.14	0.36	0.31
		Vertebral	0.58	0.67	0.40	0.53
		Other	0.38	0.32	0.75	0.53
ED Presentation (not admitted) (AusICUROS)		Hip	0.00	0.00	0.00	0.00
		Wrist	0.53	0.53	0.48	0.35
		Vertebral	0.48	0.58	0.48	0.31
		Other	0.55	0.40	0.31	0.26
Hospital Outpatient Fracture Clinic (AusICUROS)		Hip	0.61	0.61	0.61	0.61
		Wrist	0.35	0.35	0.35	0.35
		Vertebral	0.41	0.41	0.41	0.41
		Other	0.39	0.39	0.39	0.39
Non-admitted Fracture Management (GP, X-ray) (AusICUROS)		Hip	0.00	0.00	0.00	0.00
		Wrist	0.08	0.03	0.02	0.02
		Vertebral	0.02	0.09	0.02	0.02
		Other	0.02	0.02	0.02	0.02
Orthopaedic Specialist (AusICUROS)		Hip	0.37	0.37	0.37	0.37
		Wrist	0.30	0.30	0.30	0.30
		Vertebral	0.28	0.28	0.28	0.28
		Other	0.30	0.30	0.30	0.30
Community Physiotherapy (AusICUROS)		Hip	0.65	0.65	0.65	0.65
		Wrist	0.58	0.58	0.58	0.58
		Vertebral	0.46	0.46	0.46	0.46
		Other	0.66	0.66	0.66	0.66
Rehabilitation/Subacute Care (AusICUROS)		Hip	0.39	0.39	0.32	0.32
		Non-hip	0.18	0.18	0.14	0.14
Residential Aged Care		Hip (AIHW)	0.00	0.00	0.11	0.11
		Non-hip (AusICUROS)	0.00	0.00	0.01	0.01
Community-based Services (AusICUROS)	**Home help**	Hip	0.00	0.08	0.27	0.33
		Wrist	0.00	0.02	0.06	0.14
		Vertebral	0.00	0.17	0.05	0.43
		Other	0.02	0.13	0.17	0.28
	Meals on wheels	Hip	0.00	0.00	0.03	0.06
		Wrist	0.00	0.00	0.00	0.01
		Vertebral	0.00	0.00	0.05	0.10
		Other	0.00	0.00	0.13	0.05
	Informal community care	Hip	0.02	0.05	0.08	0.28
		Wrist	0.02	0.05	0.00	0.11
		Vertebral	0.13	0.13	0.10	0.27
		Other	0.17	0.17	0.33	0.22
Mortality (post fracture) (AusICUROS)		Hip	0.01	0.01	0.08	0.08
		Non-hip	0.01	0.01	0.05	0.05

(Note that 1 assumes 100%)

Appendix B: Unit Costs, Source and Assumptions for Each Component of the Model

Parameter	Unit Cost (2012 AUD)	Units	Assumptions re use	Data Source
Ambulance	$688.50	per transport	Same average cost for both metropolitan and rural/remote regions	Ambulance Victoria Annual Report 2011-2012 [47]
Emergency Department (Non-admitted) Wrist fractures	$251.00	per visit	ED non admitted Triage 5 Injury	Source: [48]
ED (Non-admitted) Non-wrist, non-hip fractures	$361.00	per visit	ED non admitted Triage 4 Injury	Source: [48]
Fracture or Orthopaedic Hospital Outpatient Clinic	$190.88	per visit	3 visits post-fracture, all age groups, for admitted patients or non-admitted with ED visit, if attended hospital clinic then no community physiotherapy	Source: [48]
General Practitioner	$35.60	per visit	2.4 visits per year for osteoporosis/osteopenia management 3 visits post fracture if no hospital attendance	MBS Online 2012 Item 23;[51] Average number of visits for osteoporosis AusICUROS; Expert opinion for fracture management
Medical specialist	$83.95	per visit	2.5 visits post fracture to medical specialist if seen in ED but no OPD, fracture population only	MBS Online 2012 Item 104;[51] Recommended Schedule fee Average number of visits from AusICUROS
Routine pathology test	$13.65	per group of 3 tests	Based on 3 tests for renal function (urea and creatinine) and serum calcium; 2 groups of 3 tests/year per person	MBS Online 2012 Item 66506;[51] Expert opinion
Serum Vitamin D Test	$39.05	per Test	Based on full blood examination; assume 1 every two years for everyone (fracture and non-fracture population)	MBS Online 2012 Item 66608;[51] Expert opinion
Diagnostic Imaging for community managed fractures:				
Hip	$47.15	per X-ray	Where no ED or admission, 1 X-ray	MBS Online 2012 Item 57712, Diagnostic imaging with referral
Hand, wrist, forearm, elbow, humerus	$29.75	per X-ray	Where no ED or admission, 1 X-ray	MBS Online 2012 Item 57506, Diagnostic imaging no referral
Spine (4 regions)	$110.00	per X-ray	Where no ED or admission, 1 X-ray	MBS Online 2012 Item 58108, Diagnostic imaging with referral
Foot, ankle, knee or femur	$32.50	per X-ray	Where no ED or admission, 1 X-ray	MBS Online 2012 Item 57518, Diagnostic imaging no referral[51]
Physiotherapist (community)	$62.25	per session	9 sessions for hip fractures, wrist (5), vertebral (4) other (6) if no Outpatient Fracture Clinic	MBS Item No.10960, number of sessions from AusICUROS
Rehabilitation costs	$12,375	per episode	Mean episode cost all fractures; both age groups	Barwon cost data (N=30; SD=$8557)
Residential aged care	$162.94	per day	Annual cost of Nursing Home was $42872 for low care in 2010, inflated to 2012 prices, assumed LOS 6 mths	Cost;[50] Admission rate and length of stay, AusICUROS
Home help	$25	per hour	Casual hourly rate for home help Level 3	Source: [57]
Home care (informal care)	$25	per hour	Cost assumed as for PCA/Home help	Source: [57]
Meals on wheels	$16.50	per day	Casual	Geelong City Council communication for daily cost
Wage rate (adult population)	$151.24	per day	Average fulltime adult wage rate (seasonally adjusted), May 2012 (7-day week)	Source: [58]

Appendix C1: Unit Costs, Source and Assumptions for Pharmaceuticals/Supplements used for Osteoporosis/Osteopenia, 2012

Table C1.1: Pharmaceuticals fracture management

Pharmaceuticals – Fracture Management	Unit Cost 2012$ Cost (as needed)	Cost (routine)	Assumptions re Use	Data Source
- Hip	8.77	80.79	Drugs taken as needed were costed for 14 days. Drugs taken on a routine basis were costed over 122 days (4 months)	Pharmaceutical online website (price)
- Wrist	14.37	38.27		
- Vertebral	13.78	43.41		
- Other	9.71	54.45		

Table C1.2: Supplements (calcium and vitamin D) for osteoporosis prevention

Osteoporosis Prevention Supplements	Population Rate of Use Women	Men	Cost 12 months (2012$) Women	Men	Assumptions re Use	Data Source
All Fractures	0.39	0.39	191.73	191.73	Osteoporosis supplements (Calcium and Vitamin D) were costed over 12 months	Pharmaceutical online website (price)

Appendix C2: List of Osteoporosis (bone-active) Pharmaceuticals used for Osteoporosis/ Osteopenia, 2012

Medication Group	Name, form and strength	Frequency	PBS Item Code (2012)	Unit (Script) Price ($2012)
Alendronate	Alendronate tablet 70mg	Weekly	8511Y	27.62
Alendronate with Cholecalciferol				
	Alendronate 70mg + Cholecalciferol 70 micrograms, tablet	Weekly	9012H	45.26
	Alendronate 70mg + Cholecalciferol 140 micrograms, tablet	Weekly	9183H	45.26
Alendronate with Cholecalciferol and Calcium Carbonate				
	Alendronate 70mg + Cholecalciferol 140 micrograms tablet and Calcium Carbonate (500mg Ca) tablet	Weekly (alendronate)	9351E	45.26
Denosumab	Denosumab, injection 60mg/ml	6 Monthly	5457F	304.97
Etidronate*	Disodium Etidronate, tablet 200mg	Daily	2920Q	115.27
	Disodium Etidronate, tablet 200mg and Calcium Carbonate sachets 1.25g (500mg Ca)	Daily (etidronate)	8056B	70.79
Raloxifene	Raloxifene 60mg	Daily	8363E	57.97
Risedronate	Risedronate Sodium, tablet 5mg	Daily	4443W, 8481J	46.65
	Risedronate Sodium, tablet 35mg	Weekly	4444X, 8621R, 8972F	46.65
	Risedronate Sodium, tablet 150mg	Monthly	9391G	49.63
Risedronate Sodium and Calcium Carbonate				
	Risedronate Sodium, tablet 35mg and Calcium Carbonate, tablet 1.25g (500mg Ca)	Weekly (risedronate)	8899J, 8973G	46.65
Risedronate Sodium and Calcium Carbonate with Cholecalciferol				
	Risedronate Sodium, tablet 35mg and Calcium Carbonate with Cholecalciferol, sachets 2.5g (1g calcium) with Cholecalciferol 22 micrograms	Weekly (risedronate)	4380M, 8974H, 9147K	46.65
Strontium Ranelate	Strontium, sachets 2g granules	Weekly	3036T	53.44
Teriparatide	Teriparatide, injection 20 microgram	Daily	9411H	488.47
Zoledronic Acid	Zoledronic acid, injection 5mg/100ml	Once a year	9288W	589.27

* *Etidronate was available on the PBS in 2012 but has been removed from the PBS in 2013.*

Appendix C2.1: More on Osteoporosis (bone active) Pharmaceuticals

Bone remodelling cycle:

Bone is a living tissue that forms new bone while replacing older bone. Bone is continually renewed and changed through a process called remodelling, which consist of bone resorption (break down or removal) and bone formation. Usually, the two processes of bone remodelling are balanced. Imbalance results into bone loss, eventually leading to osteoporosis and osteoporotic fractures.

Types of osteoporosis medications

1 Antiresorptive medication that slow bone loss;

2 Non-antiresorptive medications include drugs that increase the rate of bone formation (anabolic drugs) and drugs with both formation and resorption.

Antiresorptive medications

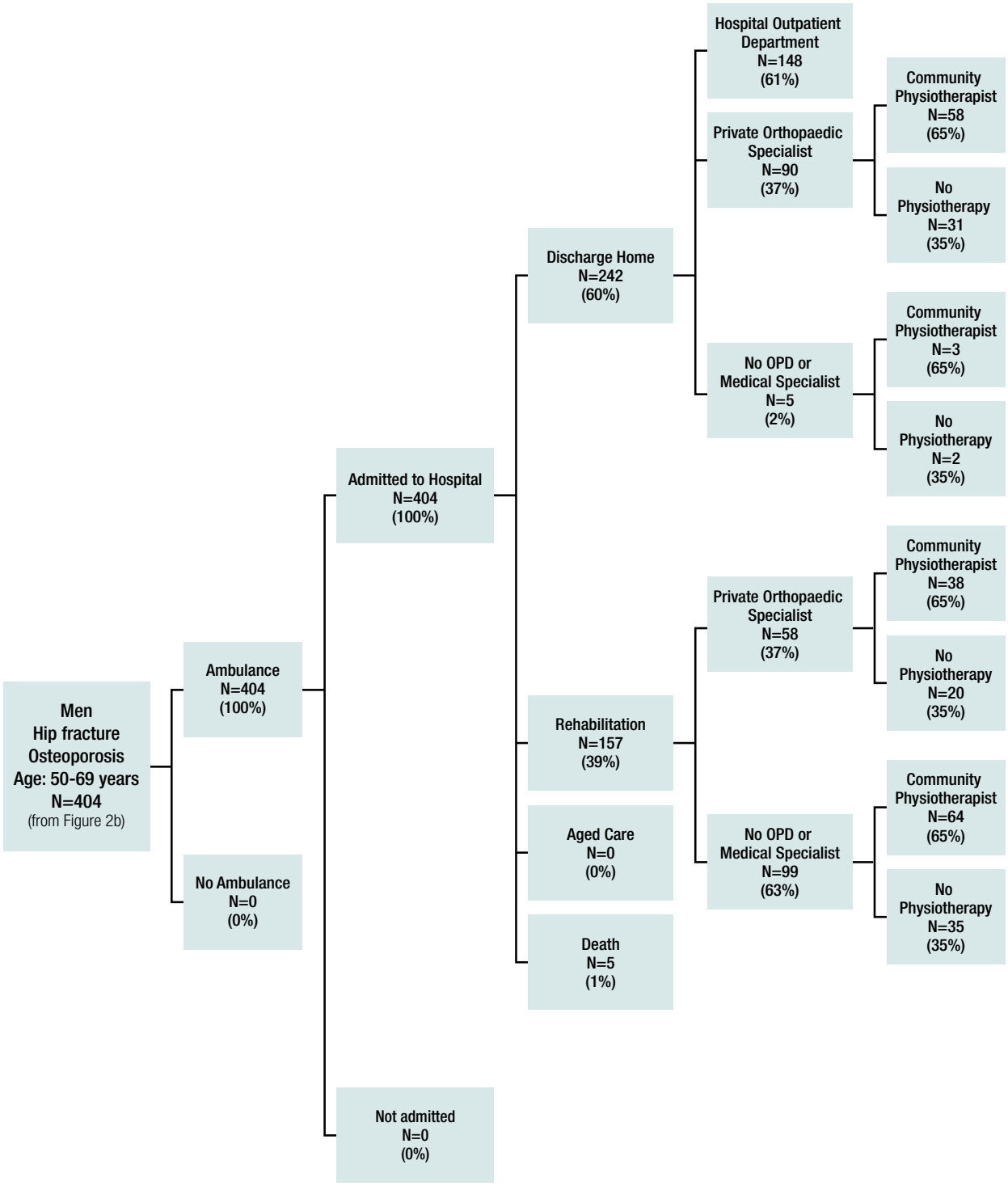
These include bisphosphonates, calcitonin, denosumab and estrogen type medications. These slow down the loss of bone during the breakdown part of bone remodelling, hence important in reducing fracture risk.

Non-resorptive medications

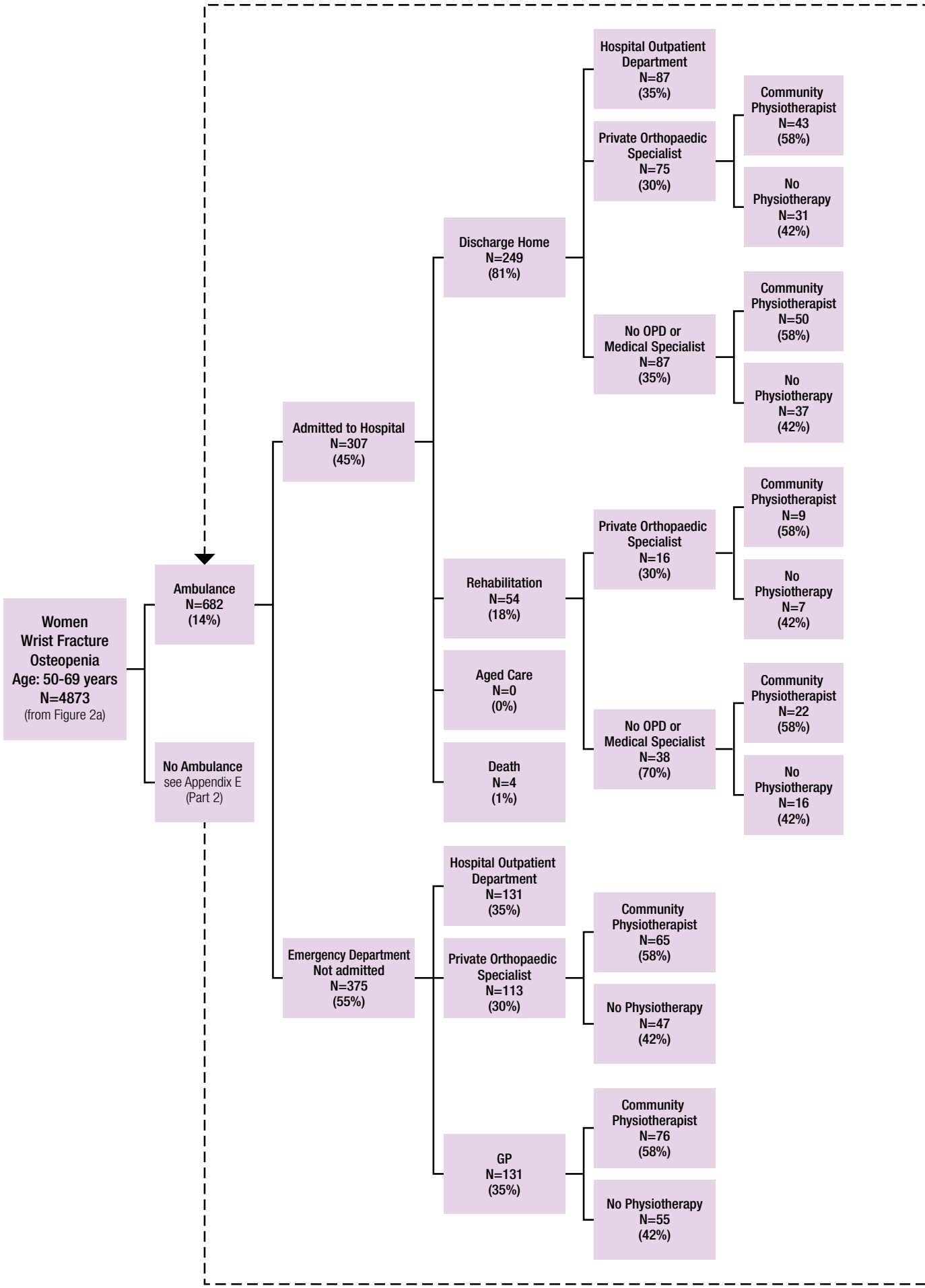
Teriparatide is an anabolic drug that increases the rate of bone formation, while Strontium Ranelate effects on both bone formation and resorption.

Source, National Institutes of Health.[73]

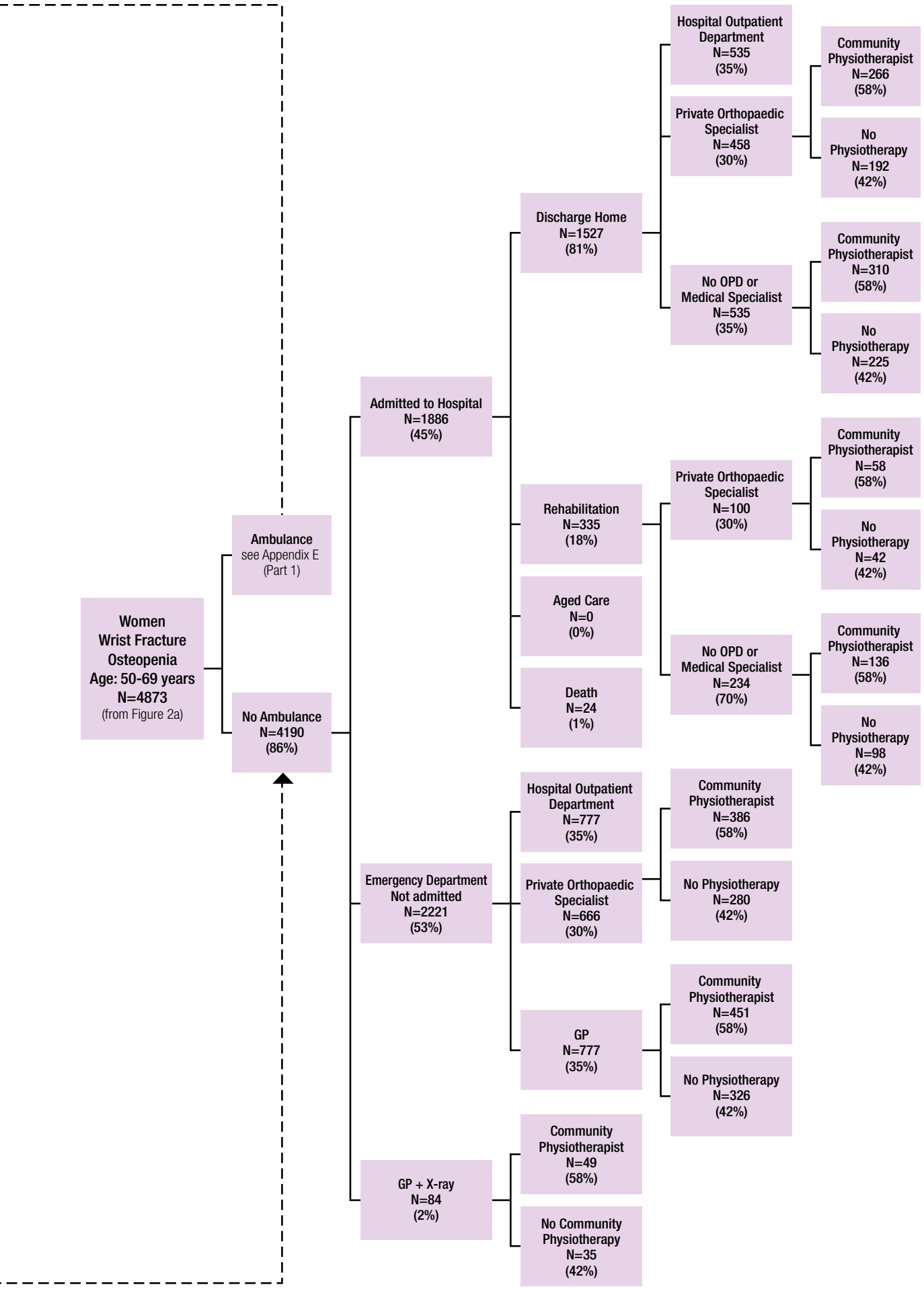
Appendix D: Clinical Pathway for Hip Fracture: Men, Aged 50-69 Years, with Osteoporosis



Appendix E (Part 1): Clinical Pathway for Wrist Fracture: Women, Aged 50-69 Years, with Osteopenia (Via Ambulance)



Appendix E (Part 2): Clinical Pathway for Wrist Fracture: Women, Aged 50-69 Years, with Osteopenia (No Ambulance)



Appendices F: Annual Cost (Direct and Indirect) Breakdown for New Fractures and Re-fractures, by Fracture Type, Gender and Age Group, 2013-2022

2013		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	36,680,112	470,014,934	29,117,357	173,318,945	709,131,348	
	- Re-fractures	1,791,926	36,384,204	2,483,603	12,743,902	53,403,635	
	Total Direct Costs	**38,472,038**	**506,399,138**	**31,600,960**	**186,062,848**	**762,534,983**	39%
Indirect costs:	- New Fractures	3,694,465	39,512,073	3,067,497	15,911,043	62,185,079	
	- Re-fractures	180,485	3,058,659	261,646	1,169,917	4,670,707	
	Total Indirect Costs	**3,874,950**	**42,570,732**	**3,329,144**	**17,080,960**	**66,855,786**	3%
Total cost:	- New Fractures	40,374,577	509,527,008	32,184,854	189,229,988	771,316,428	
	- Re-fractures	1,972,411	39,442,863	2,745,249	13,913,819	58,074,342	
	Total Hip Fracture Cost	**42,346,989**	**548,969,870**	**34,930,103**	**203,143,807**	**829,390,770**	**42%**
Wrist							
Direct costs:	- New Fractures	43,026,014	61,650,649	4,786,778	5,536,503	114,999,943	
	- Re-fractures	1,677,569	4,045,729	324,080	341,600	6,388,977	
	Total Direct Costs	**44,703,582**	**65,696,378**	**5,110,857**	**5,878,103**	**121,388,920**	6%
Indirect costs:	- New Fractures	3,058,173	4,610,615	355,568	452,241	8,476,597	
	- Re-fractures	119,237	302,565	24,073	27,903	473,778	
	Total Indirect Costs	**3,177,410**	**4,913,180**	**379,641**	**480,144**	**8,950,375**	0.5%
Total cost:	- New Fractures	46,084,187	66,261,265	5,142,346	5,988,743	123,476,540	
	- Re-fractures	1,796,806	4,348,293	348,153	369,503	6,862,755	
	Total Wrist Fracture Cost	**47,880,992**	**70,609,558**	**5,490,499**	**6,358,247**	**130,339,295**	**7%**
Vertebral							
Direct costs:	- New Fractures	36,410,320	118,791,890	15,930,654	19,718,341	190,851,205	
	- Re-fractures	1,973,619	10,621,183	1,509,039	1,701,982	15,805,824	
	Total Direct Costs	**38,383,939**	**129,413,073**	**17,439,693**	**21,420,323**	**206,657,029**	10%
Indirect costs:	- New Fractures	3,013,958	11,282,086	1,589,327	2,277,893	18,163,263	
	- Re-fractures	163,371	1,008,731	150,550	196,616	1,519,268	
	Total Indirect Costs	**3,177,329**	**12,290,817**	**1,739,876**	**2,474,508**	**19,682,531**	1%
Total cost:	- New Fractures	39,424,277	130,073,976	17,519,981	21,996,234	209,014,469	
	- Re-fractures	2,136,991	11,629,914	1,659,589	1,898,598	17,325,092	
	Total Vertebral Fracture Cost	**41,561,268**	**141,703,891**	**19,179,570**	**23,894,832**	**226,339,560**	**11%**
Other Fracture							
Direct costs:	- New Fractures	229,413,685	221,301,816	115,537,747	114,313,329	680,566,577	
	- Re-fractures	8,930,138	14,587,145	7,818,334	7,163,437	38,499,055	
	Total Direct Costs	**238,343,824**	**235,888,961**	**123,356,081**	**121,476,766**	**719,065,632**	36%
Indirect costs:	- New Fractures	18,820,509	28,838,589	8,963,629	13,526,549	70,149,277	
	- Re-fractures	732,606	1,900,900	606,561	847,640	4,087,707	
	Total Indirect Costs	**19,553,115**	**30,739,490**	**9,570,190**	**14,374,190**	**74,236,984**	4%
Total cost:	- New Fractures	248,234,195	250,140,405	124,501,376	127,839,878	750,715,854	
	- Re-fractures	9,662,744	16,488,045	8,424,895	8,011,077	42,586,761	
	Total 'Other' Fracture Cost	**257,896,939**	**266,628,450**	**132,926,271**	**135,850,956**	**793,302,616**	**40%**
All Fractures							
Direct costs:	- New Fractures	345,530,131	871,759,290	165,372,536	312,887,118	1,695,549,074	86%
	- Re-fractures	14,373,252	65,638,260	12,135,056	21,950,922	114,097,490	6%
	Total Direct Costs	**359,903,383**	**937,397,550**	**177,507,592**	**334,838,040**	**1,809,646,565**	**91%**
Indirect costs:	- New Fractures	28,587,105	84,243,364	13,976,021	32,167,726	158,974,217	8%
	- Re-fractures	1,195,699	6,270,855	1,042,830	2,242,076	10,751,460	1%
	Total Indirect Costs	**29,782,804**	**90,514,219**	**15,018,851**	**34,409,801**	**169,725,676**	**9%**
Total cost:	- New Fractures	374,117,236	956,002,654	179,348,557	345,054,844	1,854,523,291	94%
	- Re-fractures	15,568,951	71,909,115	13,177,886	24,192,998	124,848,950	6%
	TOTAL COST – ALL FRACTURES	**389,686,188**	**1,027,911,769**	**192,526,443**	**369,247,841**	**1,979,372,241**	**100%**

2014		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	37,433,375	484,080,834	29,651,469	179,583,351	730,749,028	
	- Re-fractures	1,734,360	35,077,959	2,546,015	13,257,986	52,616,320	
	Total Direct Costs	**39,167,734**	**519,158,793**	**32,197,484**	**192,841,337**	**783,365,348**	39%
Indirect costs:	- New Fractures	3,770,335	40,694,531	3,123,766	16,486,129	64,074,760	
	- Re-fractures	174,687	2,948,849	268,221	1,217,111	4,608,868	
	Total Indirect Costs	**3,945,022**	**43,643,380**	**3,391,987**	**17,703,239**	**68,683,628**	3%
Total cost:	- New Fractures	41,203,710	524,775,366	32,775,234	196,069,479	794,823,789	
	- Re-fractures	1,909,047	38,026,807	2,814,236	14,475,097	57,225,188	
	Total Hip Fracture Cost	**43,112,756**	**562,802,173**	**35,589,471**	**210,544,577**	**852,048,976**	**42%**
Wrist							
Direct costs:	- New Fractures	43,860,481	63,401,077	4,871,404	5,731,803	117,864,765	
	- Re-fractures	1,710,192	4,147,295	356,612	373,161	6,587,259	
	Total Direct Costs	**45,570,673**	**67,548,372**	**5,228,016**	**6,104,964**	**124,452,025**	6%
Indirect costs:	- New Fractures	3,117,485	4,741,523	361,854	468,193	8,689,056	
	- Re-fractures	121,556	310,160	26,490	30,481	488,687	
	Total Indirect Costs	**3,239,041**	**5,051,683**	**388,344**	**498,674**	**9,177,742**	0.5%
Total cost:	- New Fractures	46,977,966	68,142,600	5,233,259	6,199,996	126,553,821	
	- Re-fractures	1,831,748	4,457,455	383,101	403,642	7,075,946	
	Total Wrist Fracture Cost	**48,809,714**	**72,600,055**	**5,616,360**	**6,603,638**	**133,629,767**	**7%**
Vertebral							
Direct costs:	- New Fractures	37,178,126	122,433,499	16,228,037	20,439,380	196,279,042	
	- Re-fractures	1,845,931	9,881,739	1,475,239	1,724,015	14,926,924	
	Total Direct Costs	**39,024,056**	**132,315,238**	**17,703,276**	**22,163,395**	**211,205,966**	10%
Indirect costs:	- New Fractures	3,077,515	11,627,943	1,618,995	2,361,188	18,685,641	
	- Re-fractures	152,802	938,504	147,178	199,161	1,437,644	
	Total Indirect Costs	**3,230,316**	**12,566,446**	**1,766,173**	**2,560,349**	**20,123,285**	1%
Total cost:	- New Fractures	40,255,640	134,061,442	17,847,032	22,800,568	214,964,682	
	- Re-fractures	1,998,733	10,820,242	1,622,417	1,923,176	16,364,568	
	Total Vertebral Fracture Cost	**42,254,373**	**144,881,684**	**19,469,449**	**24,723,744**	**231,329,250**	**11%**
Other Fracture							
Direct costs:	- New Fractures	233,863,047	227,585,170	117,580,369	118,345,729	697,374,314	
	- Re-fractures	9,103,802	14,835,206	8,603,157	7,659,035	40,201,201	
	Total Direct Costs	**242,966,849**	**242,420,376**	**126,183,526**	**126,004,764**	**737,575,515**	36%
Indirect costs:	- New Fractures	19,185,523	29,657,395	9,122,100	14,003,698	71,968,715	
	- Re-fractures	746,853	1,933,226	667,449	906,284	4,253,811	
	Total Indirect Costs	**19,932,376**	**31,590,621**	**9,789,548**	**14,909,982**	**76,222,526**	4%
Total cost:	- New Fractures	253,048,570	257,242,564	126,702,468	132,349,427	769,343,029	
	- Re-fractures	9,850,655	16,768,432	9,270,606	8,565,319	44,455,012	
	Total 'Other' Fracture Cost	**262,899,225**	**274,010,997**	**135,973,074**	**140,914,746**	**813,798,041**	**40%**
All Fractures							
Direct costs:	- New Fractures	352,335,028	897,500,580	168,331,279	324,100,262	1,742,267,149	86%
	- Re-fractures	14,394,285	63,942,199	12,981,023	23,014,198	114,331,704	6%
	Total Direct Costs	**366,729,314**	**961,442,779**	**181,312,301**	**347,114,460**	**1,856,598,854**	**91%**
Indirect costs:	- New Fractures	29,150,858	86,721,392	14,226,715	33,319,208	163,418,172	8%
	- Re-fractures	1,195,897	6,130,739	1,109,337	2,353,037	10,789,009	1%
	Total Indirect Costs	**30,346,755**	**92,852,130**	**15,336,052**	**35,672,245**	**174,207,182**	**9%**
Total cost:	- New Fractures	381,485,886	984,221,972	182,557,993	357,419,470	1,905,685,322	94%
	- Re-fractures	15,590,182	70,072,937	14,090,360	25,367,234	125,120,714	6%
	TOTAL COST – ALL FRACTURES	**397,076,068**	**1,054,294,909**	**196,648,353**	**382,786,704**	**2,030,806,035**	**100%**

2015		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	38,089,362	499,658,834	30,113,604	186,694,845	754,556,645	
	- Re-fractures	1,743,971	35,443,041	2,560,556	13,479,700	53,227,267	
	Total Direct Costs	**39,833,332**	**535,101,875**	**32,674,160**	**200,174,544**	**807,783,912**	39%
Indirect costs:	- New Fractures	3,836,407	42,004,105	3,172,452	17,138,979	66,151,942	
	- Re-fractures	175,655	2,979,539	269,753	1,237,465	4,662,412	
	Total Indirect Costs	**4,012,062**	**44,983,644**	**3,442,205**	**18,376,443**	**70,814,354**	3%
Total cost:	- New Fractures	41,925,768	541,662,939	33,286,056	203,833,824	820,708,586	
	- Re-fractures	1,919,626	38,422,580	2,830,309	14,717,164	57,889,679	
	Total Hip Fracture Cost	**43,845,394**	**580,085,519**	**36,116,365**	**218,550,988**	**878,598,266**	**42%**
Wrist							
Direct costs:	- New Fractures	44,625,005	65,443,920	4,947,042	5,958,866	120,974,834	
	- Re-fractures	1,736,129	4,239,392	369,123	383,979	6,728,622	
	Total Direct Costs	**46,361,134**	**69,683,313**	**5,316,165**	**6,342,845**	**127,703,456**	6%
Indirect costs:	- New Fractures	3,171,825	4,894,300	367,473	486,741	8,920,338	
	- Re-fractures	123,399	317,048	27,419	31,365	499,231	
	Total Indirect Costs	**3,295,224**	**5,211,347**	**394,892**	**518,105**	**9,419,569**	0.5%
Total cost:	- New Fractures	47,796,830	70,338,220	5,314,515	6,445,607	129,895,172	
	- Re-fractures	1,859,528	4,556,440	396,542	415,343	7,227,853	
	Total Wrist Fracture Cost	**49,656,358**	**74,894,660**	**5,711,056**	**6,860,951**	**137,123,025**	**7%**
Vertebral							
Direct costs:	- New Fractures	37,831,313	126,371,136	16,481,425	21,248,632	201,932,505	
	- Re-fractures	1,854,534	9,974,525	1,485,495	1,751,471	15,066,025	
	Total Direct Costs	**39,685,847**	**136,345,660**	**17,966,920**	**23,000,103**	**216,998,530**	10%
Indirect costs:	- New Fractures	3,131,584	12,001,914	1,644,274	2,454,674	19,232,446	
	- Re-fractures	153,514	947,316	148,201	202,333	1,451,363	
	Total Indirect Costs	**3,285,098**	**12,949,230**	**1,792,475**	**2,657,007**	**20,683,810**	1%
Total cost:	- New Fractures	40,962,897	138,373,049	18,125,699	23,703,306	221,164,952	
	- Re-fractures	2,008,047	10,921,841	1,633,696	1,953,804	16,517,388	
	Total Vertebral Fracture Cost	**42,970,944**	**149,294,890**	**19,759,395**	**25,657,110**	**237,682,339**	**11%**
Other Fracture							
Direct costs:	- New Fractures	237,939,469	234,918,182	119,406,023	123,033,962	715,297,636	
	- Re-fractures	9,241,869	15,152,547	8,904,987	7,865,191	41,164,594	
	Total Direct Costs	**247,181,338**	**250,070,729**	**128,311,010**	**130,899,154**	**756,462,230**	36%
Indirect costs:	- New Fractures	19,519,943	30,612,984	9,263,737	14,558,451	73,955,115	
	- Re-fractures	758,179	1,974,580	690,865	930,678	4,354,302	
	Total Indirect Costs	**20,278,122**	**32,587,564**	**9,954,602**	**15,489,129**	**78,309,417**	4%
Total cost:	- New Fractures	257,459,412	265,531,166	128,669,760	137,592,413	789,252,751	
	- Re-fractures	10,000,048	17,127,127	9,595,852	8,795,869	45,518,896	
	Total 'Other' Fracture Cost	**267,459,460**	**282,658,293**	**138,265,612**	**146,388,282**	**834,771,646**	**40%**
All Fractures							
Direct costs:	- New Fractures	358,485,149	926,392,072	170,948,094	336,936,305	1,792,761,620	86%
	- Re-fractures	14,576,501	64,809,505	13,320,160	23,480,341	116,186,508	6%
	Total Direct Costs	**373,061,650**	**991,201,577**	**184,268,254**	**360,416,646**	**1,908,948,128**	**91%**
Indirect costs:	- New Fractures	29,659,758	89,513,302	14,447,936	34,638,844	168,259,841	8%
	- Re-fractures	1,210,747	6,218,483	1,136,238	2,401,840	10,967,308	1%
	Total Indirect Costs	**30,870,506**	**95,731,785**	**15,584,174**	**37,040,684**	**179,227,149**	**9%**
Total cost:	- New Fractures	388,144,907	1,015,905,374	185,396,030	371,575,149	1,961,021,461	94%
	- Re-fractures	15,787,249	71,027,988	14,456,398	25,882,181	127,153,816	6%
	TOTAL COST – ALL FRACTURES	**403,932,156**	**1,086,933,362**	**199,852,428**	**397,457,330**	**2,088,175,277**	**100%**

2016		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	38,683,147	515,933,913	30,521,132	194,335,912	779,474,104	
	- Re-fractures	1,781,799	36,818,772	2,599,832	14,167,816	55,368,219	
	Total Direct Costs	**40,464,947**	**552,752,685**	**33,120,964**	**208,503,727**	**834,842,323**	39%
Indirect costs:	- New Fractures	3,896,213	43,372,278	3,215,384	17,840,445	68,324,321	
	- Re-fractures	179,465	3,095,191	273,891	1,300,635	4,849,182	
	Total Indirect Costs	**4,075,678**	**46,467,470**	**3,489,275**	**19,141,080**	**73,173,503**	3%
Total cost:	- New Fractures	42,579,361	559,306,191	33,736,516	212,176,356	847,798,425	
	- Re-fractures	1,961,264	39,913,963	2,873,723	15,468,451	60,217,402	
	Total Hip Fracture Cost	**44,540,625**	**599,220,154**	**36,610,240**	**227,644,807**	**908,015,826**	**42%**
Wrist							
Direct costs:	- New Fractures	45,318,377	67,577,545	5,013,797	6,202,916	124,112,635	
	- Re-fractures	1,775,196	4,407,508	377,433	404,096	6,964,234	
	Total Direct Costs	**47,093,574**	**71,985,053**	**5,391,230**	**6,607,012**	**131,076,869**	6%
Indirect costs:	- New Fractures	3,221,108	5,053,865	372,431	506,676	9,154,080	
	- Re-fractures	126,176	329,621	28,036	33,008	516,841	
	Total Indirect Costs	**3,347,284**	**5,383,486**	**400,468**	**539,683**	**9,670,921**	0.4%
Total cost:	- New Fractures	48,539,485	72,631,410	5,386,228	6,709,591	133,266,715	
	- Re-fractures	1,901,373	4,737,129	405,470	437,104	7,481,075	
	Total Wrist Fracture Cost	**50,440,858**	**77,368,539**	**5,791,698**	**7,146,695**	**140,747,790**	**7%**
Vertebral							
Direct costs:	- New Fractures	38,422,016	130,485,549	16,704,783	22,118,013	207,730,361	
	- Re-fractures	1,894,935	10,368,229	1,508,885	1,842,577	15,614,626	
	Total Direct Costs	**40,316,951**	**140,853,778**	**18,213,668**	**23,960,590**	**223,344,987**	10%
Indirect costs:	- New Fractures	3,180,481	12,392,674	1,666,558	2,555,107	19,794,820	
	- Re-fractures	156,858	984,707	150,534	212,857	1,504,957	
	Total Indirect Costs	**3,337,339**	**13,377,382**	**1,817,092**	**2,767,964**	**21,299,777**	1%
Total cost:	- New Fractures	41,602,497	142,878,224	18,371,341	24,673,120	227,525,181	
	- Re-fractures	2,051,794	11,352,936	1,659,420	2,055,434	17,119,583	
	Total Vertebral Fracture Cost	**43,654,291**	**154,231,160**	**20,030,760**	**26,728,554**	**244,644,764**	**11%**
Other Fracture							
Direct costs:	- New Fractures	241,636,514	242,577,064	121,017,271	128,072,901	733,303,750	
	- Re-fractures	9,449,837	15,752,000	9,105,476	8,275,092	42,582,405	
	Total Direct Costs	**251,086,351**	**258,329,063**	**130,122,748**	**136,347,993**	**775,886,155**	36%
Indirect costs:	- New Fractures	19,823,239	31,611,039	9,388,741	15,154,702	75,977,720	
	- Re-fractures	775,240	2,052,696	706,419	979,181	4,513,537	
	Total Indirect Costs	**20,598,479**	**33,663,736**	**10,095,160**	**16,133,883**	**80,491,257**	4%
Total cost:	- New Fractures	261,459,752	274,188,103	130,406,012	143,227,603	809,281,470	
	- Re-fractures	10,225,077	17,804,696	9,811,896	9,254,273	47,095,942	
	Total 'Other' Fracture Cost	**271,684,830**	**291,992,799**	**140,217,908**	**152,481,876**	**856,377,412**	**40%**
All Fractures							
Direct costs:	- New Fractures	364,060,054	956,574,071	173,256,983	350,729,742	1,844,620,850	86%
	- Re-fractures	14,901,768	67,346,509	13,591,627	24,689,580	120,529,484	6%
	Total Direct Costs	**378,961,822**	**1,023,920,579**	**186,848,610**	**375,419,322**	**1,965,150,334**	**91%**
Indirect costs:	- New Fractures	30,121,041	92,429,857	14,643,114	36,056,928	173,250,941	8%
	- Re-fractures	1,237,740	6,462,215	1,158,881	2,525,681	11,384,518	1%
	Total Indirect Costs	**31,358,781**	**98,892,072**	**15,801,995**	**38,582,610**	**184,635,458**	**9%**
Total cost:	- New Fractures	394,181,095	1,049,003,928	187,900,097	386,786,670	2,017,871,791	94%
	- Re-fractures	16,139,508	73,808,724	14,750,508	27,215,261	131,914,002	6%
	TOTAL COST – ALL FRACTURES	**410,320,603**	**1,122,812,652**	**202,650,605**	**414,001,932**	**2,149,785,792**	**100%**

2017		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	38,986,762	539,767,381	30,723,972	204,893,489	814,371,603	
	- Re-fractures	1,809,218	38,013,328	2,632,316	14,744,365	57,199,227	
	Total Direct Costs	**40,795,980**	**577,780,709**	**33,356,287**	**219,637,854**	**871,570,831**	39%
Indirect costs:	- New Fractures	3,926,794	45,375,853	3,236,753	18,809,652	71,349,052	
	- Re-fractures	182,227	3,195,612	277,313	1,353,564	5,008,715	
	Total Indirect Costs	**4,109,021**	**48,571,465**	**3,514,066**	**20,163,216**	**76,357,768**	3%
Total cost:	- New Fractures	42,913,556	585,143,234	33,960,725	223,703,141	885,720,655	
	- Re-fractures	1,991,445	41,208,940	2,909,629	16,097,929	62,207,943	
	Total Hip Fracture Cost	**44,905,001**	**626,352,174**	**36,870,354**	**239,801,070**	**947,928,598**	**43%**
Wrist							
Direct costs:	- New Fractures	45,665,323	70,732,903	5,046,496	6,541,459	127,986,181	
	- Re-fractures	1,802,936	4,550,723	382,913	420,589	7,157,161	
	Total Direct Costs	**47,468,258**	**75,283,627**	**5,429,408**	**6,962,048**	**135,143,341**	6%
Indirect costs:	- New Fractures	3,245,768	5,289,842	374,860	534,329	9,444,800	
	- Re-fractures	128,148	340,331	28,443	34,355	531,277	
	Total Indirect Costs	**3,373,916**	**5,630,173**	**403,304**	**568,684**	**9,976,077**	0.4%
Total cost:	- New Fractures	48,911,091	76,022,745	5,421,356	7,075,788	137,430,980	
	- Re-fractures	1,931,084	4,891,055	411,356	454,944	7,688,438	
	Total Wrist Fracture Cost	**50,842,174**	**80,913,800**	**5,832,712**	**7,530,732**	**145,119,418**	**7%**
Vertebral							
Direct costs:	- New Fractures	38,727,158	136,482,515	16,816,810	23,316,898	215,343,382	
	- Re-fractures	1,923,954	10,704,746	1,527,664	1,917,604	16,073,968	
	Total Direct Costs	**40,651,112**	**147,187,261**	**18,344,474**	**25,234,502**	**231,417,349**	10%
Indirect costs:	- New Fractures	3,205,740	12,962,227	1,677,734	2,693,604	20,539,305	
	- Re-fractures	159,260	1,016,668	152,408	221,525	1,549,860	
	Total Indirect Costs	**3,365,000**	**13,978,895**	**1,830,142**	**2,915,128**	**22,089,165**	1%
Total cost:	- New Fractures	41,932,898	149,444,742	18,494,544	26,010,502	235,882,687	
	- Re-fractures	2,083,214	11,721,414	1,680,072	2,139,128	17,623,828	
	Total Vertebral Fracture Cost	**44,016,112**	**161,166,156**	**20,174,616**	**28,149,630**	**253,506,515**	**11%**
Other Fracture							
Direct costs:	- New Fractures	243,486,418	253,903,569	121,806,521	135,062,876	754,259,385	
	- Re-fractures	9,597,501	16,263,671	9,237,668	8,612,519	43,711,358	
	Total Direct Costs	**253,083,919**	**270,167,240**	**131,044,189**	**143,675,395**	**797,970,743**	36%
Indirect costs:	- New Fractures	19,975,000	33,087,034	9,449,972	15,981,816	78,493,823	
	- Re-fractures	787,354	2,119,374	716,675	1,019,108	4,642,512	
	Total Indirect Costs	**20,762,354**	**35,206,408**	**10,166,647**	**17,000,925**	**83,136,335**	4%
Total cost:	- New Fractures	263,461,418	286,990,604	131,256,493	151,044,693	832,753,208	
	- Re-fractures	10,384,855	18,383,045	9,954,343	9,631,627	48,353,870	
	Total 'Other' Fracture Cost	**273,846,273**	**305,373,648**	**141,210,837**	**160,676,320**	**881,107,078**	**40%**
All Fractures							
Direct costs:	- New Fractures	366,865,661	1,000,886,368	174,393,799	369,814,722	1,911,960,550	86%
	- Re-fractures	15,133,609	69,532,468	13,780,561	25,695,076	124,141,714	6%
	Total Direct Costs	**381,999,270**	**1,070,418,837**	**188,174,359**	**395,509,799**	**2,036,102,265**	**91%**
Indirect costs:	- New Fractures	30,353,302	96,714,957	14,739,320	38,019,401	179,826,980	8%
	- Re-fractures	1,256,989	6,671,985	1,174,839	2,628,552	11,732,365	1%
	Total Indirect Costs	**31,610,291**	**103,386,941**	**15,914,159**	**40,647,953**	**191,559,345**	**9%**
Total cost:	- New Fractures	397,218,963	1,097,601,325	189,133,119	407,834,124	2,091,787,530	94%
	- Re-fractures	16,390,598	76,204,453	14,955,400	28,323,628	135,874,079	6%
	TOTAL COST – ALL FRACTURES	**413,609,561**	**1,173,805,778**	**204,088,519**	**436,157,752**	**2,227,661,609**	**100%**

2018		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	39,416,928	560,316,963	31,028,321	214,112,782	844,874,994	
	- Re-fractures	1,822,917	39,768,899	2,649,272	15,542,050	59,783,137	
	Total Direct Costs	**41,239,845**	**600,085,862**	**33,677,593**	**229,654,832**	**904,658,131**	39%
Indirect costs:	- New Fractures	3,970,121	47,103,365	3,268,816	19,656,003	73,998,305	
	- Re-fractures	183,606	3,343,195	279,099	1,426,793	5,232,694	
	Total Indirect Costs	**4,153,727**	**50,446,560**	**3,547,916**	**21,082,796**	**79,230,999**	3%
Total cost:	- New Fractures	43,387,049	607,420,328	34,297,137	233,768,785	918,873,299	
	- Re-fractures	2,006,523	43,112,094	2,928,372	16,968,843	65,015,831	
	Total Hip Fracture Cost	**45,393,572**	**650,532,422**	**37,225,509**	**250,737,628**	**983,889,130**	**43%**
Wrist							
Direct costs:	- New Fractures	46,172,072	73,409,216	5,096,735	6,834,779	131,512,802	
	- Re-fractures	1,817,519	4,756,464	385,843	443,011	7,402,837	
	Total Direct Costs	**47,989,592**	**78,165,679**	**5,482,578**	**7,277,790**	**138,915,639**	6%
Indirect costs:	- New Fractures	3,281,787	5,489,993	378,592	558,288	9,708,660	
	- Re-fractures	129,184	355,718	28,661	36,187	549,750	
	Total Indirect Costs	**3,410,971**	**5,845,711**	**407,253**	**594,475**	**10,258,410**	0.4%
Total cost:	- New Fractures	49,453,859	78,899,209	5,475,327	7,393,067	141,221,463	
	- Re-fractures	1,946,704	5,112,181	414,504	479,197	7,952,586	
	Total Wrist Fracture Cost	**51,400,563**	**84,011,390**	**5,889,831**	**7,872,265**	**149,174,049**	**6%**
Vertebral							
Direct costs:	- New Fractures	39,153,276	141,693,740	16,982,992	24,367,818	222,197,826	
	- Re-fractures	1,937,965	11,204,462	1,537,024	2,022,021	16,701,471	
	Total Direct Costs	**41,091,241**	**152,898,201**	**18,520,016**	**26,389,839**	**238,899,298**	10%
Indirect costs:	- New Fractures	3,241,013	13,457,156	1,694,313	2,815,007	21,207,489	
	- Re-fractures	160,420	1,064,127	153,342	233,587	1,611,476	
	Total Indirect Costs	**3,401,433**	**14,521,283**	**1,847,655**	**3,048,594**	**22,818,965**	1%
Total cost:	- New Fractures	42,394,289	155,150,895	18,677,305	27,182,826	243,405,316	
	- Re-fractures	2,098,385	12,268,589	1,690,366	2,255,608	18,312,947	
	Total Vertebral Fracture Cost	**44,492,674**	**167,419,484**	**20,367,671**	**29,438,433**	**261,718,263**	**11%**
Other Fracture							
Direct costs:	- New Fractures	246,188,396	263,510,490	123,019,142	141,119,113	773,837,141	
	- Re-fractures	9,675,134	16,998,938	9,308,354	9,071,610	45,054,036	
	Total Direct Costs	**255,863,530**	**280,509,428**	**132,327,496**	**150,190,723**	**818,891,177**	36%
Indirect costs:	- New Fractures	20,196,663	34,338,945	9,544,050	16,698,443	80,778,101	
	- Re-fractures	793,723	2,215,189	722,159	1,073,432	4,804,503	
	Total Indirect Costs	**20,990,387**	**36,554,134**	**10,266,209**	**17,771,875**	**85,582,604**	4%
Total cost:	- New Fractures	266,385,060	297,849,435	132,563,192	157,817,556	854,615,242	
	- Re-fractures	10,468,857	19,214,127	10,030,513	10,145,042	49,858,539	
	Total 'Other' Fracture Cost	**276,853,917**	**317,063,562**	**142,593,705**	**167,962,598**	**904,473,781**	**39%**
All Fractures							
Direct costs:	- New Fractures	370,930,673	1,038,930,408	176,127,190	386,434,492	1,972,422,764	86%
	- Re-fractures	15,253,535	72,728,762	13,880,493	27,078,692	128,941,481	6%
	Total Direct Costs	**386,184,208**	**1,111,659,170**	**190,007,683**	**413,513,184**	**2,101,364,245**	**91%**
Indirect costs:	- New Fractures	30,689,584	100,389,459	14,885,772	39,727,742	185,692,556	8%
	- Re-fractures	1,266,934	6,978,229	1,183,261	2,769,998	12,198,423	1%
	Total Indirect Costs	**31,956,518**	**107,367,688**	**16,069,033**	**42,497,740**	**197,890,978**	**9%**
Total cost:	- New Fractures	401,620,257	1,139,319,867	191,012,962	426,162,234	2,158,115,319	94%
	- Re-fractures	16,520,469	79,706,991	15,063,754	29,848,690	141,139,904	6%
	TOTAL COST – ALL FRACTURES	**418,140,726**	**1,219,026,858**	**206,076,716**	**456,010,924**	**2,299,255,223**	**100%**

2019		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	39,942,772	580,284,646	31,417,629	222,754,754	874,399,801	
	- Re-fractures	1,843,039	41,289,458	2,674,807	16,245,086	62,052,389	
	Total Direct Costs	**41,785,811**	**621,574,104**	**34,092,435**	**238,999,840**	**936,452,190**	40%
Indirect costs:	- New Fractures	4,023,084	48,781,960	3,309,830	20,449,354	76,564,228	
	- Re-fractures	185,633	3,471,022	281,789	1,491,333	5,429,777	
	Total Indirect Costs	**4,208,718**	**52,252,981**	**3,591,619**	**21,940,687**	**81,994,005**	3%
Total cost:	- New Fractures	43,965,857	629,066,605	34,727,459	243,204,108	950,964,029	
	- Re-fractures	2,028,672	44,760,480	2,956,596	17,736,419	67,482,166	
	Total Hip Fracture Cost	**45,994,529**	**673,827,085**	**37,684,055**	**260,940,527**	**1,018,446,195**	**43%**
Wrist							
Direct costs:	- New Fractures	46,790,908	76,016,729	5,160,938	7,109,985	135,078,561	
	- Re-fractures	1,837,396	4,939,938	389,588	463,208	7,630,130	
	Total Direct Costs	**48,628,304**	**80,956,668**	**5,550,526**	**7,573,193**	**142,708,691**	6%
Indirect costs:	- New Fractures	3,325,772	5,684,999	383,361	580,768	9,974,900	
	- Re-fractures	130,597	369,439	28,939	37,836	566,812	
	Total Indirect Costs	**3,456,369**	**6,054,438**	**412,300**	**618,604**	**10,541,712**	0.4%
Total cost:	- New Fractures	50,116,680	81,701,729	5,544,299	7,690,753	145,053,461	
	- Re-fractures	1,967,993	5,309,377	418,527	501,044	8,196,942	
	Total Wrist Fracture Cost	**52,084,673**	**87,011,106**	**5,962,826**	**8,191,797**	**153,250,403**	**6%**
Vertebral							
Direct costs:	- New Fractures	39,674,428	146,751,003	17,195,661	25,352,487	228,973,580	
	- Re-fractures	1,959,558	11,630,059	1,552,074	2,113,003	17,254,693	
	Total Direct Costs	**41,633,986**	**158,381,062**	**18,747,735**	**27,465,490**	**246,228,273**	10%
Indirect costs:	- New Fractures	3,284,153	13,937,462	1,715,530	2,928,758	21,865,903	
	- Re-fractures	162,207	1,104,548	154,843	244,097	1,665,696	
	Total Indirect Costs	**3,446,360**	**15,042,010**	**1,870,373**	**3,172,855**	**23,531,599**	1%
Total cost:	- New Fractures	42,958,580	160,688,465	18,911,192	28,281,245	250,839,483	
	- Re-fractures	2,121,765	12,734,606	1,706,917	2,357,101	18,920,389	
	Total Vertebral Fracture Cost	**45,080,346**	**173,423,072**	**20,618,108**	**30,638,346**	**269,759,871**	**11%**
Other Fracture							
Direct costs:	- New Fractures	249,488,014	272,870,447	124,568,800	146,801,351	793,728,612	
	- Re-fractures	9,780,943	17,654,649	9,398,707	9,485,182	46,319,481	
	Total Direct Costs	**259,268,957**	**290,525,096**	**133,967,507**	**156,286,533**	**840,048,093**	35%
Indirect costs:	- New Fractures	20,467,356	35,558,672	9,664,275	17,370,815	83,061,118	
	- Re-fractures	802,403	2,300,637	729,169	1,122,369	4,954,579	
	Total Indirect Costs	**21,269,759**	**37,859,310**	**10,393,444**	**18,493,184**	**88,015,697**	4%
Total cost:	- New Fractures	269,955,370	308,429,119	134,233,075	164,172,166	876,789,730	
	- Re-fractures	10,583,346	19,955,287	10,127,876	10,607,551	51,274,060	
	Total 'Other' Fracture Cost	**280,538,716**	**328,384,406**	**144,360,951**	**174,779,717**	**928,063,790**	**39%**
All Fractures							
Direct costs:	- New Fractures	375,896,122	1,075,922,825	178,343,028	402,018,578	2,032,180,554	86%
	- Re-fractures	15,420,935	75,514,104	14,015,175	28,306,479	133,256,694	6%
	Total Direct Costs	**391,317,058**	**1,151,436,929**	**192,358,204**	**430,325,056**	**2,165,437,247**	**91%**
Indirect costs:	- New Fractures	31,100,364	103,963,093	15,072,996	41,329,695	191,466,149	8%
	- Re-fractures	1,280,841	7,245,646	1,194,740	2,895,636	12,616,863	1%
	Total Indirect Costs	**32,381,205**	**111,208,739**	**16,267,737**	**44,225,331**	**204,083,012**	**9%**
Total cost:	- New Fractures	406,996,487	1,179,885,918	193,416,025	443,348,273	2,223,646,702	94%
	- Re-fractures	16,701,777	82,759,750	15,209,916	31,202,115	145,873,557	6%
	TOTAL COST – ALL FRACTURES	**423,698,263**	**1,262,645,669**	**208,625,940**	**474,550,387**	**2,369,520,260**	**100%**

2020		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	40,445,510	601,519,988	31,808,149	231,745,316	905,518,964	
	- Re-fractures	1,867,805	42,758,306	2,708,161	16,901,131	64,235,403	
	Total Direct Costs	**42,313,315**	**644,278,294**	**34,516,310**	**248,646,447**	**969,754,366**	40%
Indirect costs:	- New Fractures	4,073,721	50,567,121	3,350,971	21,274,706	79,266,519	
	- Re-fractures	188,128	3,594,501	285,303	1,551,559	5,619,491	
	Total Indirect Costs	**4,261,848**	**54,161,622**	**3,636,274**	**22,826,266**	**84,886,010**	3%
Total cost:	- New Fractures	44,519,231	652,087,109	35,159,120	253,020,023	984,785,482	
	- Re-fractures	2,055,933	46,352,807	2,993,464	18,452,690	69,854,894	
	Total Hip Fracture Cost	**46,575,163**	**698,439,916**	**38,152,584**	**271,472,713**	**1,054,640,376**	**43%**
Wrist							
Direct costs:	- New Fractures	47,379,195	78,800,218	5,225,094	7,396,905	138,801,413	
	- Re-fractures	1,861,769	5,117,029	394,330	482,089	7,855,216	
	Total Direct Costs	**49,240,964**	**83,917,247**	**5,619,424**	**7,878,994**	**146,656,629**	6%
Indirect costs:	- New Fractures	3,367,586	5,893,166	388,127	604,205	10,253,083	
	- Re-fractures	132,330	382,683	29,291	39,379	583,682	
	Total Indirect Costs	**3,499,915**	**6,275,849**	**417,418**	**643,583**	**10,836,765**	0.4%
Total cost:	- New Fractures	50,746,781	84,693,384	5,613,221	8,001,110	149,054,495	
	- Re-fractures	1,994,098	5,499,712	423,621	521,467	8,438,899	
	Total Wrist Fracture Cost	**52,740,879**	**90,193,096**	**6,036,842**	**8,522,577**	**157,493,394**	**6%**
Vertebral							
Direct costs:	- New Fractures	40,174,052	152,119,775	17,409,393	26,375,811	236,079,031	
	- Re-fractures	1,986,068	12,042,509	1,571,618	2,198,068	17,798,263	
	Total Direct Costs	**42,160,120**	**164,162,284**	**18,981,011**	**28,573,879**	**253,877,294**	10%
Indirect costs:	- New Fractures	3,325,510	14,447,353	1,736,853	3,046,974	22,556,691	
	- Re-fractures	164,402	1,143,720	156,793	253,924	1,718,839	
	Total Indirect Costs	**3,489,912**	**15,591,073**	**1,893,646**	**3,300,898**	**24,275,529**	1%
Total cost:	- New Fractures	43,499,562	166,567,128	19,146,247	29,422,785	258,635,722	
	- Re-fractures	2,150,470	13,186,229	1,728,411	2,451,992	19,517,102	
	Total Vertebral Fracture Cost	**45,650,032**	**179,753,357**	**20,874,657**	**31,874,777**	**278,152,824**	**11%**
Other Fracture							
Direct costs:	- New Fractures	252,624,745	282,862,088	126,117,327	152,725,454	814,329,614	
	- Re-fractures	9,910,685	18,287,546	9,513,100	9,871,808	47,583,140	
	Total Direct Costs	**262,535,430**	**301,149,634**	**135,630,428**	**162,597,262**	**861,912,754**	35%
Indirect costs:	- New Fractures	20,724,685	36,860,717	9,784,412	18,071,807	85,441,621	
	- Re-fractures	813,047	2,383,112	738,044	1,168,118	5,102,321	
	Total Indirect Costs	**21,537,732**	**39,243,829**	**10,522,456**	**19,239,925**	**90,543,942**	4%
Total cost:	- New Fractures	273,349,430	319,722,805	135,901,740	170,797,261	899,771,234	
	- Re-fractures	10,723,732	20,670,658	10,251,144	11,039,927	52,685,461	
	Total 'Other' Fracture Cost	**284,073,162**	**340,393,463**	**146,152,884**	**181,837,187**	**952,456,696**	**39%**
All Fractures							
Direct costs:	- New Fractures	380,623,501	1,115,302,069	180,559,963	418,243,487	2,094,729,021	86%
	- Re-fractures	15,626,327	78,205,390	14,187,209	29,453,096	137,472,023	6%
	Total Direct Costs	**396,249,829**	**1,193,507,459**	**194,747,172**	**447,696,583**	**2,232,201,043**	**91%**
Indirect costs:	- New Fractures	31,491,501	107,768,357	15,260,364	42,997,692	197,517,913	8%
	- Re-fractures	1,297,906	7,504,016	1,209,431	3,012,981	13,024,334	1%
	Total Indirect Costs	**32,789,408**	**115,272,373**	**16,469,795**	**46,010,672**	**210,542,247**	**9%**
Total cost:	- New Fractures	412,115,003	1,223,070,425	195,820,327	461,241,178	2,292,246,934	94%
	- Re-fractures	16,924,234	85,709,406	15,396,640	32,466,077	150,496,357	6%
	TOTAL COST – ALL FRACTURES	**429,039,236**	**1,308,779,832**	**211,216,967**	**493,707,255**	**2,442,743,291**	**100%**

2021		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	41,080,220	622,651,840	32,285,873	240,558,446	936,576,380	
	- Re-fractures	1,891,327	44,321,183	2,741,919	17,582,471	66,536,901	
	Total Direct Costs	**42,971,547**	**666,973,024**	**35,027,792**	**258,140,918**	**1,003,113,281**	40%
Indirect costs:	- New Fractures	4,137,650	52,343,582	3,401,299	22,083,770	81,966,301	
	- Re-fractures	190,497	3,725,886	288,860	1,614,108	5,819,350	
	Total Indirect Costs	**4,328,146**	**56,069,467**	**3,690,159**	**23,697,878**	**87,785,650**	3%
Total cost:	- New Fractures	45,217,870	674,995,422	35,687,172	262,642,217	1,018,542,681	
	- Re-fractures	2,081,824	48,047,069	3,030,779	19,196,579	72,356,251	
	Total Hip Fracture Cost	**47,299,694**	**723,042,491**	**38,717,951**	**281,838,796**	**1,090,898,931**	**43%**
Wrist							
Direct costs:	- New Fractures	48,126,266	81,564,600	5,303,807	7,677,881	142,672,554	
	- Re-fractures	1,885,244	5,304,011	399,205	501,563	8,090,023	
	Total Direct Costs	**50,011,510**	**86,868,611**	**5,703,012**	**8,179,444**	**150,762,577**	6%
Indirect costs:	- New Fractures	3,420,685	6,099,903	393,974	627,156	10,541,718	
	- Re-fractures	133,998	396,667	29,653	40,969	601,288	
	Total Indirect Costs	**3,554,683**	**6,496,570**	**423,627**	**668,125**	**11,143,006**	0.4%
Total cost:	- New Fractures	51,546,952	87,664,503	5,697,781	8,305,037	153,214,272	
	- Re-fractures	2,019,242	5,700,677	428,858	542,533	8,691,311	
	Total Wrist Fracture Cost	**53,566,194**	**93,365,180**	**6,126,639**	**8,847,570**	**161,905,583**	**6%**
Vertebral							
Direct costs:	- New Fractures	40,803,050	157,467,455	17,670,478	27,379,429	243,320,412	
	- Re-fractures	2,011,033	12,482,985	1,591,196	2,286,674	18,371,888	
	Total Direct Costs	**42,814,083**	**169,950,440**	**19,261,674**	**29,666,104**	**261,692,301**	10%
Indirect costs:	- New Fractures	3,377,577	14,955,241	1,762,901	3,162,913	23,258,632	
	- Re-fractures	166,468	1,185,553	158,746	264,160	1,774,928	
	Total Indirect Costs	**3,544,046**	**16,140,795**	**1,921,647**	**3,427,073**	**25,033,560**	1%
Total cost:	- New Fractures	44,180,627	172,422,697	19,433,378	30,542,343	266,579,045	
	- Re-fractures	2,177,502	13,668,538	1,749,942	2,550,835	20,146,816	
	Total Vertebral Fracture Cost	**46,358,129**	**186,091,234**	**21,183,320**	**33,093,177**	**286,725,861**	**11%**
Other Fracture							
Direct costs:	- New Fractures	256,608,111	292,785,141	128,017,211	158,526,813	835,937,277	
	- Re-fractures	10,035,650	18,955,793	9,630,702	10,270,596	48,892,742	
	Total Direct Costs	**266,643,762**	**311,740,934**	**137,647,914**	**168,797,410**	**884,830,019**	35%
Indirect costs:	- New Fractures	21,051,470	38,153,824	9,931,809	18,758,274	87,895,377	
	- Re-fractures	823,299	2,470,194	747,167	1,215,306	5,255,966	
	Total Indirect Costs	**21,874,769**	**40,624,017**	**10,678,976**	**19,973,580**	**93,151,343**	4%
Total cost:	- New Fractures	277,659,581	330,938,965	137,949,020	177,285,087	923,832,654	
	- Re-fractures	10,858,949	21,425,986	10,377,870	11,485,903	54,148,708	
	Total 'Other' Fracture Cost	**288,518,531**	**352,364,951**	**148,326,890**	**188,770,990**	**977,981,362**	**39%**
All Fractures							
Direct costs:	- New Fractures	386,617,648	1,154,469,037	183,277,369	434,142,570	2,158,506,623	86%
	- Re-fractures	15,823,255	81,063,971	14,363,022	30,641,306	141,891,554	6%
	Total Direct Costs	**402,440,903**	**1,235,533,008**	**197,640,391**	**464,783,876**	**2,300,398,178**	**91%**
Indirect costs:	- New Fractures	31,987,382	111,552,550	15,489,982	44,632,113	203,662,028	8%
	- Re-fractures	1,314,262	7,778,299	1,224,427	3,134,544	13,451,532	1%
	Total Indirect Costs	**33,301,644**	**119,330,849**	**16,714,409**	**47,766,657**	**217,113,559**	**9%**
Total cost:	- New Fractures	418,605,030	1,266,021,587	198,767,351	478,774,683	2,362,168,651	94%
	- Re-fractures	17,137,517	88,842,270	15,587,449	33,775,850	155,343,086	6%
	TOTAL COST – ALL FRACTURES	**435,742,547**	**1,354,863,857**	**214,354,800**	**512,550,533**	**2,517,511,737**	**100%**

2022		Total Cost of of Fractures (2012$)					
		Women		Men		All	% Total Cost – All Fractures
Fracture Type		50-69 years	70+ years	50-69 years	70+ years		
Hip							
Direct costs:	- New Fractures	41,673,321	643,612,013	32,731,890	249,300,594	967,317,819	
	- Re-fractures	1,921,182	45,878,413	2,782,981	18,251,565	68,834,141	
	Total Direct Costs	**43,594,503**	**689,490,426**	**35,514,872**	**267,552,158**	**1,036,151,960**	40%
Indirect costs:	- New Fractures	4,197,387	54,105,611	3,448,287	22,886,318	84,637,603	
	- Re-fractures	193,504	3,856,795	293,186	1,675,532	6,019,016	
	Total Indirect Costs	**4,390,891**	**57,962,406**	**3,741,472**	**24,561,850**	**90,656,619**	3%
Total cost:	- New Fractures	45,870,709	697,717,624	36,180,177	272,186,911	1,051,955,421	
	- Re-fractures	2,114,686	49,735,208	3,076,167	19,927,097	74,853,157	
	Total Hip Fracture Cost	**47,985,394**	**747,452,832**	**39,256,344**	**292,114,008**	**1,126,808,578**	**43%**
Wrist							
Direct costs:	- New Fractures	48,819,903	84,305,490	5,376,981	7,956,639	146,459,012	
	- Re-fractures	1,914,646	5,490,874	405,068	520,726	8,331,314	
	Total Direct Costs	**50,734,549**	**89,796,364**	**5,782,049**	**8,477,365**	**154,790,327**	6%
Indirect costs:	- New Fractures	3,469,987	6,304,884	399,409	649,926	10,824,206	
	- Re-fractures	136,088	410,641	30,089	42,535	619,353	
	Total Indirect Costs	**3,606,075**	**6,715,525**	**429,498**	**692,460**	**11,443,559**	0.4%
Total cost:	- New Fractures	52,289,890	90,610,374	5,776,390	8,606,565	157,283,218	
	- Re-fractures	2,050,734	5,901,516	435,157	563,261	8,950,667	
	Total Wrist Fracture Cost	**54,340,624**	**96,511,889**	**6,211,547**	**9,169,825**	**166,233,886**	**6%**
Vertebral							
Direct costs:	- New Fractures	41,392,637	162,772,637	17,914,745	28,374,885	250,454,904	
	- Re-fractures	2,043,006	12,920,936	1,615,213	2,373,551	18,952,706	
	Total Direct Costs	**43,435,643**	**175,693,573**	**19,529,958**	**30,748,436**	**269,407,610**	10%
Indirect costs:	- New Fractures	3,426,382	15,459,093	1,787,270	3,277,910	23,950,655	
	- Re-fractures	169,115	1,227,147	161,142	274,196	1,831,601	
	Total Indirect Costs	**3,595,497**	**16,686,240**	**1,948,412**	**3,552,106**	**25,782,255**	1%
Total cost:	- New Fractures	44,819,019	178,231,730	19,702,015	31,652,795	274,405,558	
	- Re-fractures	2,212,121	14,148,083	1,776,355	2,647,747	20,784,307	
	Total Vertebral Fracture Cost	**47,031,140**	**192,379,813**	**21,478,370**	**34,300,543**	**295,189,865**	**11%**
Other Fracture							
Direct costs:	- New Fractures	260,306,564	302,623,869	129,783,401	164,282,386	856,996,220	
	- Re-fractures	10,192,165	19,623,616	9,772,157	10,662,992	50,250,930	
	Total Direct Costs	**270,498,729**	**322,247,485**	**139,555,558**	**174,945,379**	**907,247,150**	35%
Indirect costs:	- New Fractures	21,354,882	39,435,942	10,068,833	19,439,323	90,298,980	
	- Re-fractures	836,139	2,557,220	758,142	1,261,738	5,413,239	
	Total Indirect Costs	**22,191,021**	**41,993,162**	**10,826,975**	**20,701,062**	**95,712,219**	4%
Total cost:	- New Fractures	281,661,445	342,059,811	139,852,234	183,721,710	947,295,200	
	- Re-fractures	11,028,304	22,180,836	10,530,298	11,924,731	55,664,169	
	Total 'Other' Fracture Cost	**292,689,749**	**364,240,647**	**150,382,533**	**195,646,440**	**1,002,959,369**	**39%**
All Fractures							
Direct costs:	- New Fractures	392,192,424	1,193,314,009	185,807,018	449,914,504	2,221,227,955	86%
	- Re-fractures	16,070,999	83,913,840	14,575,419	31,808,834	146,369,092	6%
	Total Direct Costs	**408,263,423**	**1,277,227,849**	**200,382,437**	**481,723,338**	**2,367,597,047**	**91%**
Indirect costs:	- New Fractures	32,448,638	115,305,530	15,703,799	46,253,477	209,711,443	8%
	- Re-fractures	1,334,846	8,051,803	1,242,558	3,254,001	13,883,209	1%
	Total Indirect Costs	**33,783,484**	**123,357,333**	**16,946,357**	**49,507,478**	**223,594,652**	**9%**
Total cost:	- New Fractures	424,641,062	1,308,619,539	201,510,817	496,167,981	2,430,939,398	94%
	- Re-fractures	17,405,845	91,965,643	15,817,977	35,062,836	160,252,301	6%
	TOTAL COST – ALL FRACTURES	**442,046,907**	**1,400,585,182**	**217,328,794**	**531,230,816**	**2,591,191,699**	**100%**

osteoporosis australia

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This report was prepared for Osteoporosis Australia, Level 2, 255 Broadway, Glebe, NSW 2037
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