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The current economic burden of illness of osteoporosis in Canada

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Abstract

Summary—We estimate the current burden of illness of osteoporosis in Canada is double ($4.6 billion) our previous estimates ($2.3 billion) due to improved data capture of the multiple encounters and services that accompany a fracture: emergency room, admissions to acute and step-down non-acute institutions, rehabilitation, home-assisted or long-term residency support.

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Introduction—We previously estimated the economic burden of illness of osteoporosis-attributable fractures in Canada for the year 2008 to be $2.3 billion in the base case and as much as $3.9 billion. The aim of this study is to update the estimate of the economic burden of illness for osteoporosis-attributable fractures for Canada based on newly available home care and long-term care (LTC) data.

Methods—Multiple national databases were used for the fiscal-year ending March 31, 2011 (FY 2010/2011) for acute institutional care, emergency visits, day surgery, secondary admissions for rehabilitation, and complex continuing care, as well as national dispensing data for osteoporosis medications. Gaps in national data were supplemented by provincial and community survey data. Osteoporosis-attributable fractures for Canadians age 50+ were identified by ICD-10-CA codes. Costs were expressed in 2014 dollars.

Results—In FY 2010/2011, the number of osteoporosis-attributable fractures was 131,443 resulting in 64,884 acute care admissions and 983,074 acute hospital days. Acute care costs were $1.5 billion, an 18 % increase since 2008. The cost of LTC was 33.4 times the previous estimate ($31 million versus $1.03 billion) because of improved data capture. The cost for rehabilitation and secondary admissions increased 3.4 fold, while drug costs decreased 19 %. The overall cost of osteoporosis was over $4.6 billion, an increase of 83 % from the 2008 estimate.

Conclusion—Since the 2008 estimate, new Canadian data on home care and LTC are available which provided a better estimate of the burden of osteoporosis in Canada. This suggests that our previous estimates were seriously underestimated.

Keywords

Burden of illness; Canada; Fractures; Health economics; Osteoporosis

Introduction

We previously estimated the economic burden of illness of osteoporosis in Canada in 2008 to be $2.3 billion, which consisted of $1.2 billion for acute institutional care, $0.2 billion for secondary admissions for extended care such as rehabilitation hospitals or wards, $142 million for physician costs, $390 million for prescribed drug costs, and $115 million for time loss for patients and caregivers [1]. The analysis was conducted with several data sources including national administrative data for acute institutional care from the Canadian Institute for Health Information (CIHI) [2], which are high quality standardized mandatory data in Canada.

While the burden of illness estimates for acute and secondary admissions were constructed from available high quality standardized mandatory data, other costs were estimated from assumptions and extrapolations, which were not nationally available. The cost estimates that were considered the weakest were for supportive care at home (home care) and long-term care (LTC), due to the lack of mandatory reporting and relative resource intensity-based estimates in Canada. The first weakness was that we relied on the provincial and non-fracture specific average daily cost for home care and LTC observed in Ontario. However, these estimates did not reflect the increased level of resources that might be provided in home care or LTC for patients with a fracture who may have limited ability to perform daily

tasks and require intensive rehabilitation. A second limitation of our previous analysis was that we could not estimate the increased level of care that occurred for a patient with a fracture who already resided in LTC and then returned to LTC requiring more intensive healthcare services. In the absence of reliable data, we only included the costs associated with net transfers to LTC (number of individuals discharged to LTC following a fracture minus the number of individuals originally living in LTC before the fracture). For these reasons, our previous estimate regarding LTC costs was very conservative at $28 million. In a scenario analysis in which we assumed that a proportion of patients were residing in LTC due to osteoporosis-attributable fractures, the estimate of the attributable cost of LTC was $1.6 billion.

Fortunately, the InterRai Minimum Data Set quarterly assessments provide an accurate estimate of duration and resource intensity for LTC and have become mandatory for all home care and LTC in Ontario, the largest province of Canada (e.g., 38 % of the Canadian population) since 2009 [3]. This provides an opportunity to revise our previous estimates regarding the LTC and home care costs associated with osteoporosis-attributable fractures. Although there are important differences in home care services across the provinces (e.g., level of coverage, physician prescribing requirement to receive home care services), data from Ontario were used in our analyses to represent the other Canadian provinces due to the comprehensive and mandatary reporting of home care and LTC services in Ontario. In addition, the previous estimates did not include the costs associated with rehabilitation clinic visits, such as physiotherapy and occupational therapy, which have been available for Alberta since 2010, and the indication of use of mobility devices in home care and LTC in Ontario since 2009.

The availability of these new data allows us to provide a better estimate of the economic costs of osteoporosis in Canada. Specifically, the objectives of this analysis were to update the previous burden of illness of osteoporosis-attributable fractures in Canada with recently made available mandatory reporting for home care and LTC. All the other costs (acute care, physician visits, and medications) were also updated using more recent data.

Methods

Overview

Based on the method that has been previously published [1] to estimate the economic burden of osteoporosis in Canada in 2008, we followed a prevalence-based macro-approach, using national data, if available, and supplemented with provincial and community data extrapolated to the national level. We identified fractures based on International Statistical Classification of Diseases and Related Health Problems (ICD CA) diagnosis codes at the time of hospital admission or emergency room visit. We updated the costs for home care, LTC, and mobility devices with newly available Ontario-based data on daily service costs and duration of care, as well as the costs of rehabilitation clinic visits based on the new data from Alberta. To capture all post-fracture discharges and transfers to institutional care, we identified the costs incurred in the FY 2010 and FY 2011 for patients who sustained a fracture in FY 2010, to provide at least 1 year follow-up for all patients. All other costs (e.g., acute care) were updated using 2011 data (rather than 2008 data). In the absence of national

data, provincial data were extrapolated to national levels, using data from the most comprehensive provinces (Alberta and Ontario). The burden of illness estimate is presented in 2014 Canadian dollars reflecting current unit costs, and where current costs were not available, we inflated historical costs with the health care inflation index for health care services.

Data

A detailed description of the main data sources used for the analysis has been published elsewhere [1]. In brief, we used five linked administrative data sets from the Canadian Institute for Health Information (CIHI) to gather national data on: acute care (Discharge Abstract Database—DAD) [4]; emergency visits, same day surgery, and hospital-based clinics (National Ambulatory Care Reporting System—NACRS for Ontario and Alberta) [5]; rehabilitation services (National Rehabilitation Reporting System—NRS) [6]; home care (Home Care Reporting System—HCRS for Ontario) [7]; and LTC (Continuing Care Reporting System—CCRS for Ontario) [8] [See Supplementary Table S1 for a summary of data sources and costing methods]. Since 2009, mandatory assessments are made for any patient receiving home care or LTC and are conducted quarterly or with a change in clinical status. The assessments are conducted, by a nurse or social worker, using the InterRai Minimum Data Set (MDS) questionnaire, which has more than 200 questions and include sections on relative resource use based on Case Mixed Index (CMI) (3). The CMI is a group index that includes 33 Resource Utilization Group (RUG)-III categories for resource intensity including: personal support, nursing, physical therapy, occupational therapy, social work, and dietetics, which can be translated as a relative resource intensity cost per day by CMI. Unlike the previous estimate, which was based on a small survey, outpatient physician costs were derived from linked data from the province of Manitoba [9]. Like the previous estimate, prescription drugs costs were derived from IMS Brogan [10]. Patient and family productivity losses were estimated from the Canadian Multicentre Osteoporosis Study (CaMos) [11] and Statistics Canada [12]. All data were abstracted for the fiscal-year April 1, 2010, to March 31, 2011, for simplicity referred to as the year 2011.

Identification of fractures

Unique patients aged 50 years and above were identified as having a fracture if they reported an admission, day surgery, emergency room visit, or hospital-based clinic visit with an ICD-10-CA code for fracture in the year 2011. [See Supplementary Table S2 for ICD-10-CA codes]. Fracture types included only those sites that are considered osteoporosis-attributable based on low bone mineral density as a causal factor: hip, humerus, vertebral, wrist (distal forearm), other (femur, lower leg (tibia, fibula, knee, foot), lower arm (radius, ulna), ribs, shoulder, arm, sternum, clavicle, pelvis), and multiple (more than 1 of the above) [13]. Fractures with high impact trauma codes such as accidents were excluded. Hip and vertebral fractures were considered 100 % attributable to osteoporosis, while all other fractures were considered 81.5 % attributable to osteoporosis for women and 56 % for men. These attribution rates were based on Mackey et al.[13], using the same methodology described in our previous study [1].

For every admission, day surgery, or emergency/clinic visit, as part of the mandatory data captured across Canada, there is a unique field that lists the patient's residency status prior to fracture and to where they were discharged. Residency status included the following: at home with supportive care (home care); in nurse-based residential LTC; and transfers from other non-acute institutions, i.e., a rehabilitation hospital or dedicated rehabilitation ward and admission to complex continuing chronic care. From this linkage, we estimated the healthcare utilization and costs incurred during the 1-year period following the index fracture, such as secondary admissions, home care, LTC, outpatient physician services, mobility devices, and rehabilitation clinic visits. The total economic burden of osteoporosis-attributable fractures was estimated using average cost per fracture times the number of osteoporosis-attributable fractures (after the attribution percentage was applied).

Estimation of costs for acute care

Similar to our previous publication, we were required to make some extrapolations for provinces for which data was not available. The number of hospital admissions was based on the DAD database, excluding the provinces of Quebec and British Columbia, which were not available due to their local privacy regulations, requiring further data release approval. As such, the number of fractures and costs were extrapolated for Quebec and British Columbia based on population demographics. Similarly, the number of emergency room visits and same day surgeries were based on the NACRS database for Ontario and Alberta and extrapolated to the national level. The costs associated with each category of acute care were calculated by multiplying the resource intensity weight (RIW) recorded for each individual and standardized by CIHI, by the average cost per RIW unit, where RIW = 1.0 represents the average cost for all admissions in Canada. Additional costs for physician fees for daily assessments in hospital, surgical procedures, and diagnostic tests are not included in RIWs, and the typical resource utilization was added with guidance from clinical experts, and then unit costs were estimated using Ontario billing fee schedule [14]. Relevant admissions included most responsible diagnosis for fracture and subsequent fracture-related admissions such as ICD-10-CA: T84—complications of internal orthopedic prosthetic devices, implants, and grafts; Z47—other orthopedic follow-up care; and Z544—convalescence following treatment of fracture. In Canada, the most responsible diagnosis is recorded for every admission or hospital/ward transfer and is the diagnosis code which accounts for the majority of the costs or contributes the most to the length of stay.

Estimation of physician and prescription drug costs

The cost of physician visits due to osteoporosis-attributable fractures was based on a previous publication which reported the excess number of physician visits that occurred 1 year post-fracture for incident fractures relative to non-fracture controls from a provincial-based analysis from Manitoba for the year 2008 [9]. Since physician billings data are not captured in the administrative databases, the excess number of physician visits provided an estimate of physician fees post-fracture, by type of fracture, after adjustment for a control group to adjust for comorbidities.[9] Ontario fees were applied to the number of visits to derive the total cost of physician visits, acknowledging the limitation that fees vary according to provincial jurisdiction, with Ontario fees for general consultations being lower than the median for all provinces [15]. The 2014 costs associated with osteoporosis-

attributable prescription drugs (e.g., alendronate, denosumab, etidronate, risedronate, zoledronic acid, teriparatide, raloxifene) were derived from IMS Brogan Inc. [10], similar to the previous publication. IMS Brogan data were provided in aggregate form by Amgen Canada. Calcium and vitamin D supplements were not included in the analyses.

Estimation of costs for rehabilitation, complex continuing care, mobility devices, home care, and LTC

Using recently available data, the costs for admissions to rehabilitation and complex continuing care institutions or dedicated wards were estimated with the same methodology as the cost of an admission in acute care. Costs were calculated by multiplying the number of new transfers by the average NRS and CCRS's RIW adjusted for resource intensity using Ontario average pricing and supplemented with associated physician fees.

The cost for rehabilitation clinic visits was estimated using data from the province of Alberta's hospital-based rehabilitation clinics and extrapolated to the rest of Canada. For each patient, we captured the probability of visiting rehabilitation clinics, the number of visits, and cost per visit to derive the average cost per rehabilitation treatment by type of fracture. Visits were included based on appropriate ICD 10 CA codes (i.e., Z501: other physical therapy, Z507: occupational therapy and vocational rehabilitation, not elsewhere classified). We relied on the MDS to report the use of medical devices to aid mobility, i.e., cane, walker, or wheelchair, and applied local Ontario prices to estimate the average cost of devices to aid mobility, for patients that required home care and LTC. The costs for home care and LTC were estimated using Ontario-based cost and resource use data and extrapolated to the rest of Canada based on population demographics. Specifically, using MDS data from Ontario, we multiplied the resource intensity by the average cost per day at each assessment by the duration between assessments to estimate total costs for the episode for each patient for home care and LTC. Results were extrapolated to Canada based on population demographics.

Estimation of costs associated with wage losses

For an estimate of the wage loss incurred for patients who were in a health care institution and consistent with our previous study [1], we multiplied the number of days spent in acute and non-acute care by the age-specific labor force participation rate and by the Canadian average daily wage of $25.89 [12] per hour. To estimate the cost for time loss by a caregiver associated with each fracture, we used CaMos [11] and CIHI data [12]. CaMos is an ongoing population-based longitudinal study of community-dwelling adults (ages 25 years and older) which are being assessed annually to obtain medication and fracture history, and have periodic detailed clinical assessment including bone mineral density testing. The value of time loss for caregiving by the patients' family member or friends were derived from CaMOS and included as forgone wages. This was calculated by multiplying the number of admissions, times the proportion of patients using caregivers, times the number of days of care by the caregiver, times the proportion of caregivers being employed, times the average daily wage. Caregiver's time was only estimated post-discharge.

Sensitivity analysis

Sensitivity analyses were conducted to assess the impact of changing the base case assumption on the attribution rate of osteoporosis fractures which were based on Mackey et al.[13], who estimated the percentage of fractures which occurred in patients with low bone mineral density. In a sensitivity analysis, we applied attribution rates from the Recognizing Osteoporosis and its Consequences (ROCQ) study, which specifically identified fragility fractures [16]. For a reference value, we also included a sensitivity analysis where 100 % of the fractures identified were considered osteoporosis-related.

Results

Number of fractures and annual risk

In 2011, there were an estimated 164,763 unique patients with a fracture, 69 % were women (N = 113,709) and 31 % were men (N = 51,054) (Table 1). The number of fractures that were attributable to osteoporosis was estimated to be 131,443 (81 %). For women, the most common types of fractures were “other” (38 %), wrist (23 %), and hip (19 %). For men, the most common types of fractures were “other” (50 %), hip fractures (17 %), and wrist fractures (15 %). The percentage of the population that had a fracture was 2.0 times higher in women than in men for all ages (women 1.85 % versus 0.92 % for men), and the percentage of the population that had any fracture increased with age. The overall percentage of the population, that had any fracture, and for both sexes was 1.41 %.

Acute care costs

The rates of healthcare resource utilization in the year following the fracture varied by type of fracture (Table 2). For example, a hip fracture on average resulted in 2.15 (standard error (SE) 0.01) emergency room visits or same day surgeries and 1.10 (SE 0.01) hospitalizations with an average length of stay of 16.1 days (SE 0.3). A wrist fracture required 1.47 (SE 0.01) emergency room visits or same day surgeries and 0.12 (SE <0.01) admissions with an average length of stay of 5.5 (SE 0.03) days.

For Canada in 2011, the total number of acute care admissions for fractures was 75,166, of which 64,884 were osteoporosis-attributable. Similarly, the total number of emergency or same day surgery visits for fractures was 267,214, of which 216,753 were osteoporosis-attributable. The total number of days spent in acute care hospitals for fractures was 1,127, 115 days, of which 983,074 days were osteoporosis-attributable. The total cost of acute care for Canada in 2011 attributable to osteoporosis was $1524 million: $1035 million for women (68 %) and $489 million for men (32 %).

Physician and prescription drug costs

The average number of physician visits in the year following fracture ranged from 11.3 for humerus fracture to 23.1 for multiple fractures (Table 2). The total number of osteoporosis-attributable visits for Canada was estimated to be 3.0 million visits, and the estimated total cost of the physician visits was $253 million. For Canada, in 2014, there was an estimated 6.37 million claims for osteoporosis drugs, of which 84 % were from public plans. The

estimated total costs for prescription drugs was $346 million, of which $249 million were from public plans (72 %) and $96 million were from private plans.

Costs for rehabilitation, complex continuing care, home care, and LTC

There was variation in the pre-fracture residency status of the patients by type of fracture, which may have an impact on the type of acute care (Table 3). Wrist fractures occurred in patients that were mostly living at home (97 %). On the other hand, 17 % of hip fractures occurred in LTC and 83 % occurred in those living at home.

In addition, the type of fracture and pre-fracture residency status may have an impact on the level of secondary care (Table 3). Following a hip fracture, the proportion of patients that transferred to a rehabilitation ward or hospital was 16 %, and 35 % of patients were admitted to a longer term complex continuing care hospital bed. On the other hand, a patient with a wrist fracture had less than 3 % chance of admission to either rehabilitation or complex continuing care. The rate of transfer to home care was higher for patients with vertebral fractures (32 %), multiple fractures (28 %), and hip fractures (28 %). The rate of transfer to LTC was overall lower than the rates of new transfers to home care, except for hip fractures which were more likely to lead to a transfer to LTC. As a result, the osteoporosis-attributable total cost for home care was $274 million and the total cost for LTC was $1.03 billion. The cost of rehabilitation medical clinics was $19 million with 40 % of patients with a fracture requiring on average six clinic visits, and the cost of mobility devices was $101 million with 85 % of home care patients and 90 % of LTC patients requiring a mobility device (Table 4).

Costs associated with wage loss

The total days in health care institutions for patients with osteoporosis-attributable fractures that would be eligible to work (i.e., ages 50 to 69 years) was 2,601,905 days. Applying the national average labor participation rates resulted in an estimated 1,492,533 days lost work for the patients. In addition to the 405,664 days lost work for caregivers, the total osteoporosis-attributable cost of wage loss for both patients and caregivers was $304 million, which was 72 % borne by the patient.

Cost of osteoporosis and comparison to previous publication

In Canada for 2011, the aggregate cost of osteoporosis-attributable fractures was $4.6 billion, which represents an increase of 83 % from the previous publication, from $2.5 billion (2015 CAD$), after adjusting for inflation (Table 5). One source of increase was from acute care costs increasing from $1.3 billion to $1.5 billion, mostly due to the increased number of acute care admissions for osteoporosis-attributable fractures rising between 2008 and 2011 (57,413 to 64,884), and the increased costs of hospitalization beyond inflation.

The largest changes from the previous publication were the cost of LTC, increasing from $31 million to $1.03 billion (or 33.4 times higher). This change was due to our ability to capture the additional cost of patients that returned to LTC post-fracture and from identifying more unique cases that transferred to LTC beyond the first hospital discharge. In addition, the cost of rehabilitation admissions increased considerably from $106 million in 2008 to $334 million in 2011 and the cost of complex continuing care admissions increased

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from $123 to $434 million, both due to capturing the new transfers, instead of relying on net transfers only as in the previous publication. While the number of prescription drug claims remaining unchanged, the drug costs decreased by 19 %, most likely due to the introduction of generics between 2008 and 2011. The addition of the costs for mobility devices was also important ($101 million), which was not previously available.

Sensitivity analyses results

Our base case analysis which was based on the osteoporosis attribution rates given in Mackey et al.[13] resulted in 131,443 osteoporosis-related fractures in FY 2010/2011 (80 % of the total number of fractures) with associated costs estimated at $4.62 billion. When the attribution rate from the ROCQ study [16] was applied, the number of fractures attributable to osteoporosis increased to 143,377 (87 % of total number of fractures) with a burden of $4.80 billion (Table 6). When 100 % attribution was applied, the burden of illness was $5.20 billion (a rise of 13 % from base case).

Discussion

Our objective was to update our previous 2008 estimate of the burden of illness of osteoporosis in Canada, because of the availability of new data that has not been previously explored at the national level. These data, the mandatory reporting of case mix index and associated care in home care and LTC, have become mandatory in Ontario since 2009, with other provinces soon following. The new data allowed us to track and quantify the resource intensity for new transitions to home care and LTC and the incremental cost for patients who previously resided in home care or LTC and returned. Results of the current analysis show that the cost of home care and LTC in our previous work was greatly under-reported, as discussed in our previous publication, due to the paucity of data.

Specifically, our current analysis updated the cost of LTC, which accounted for 22 % of the total economic burden of illness for osteoporosis-attributable fractures being $1.03 billion instead of $31 million, but there is still some uncertainty. Previous estimates, such as Nikitovic et al. 2013 [17] found that LTC costs accounted for 70 and 51 % of costs in the second year after fracture in women and men, respectively. Further investigation into whether there was a long-term rise in resource intensity will be possible as the new data matures with even longer duration follow-up. Recently, the economic burden of osteoporosis in 27 countries of the European Union has been calculated using a model based on literature data on fracture incidence and costs [18]. Despite the differences in methodology, our cost estimates per capita (e.g., $4.6 billion for a population of 31.6 million or $146 per capita) are aligned with figures reported in Europe after transformation to Canadian dollars. For example, the cost of osteoporosis in the UK was estimated at €4.4 billion (2010) Euros ($6.3 billion in 2015 Canadian dollars) for a population of 62 million resulting in a cost of $101 per capita. In Germany, the osteoporosis cost per capita expressed in Canadian dollars was $169 (€9 billion or nearly $14 billion in 2015 Canadian dollars for a population of 81.8 million). These European publications also highlighted the future costs of osteoporosis as a result of an increased number of fractures due to the aging of the population. Overall, the

cost of osteoporosis in these 27 European countries is expected to increase from €37 billion to approximately €46 by 2025 (25 % increase).

The current analysis is referred to as the “sum diagnosis specific method” by Akobundu et al. 2006 [19], which is to identify all patients with a primary diagnosis and include only specific costs that are directly related to that diagnosis. In the case of fractures, the reasons for any admissions/visits are clearly attributable to a fracture. However, there may be co-morbidities that have also contributed to the average cost of an admission or LTC transfer after a fracture, such as dementia. Future work will include exploring the interaction that dementia has on the probability of transferring to non-acute institutions and has on costs.

The strength of our analysis is the improving ability to link data across different health care institutions. In this analysis, we were able to track a patient with a fracture through acute care to secondary admissions to home care and LTC. In addition, we were able to estimate the relative resource intensity and approximate cost of care at different institutions, which we previously were not able to, relying only on average per diem rates. Another strength of our national analysis is that were able to verify our estimates with different data within Canada, from three other independent research bodies: the Manitoba Centre for Health Policy (MCHP) [20], the Recognizing Osteoporosis and its Consequences in Quebec (ROCQ) [16], and the prospective Canadian Multicentre Osteoporosis Study (CaMos) [21]. As verification, our estimate of the cost of physician claims was similar to ROCQ [22] and MCHP [9] and the percentage use of home care and LTC was similar between our national estimate and the estimates from MCHP [9] and CaMOS [11]. The percentage use of LTC after a fracture is also consistent with other studies [17]. For example, we estimated that 37 % of patients that had a hip fracture will use LTC within 2 years post-fracture.

However, we acknowledge there are some limitations in our analysis. One gap was the inability to link physician billings to acute care. Physician billings are a provincial source of funding that can only be linked within each of the provinces through lengthy data request processes and are not available from some provinces due to privacy legislation. In contrast, analysis of institutional care is available at the national level through CIHI. We also acknowledge there may have been some uncertainty in extrapolation, including the following: relying on Ontario unit costs as representative for the rest of the country; extrapolating the number of fractures that are identified by emergency visits alone using Ontario and Alberta data; relying on Alberta data for publicly funded and not privately funded rehabilitation clinic services; and assuming the rate of transfer and cost of home care and LTC is constant across Canada. Another limitation is the possibility that factors other than a fracture could have contributed to a transfer to LTC, such as dementia. While, for the general population, the probability of transferring to LTC at an age of 80 years is less than 1 % [23], the probability of transferring to LTC post-fracture is considerable being between 3 and 17 %, which may or may not be attributable to fractures. As such, the burden associated with LTC for fractures may be overstated. This is left for future research. In addition, a major gap from using acute care data to identify the number of fractures is the underestimate of the number of vertebral fractures, which would often be diagnosed in an outpatient setting or coded as back pain. Only one third of vertebral fractures are clinically diagnosed and reported [24], which may benefit from early intervention. Another limitation

in the estimation of the number of fractures that are associated with osteoporosis may arise from inaccuracy in the rate of attribution to osteoporosis. It should be noted that our estimates may also have been underestimated due to the under-reporting of vertebral fractures and the fact that our analyses only focussed on the costs after the fracture, thus ignoring all the costs that could have occurred prior to the fracture (e.g., costs associated with a previous fracture). On the other hand, our estimates may be overstated, as some fractures may have been associated with other conditions than osteoporosis (e.g., secondary to cancer). To deal with this uncertainty, sensitivity analyses have been conducted using different attribution rates. Similarly, our estimate around the cost of osteoporosis medications may have been slightly overstated because, although the drugs listed are predominantly intended for primary and secondary osteoporosis, only rarely they may be prescribed for other indications. A final limitation in our estimate of the economic burden of illness is the exclusion of costs that are referred to as societal. These costs could be small such as the out of pocket cost of transportation for visits to the doctor's office. However, the costs may be more substantive such as the current copayment in Ontario for LTC of $1700 per month for a 3-bed ward or $2362 per month for a private room [25]. Collectively over a few years, the cost of LTC would accumulate into several billion dollars.

Conclusion

This study confirms the large and increasing economic impact of osteoporosis-attributable fractures to Canadian society. With an aging population, the burden of osteoporosis will be expected to rise due to acute care and LTC, warranting use of more healthcare resources and preventative care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Number of patients with fractures in Canada, in 2011, by type of fracture, age, and sex

Age group	Population	Hip	Wrist	Vertebral	Humerus	Other	Multiple	Total
Women								
50 to 59	2,472,362	737 (0.0 %)	8064 (0.3 %)	624 (0.0 %)	1314 (0.1 %)	9351 (0.4 %)	918 (0.0 %)	21,008 (0.8 %)
60 to 69	1,760,036	1826 (0.1 %)	7584 (0.4 %)	904 (0.1 %)	1844 (0.1 %)	8867 (0.5 %)	1271 (0.1 %)	22,296 (1.3 %)
70 to 79	1,085,293	4238 (0.4 %)	5131 (0.5 %)	1673 (0.2 %)	2015 (0.2 %)	8055 (0.7 %)	1835 (0.2 %)	22,947 (2.1 %)
80 to 89	681,159	9612 (1.4 %)	4486 (0.7 %)	2540 (0.4 %)	2423 (0.4 %)	11,779 (1.7 %)	2769 (0.4 %)	33,609 (4.9 %)
90 to 99	153,566	4924 (3.2 %)	1149 (0.7 %)	835 (0.5 %)	727 (0.5 %)	4845 (3.2 %)	1369 (0.9 %)	13,849 (9.0 %)
Total	6,152,416	22,041 (0.3 %)	26,414 (0.4 %) 6576 (0.1 %)		8323 (0.1 %)	42,897 (0.7 %)	8162 (0.1 %)	113,709 (1.9 %)
Men								
50 to 59	2,434,717	721 (0.0 %)	3322 (0.1 %)	612 (0.0 %)	499 (0.0 %)	9909 (0.0 %)	1202 (0.0 %)	16,265 (0.7 %)
60 to 69	1,677,584	1155 (0.1 %)	2270 (0.1 %)	564 (0.0 %)	593 (0.0 %)	6532 (0.0 %)	1042 (0.1 %)	12,156 (0.7 %)
70 to 79	931,624	2067 (0.2 %)	1274 (0.1 %)	641 (0.1 %)	508 (0.1 %)	4350 (0.1 %)	854 (0.1 %)	9694 (1.0 %)
80 to 89	434,464	3359 (0.8 %)	873 (0.2 %)	818 (0.2 %)	454 (0.1 %)	3557 (0.4 %)	912 (0.2 %)	9973 (2.3 %)
90 to 99	58,040	1263 (2.2 %)	126 (0.2 %)	201 (0.3 %)	136 (0.2 %)	976 (1.4 %)	264 (0.5 %)	2966 (5.1 %)
Total	5,536,429	8565 (0.2 %)	7865 (0.1 %)	2836 (0.1 %)	2190 (0.0 %)	25,324 (0.1 %)	4274 (0.1 %)	51,054 (0.9 %)
Women and Men	11,688,845	29,902 (0.3 %)	34,279 (0.3 %) 9412 (0.1 %)	10,513 (0.1 %)	68,221 (0.6 %)	12,436 (0.1 %)	164,763 (1.4 %)	
Percent fractures (%)		18.1	20.8	5.7	6.4	41.4	7.5	
Osteoporosis-related		29,902	25,932	9412	8010	49,142	9045	131,443

Data was extrapolated for the provinces of British Columbia and Quebec

N(%) number of fractures for each age group and sex (percentage of population)

Table 2

2011 Healthcare resource utilization by fracture type in the year following the fracture

	Hip	Wrist	Vertebral	Humerus	Other	Multiple
Proportion of patients who were hospitalized (%)	90	11	36	24	18	69
Acute care resource utilization, mean (SE)						
Emergency/Same day surgery visits	2.15 (0.01)	1.47 (0.01)	1.48 (0.02)	1.39 (0.01)	1.40 (0.01)	2.29 (0.02)
Acute care admissions	1.10 (0.01)	0.12 (0.00)	0.40 (0.01)	0.26 (0.01)	0.30 (0.00)	0.90 (0.01)
Average length of stay days, mean (SE)						
Acute care	16.1 (0.3)	5.5 (0.3)	15.4 (0.5)	10.7 (0.6)	14.2 (0.4)	17.7 (0.4)
Rehabilitation[a]	24.9 (na)	29.5 (na)	23.7 (na)	27.5 (na)	22.3 (na)	14.8 (na)
Complex continuing care[a]	102.9 (na)	97.0 (na)	84.9 (na)	80.5 (na)	88.7 (na)	40.4 (na)
Physician services, mean (SE)						
Outpatient physician visits[a]	22.8 (na)	26.2 (na)	14.7 (na)	11.3 (na)	12.4 (na)	23.1 (na)

[a]Published sources

na not available

Table 3

Pre-fracture residency status and post-fracture and non-acute institutions

	Hip	Wrist	Vertebral	Humerus	Other	Multiple
Residency status prior to fracture, %[a]						
Home	83	97	94	93	96	90
Long-term care	17	3	6	6	4	10
Home care	<1	<1	<1	<1	<1	<1
Post-fracture new transfers to non-acute institutions, %[b]						
Long-term care	37	7	22	16	11	28
Home care	28	10	32	21	15	28
Rehabilitation	16	2	9	4	4	13
Complex continuing care	35	3	13	6	7	23
Death in hospital	16	2	11	5	4	10

[a]Residency status prior to fracture sum to 100 %

[b]Includes all transfers; a patient may have more than one transfer (e.g., rehabilitation then transfer to long-term care)

Table 4

Average cost (standard error) per fracture (2014 Canadian dollars) in the year following the fracture

Cost component	Hip	Wrist	Vertebral	Humerus	Other	Multiple	All fractures
Acute care	$22,759 ($248)	$3488 ($67)	$8073 ($335)	$5570 ($173)	$6617 ($105)	$20,350 ($365)	$9948 ($160)
Rehab beds[a]	$6419 ($128)	$360 ($7)	$1773 ($35)	$770 ($15)	$711 ($14)	$4534 ($91)	$2027 ($41)
Rehab clinics	$119 ($1)	$148 ($3)	$124 ($2)	$175 ($16)	$89 ($4)	$116 ($6)	$116 ($4)
Complex continuing care[a]	$8200 ($820)	$236 ($24)	$3353 ($335)	$1234 ($123)	$1241 ($124)	$4112 ($411)	$2632 ($263)
LTC	$15,816 ($633)	$1725 ($69)	$8501 ($340)	$4356 ($174)	$2870 ($115)	$14,164 ($567)	$6250 ($250)
Home care	$4018 ($113)	$615 ($33)	$2166 ($96)	$1592 ($69)	$873 ($25)	$2902 ($272)	$1663 ($26)
Outpatient physician services[a]	$2510 (n.a.)	$1422 (n.a.)	$1298 (n.a.)	$793 (n.a.)	$915 (n.a.)	$3734 (n.a.)	$1537 (n.a.)
Mobility devices	$1700 (n.a.)	$123 (n.a.)	$678 (n.a.)	$446 (n.a.)	$263 (n.a.)	$1399 (n.a.)	$616 (n.a.)
Total direct medical cost	$61,540 ($1943)	$8117 ($202)	$25,965 ($1143)	$14,937 ($571)	$13,579 ($387)	$51,312 ($1712)	$24,789 ($744)
Wage loss[a]	$2109 ($188)	$563 ($34)	$994 ($84)	$925 ($72)	$1062 ($74)	$2834 ($232)	$1311 ($103)
Average cost per patient, by fracture	$63,649 ($2131)	$8681 ($237)	$26,960 ($1228)	$15,862 ($643)	$14,641 ($460)	$54,145 ($1944)	$26,100 ($847)
Average cost per patient, by pre-fracture residency status							
At home, return home	$47,772 ($1584)	$6336 ($117)	$14,575 ($645)	$8965 ($325)	$8728 ($253)	$34,417 ($928)	$13,947 ($429)
New to home care	$47,377 ($1331)	$16,867 ($376)	$26,560 ($1092)	$21,245 ($705)	$23,060 ($814)	$43,960 ($1,213)	$36,775 ($988)
New to LTC	$125,085 ($2,125)	$78,441 ($1,547)	$85,478 ($2,647)	$82,290 ($2,328)	$92,553 ($1,360)	$113,190 ($3,424)	$102,931 ($1,973)
From home care, return to home care	$48,835 ($1650)	$15,107 ($479)	$29,246 ($1535)	$18,927 ($597)	$27,165 ($1271)	$52,884 ($1851)	$32,939 ($1206)
From LTC, return to LTC	$54,822 ($1061)	$19,059 ($601)	$32,183 ($1698)	$26,353 ($1177)	$27,976 ($998)	$57,204 ($1999)	$42,200 ($1433)

[a]Published sources

LTC long-term care

Table 5

Updated burden of illness of osteoporosis in Canada

Cost component	2011 data	2008 data[a]	Difference	Change (%)[multiple]
Acute care	$1,523,964,923	$1,286,408,156	$237,556,767	18 [1.2]
Rehabilitation admissions	$333,954,603	$105,817,701	$228,136,902	216 [3.2]
Rehabilitation clinics	$19,161,822	Not included		
Complex Continuing Care	$433,607,466	$122,752,761	$310,854,705	253 [3.5]
Long-term Care	$1,029,823,336	$30,791,525	$999,031,811	3245 [33.4]
Home care	$274,015,268	$266,332,085	$7,683,183	3 [1.0]
Outpatient physician services	$253,202,281	$155,280,379	$97,921,902	63 [1.6]
Prescription drugs	$345,651,098	$425,640,924	−$79,989,826	−19 [0.8]
Wage Loss	$304,831,103	$125,574,731	$179,256,372	143 [2.4]
Mobility devices	$101,453,180	Not included		
Total burden of illness	$4,619,665,079	$2,518,598,262	$2,101,066,816	83 [1.8]

Total costs were estimated using average cost per fracture times the number of osteoporosis-related fractures (i.e., the number of fractures after attribution % was applied)

[a] [1] (data inflated with CPI heath care services x1.089 to 2014 dollars)

Table 6

Sensitivity analysis for attribution rates of osteoporosis (2011 Canadian dollars)

Cost component	Base case analysis (attribution rate from Mackey et al.)	Attribution rates using ROCQ data	Assume 100 % attribution rates of osteoporosis
Acute care	$1,523,964,923	$1,527,753,861	$1,639,121,026
Rehabilitation admissions	$333,954,603	$350,437,985	$379,608,785
Rehabilitation clinics	$19,161,822	$21,060,965	$24,421,897
Complex continuing care	$433,607,466	$107,271,004	$117,566,862
Long-term care	$1,029,823,336	$454,236,352	$490,743,490
Home care	$274,015,268	$1,092,539,179	$1,203,528,005
Outpatient physician services	$253,202,281	$294,253,120	$330,068,240
Prescription drugs	$345,651,098	$278,385,368	$317,836,974
Wage loss	$304,831,103	$345,651,098	$345,651,098
Mobility devices	$101,453,180	$324,876,538	$353,454,062
Total burden of illness	$4,619,665,079	$4,796,465,470	$5,202,000,439

ROCQ Recognizing Osteoporosis and its Consequences Study