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Comparative trends in incident fracture rates for all long-term care and community-dwelling seniors in Ontario, Canada, 2002–2012

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Abstract

Summary—In this population-based study, we compared incident fracture rates in long-term care (LTC) versus community seniors between 2002 and 2012. Hip fracture rates declined more rapidly in LTC than in the community. An excess burden of fractures occurred in LTC for hip, pelvis, and humerus fractures in men and hip fractures only in women.

Introduction—This study compares trends in incident fracture rates between long-term care (LTC) and community-dwelling seniors ≥65 years, 2002–2012.

Methods—This is a population-based cohort study using administrative data. Measurements were age/sex-adjusted incident fracture rates and rate ratios (RR) and annual percent change (APC).

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Conflicts of interests Alexandra Papaioannou received grants/funds from Amgen, Eli Lilly, and Merck, a honoraria from Amgen and Eli Lilly, participated in a speaker forum for Amgen and Eli Lilly, and was a consultant for Amgen and Eli Lilly. Jonathan D. Adachi received grants/funds from Actavis, Amgen, Eli Lilly, Merck, and Novartis, a honoraria from Amgen, Eli Lilly, Merck, and Novartis, participated in a speaker forum for Amgen, Eli Lilly, Merck, and Novartis, acted as a consultant for Amgen, Eli Lilly, Merck, and Novartis, and is a board member for the International Osteoporosis Foundation. Courtney Kennedy, George Ioannidis, Cathy Cameron, Ruth Croxford, Sara Mursleen, and Susan Jaglal have no conflicts of interest to declare.

Results—Over 11 years, hip fracture rates had a marked decline occurring more rapidly in LTC (APC, −3.49 (95% confidence interval (CI), −3.97, −3.01)) compared with the community (APC, −2.93 (95 % CI, −3.28, −2.57); $p < 0.05$ for difference in slopes). Humerus and wrist fracture rates decreased; however, an opposite trend occurred for pelvis and spine fractures with rates increasing over time in both cohorts (all APCs, $p < 0.05$). In 2012, incident hip fracture rates were higher in LTC than the community (RRs: women, 1.55 (95 % CI, 1.45, 1.67); men, 2.18 (95 % CI, 1.93, 2.47)). Higher rates of pelvis (RR, 1.48 (95 % CI, 1.22, 1.80)) and humerus (RR, 1.40 (95 % CI, 1.07, 1.84)) fractures were observed in LTC men, not women. In women, wrist (RR, 0.76 (95 % CI, 0.71, 0.81)) and spine (RR, 0.52 (95 % CI, 0.45, 0.61)) fracture rates were lower in LTC than the community; in men, spine (RR, 0.75 (95 % CI, 0.57, 0.98) but not wrist fracture (RR, 0.91 (95 % CI, 0.67, 1.23)) rates were significantly lower in LTC than the community.

Conclusion—Previous studies in the community have shown declining hip fracture rates over time, also demonstrated in our study but at a more rapid rate in LTC. Rates of humerus and wrist fractures also declined. An excess burden of fractures in LTC occurred for hip fractures in women and for hip, pelvis, and humerus fractures in men.

Keywords

Community-dwelling seniors; Incident fracture rates; Long-term care; Ontario

Introduction

With aging comes a gradual and progressive decline in bone quantity and quality and an increase in frailty, with a corresponding increase in fracture risk [1, 2]. The risk of a first [3] and subsequent [4–6] osteoporotic fracture increases with age. Among those aged 80 years and older, the 5-year risk of fracture has been estimated as 17 % in women and 11 % in men [3]. The consequences of fractures, particularly hip and spine, can be devastating and may be most severe in the elderly [4]. Fractures lead to substantial pain, reduced quality of life, dependence in self-care and mobility, institutionalization, and mortality [7–10].

Hip fractures, in particular, affect both mobility and the capacity to live independently. In Canada, an estimated 30 % of community-dwelling patients are institutionalized within a year following a hip fracture [9]. Approximately 50 % of long-term care (LTC) residents who have some independence in locomotion prior to hip fracture either die or develop total dependence within 6 months of their fracture [10]. Healthcare expenditures for osteoporosis-related fractures are considerable and are estimated in Canada to be $3.9 billion annually when all associated costs are considered [11].

Previous studies examining temporal trends found that hip fracture rates have been stable or declining in the last two decades both in Canada and internationally [12–14]. Fewer studies have examined non-hip fracture trends, and the majority of population-based studies do not make a distinction between institutionalized versus community-dwelling seniors, yet LTC cohorts are older, frailer, and at increased risk of falls and fractures [15, 16]. Nearly 60% of LTC residents also have some cognitive impairment, and one third of those have severe impairment [17], placing these individuals at even greater fracture risk [18]. In this population-based study, we compared incident fracture rates between LTC and community cohorts for all major osteoporotic fracture types and examined differences in demographic and temporal trends between 2002 and 2012. We hypothesized that the LTC cohort would have a different fracture profile than the community and that fracture rates would decline over time for both cohorts.

Methods

Setting

This study included seniors 65 years or older in Ontario, Canada. The province of Ontario has more than 13 million residents and has a universal, single-payer healthcare system that covers medically necessary physician and hospital services, as well as prescription drugs for individuals aged 65 years and older and all individuals residing in a LTC facility. The LTC sector provides residential care for older adults who need access to 24-h nursing, supervision, or higher levels of personal care. There are approximately 627 LTC homes in Ontario with a total of 77,000 beds. This sector does not include retirement homes, which are privately owned rental accommodations that provide some care services, although residents live independently.

Data sources and cohort

Patient records from several administrative data sources (Appendix 1) were linked to obtain demographic and fracture information for Ontario's seniors. Datasets were linked using unique, encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences (ICES).

Our study period was fiscal years 2002/2003 to 2012/2013 (1 April 2002 to 31 March 2013; for simplicity, fiscal 2002/2003, for example, will be referred to as 2002). Individuals were retained in the analysis if they were alive and aged 65 years or older on the first day of the fiscal year. Residents who were in chronic care facilities (less than 0.1 % of records) were excluded, as they are considered a distinct cohort. An individual was classified as living in a LTC facility during a given year if in the month prior to the start of the fiscal year they filled a prescription while living in LTC,[1] received a visit made by a physician to a LTC facility, or had been admitted to and not yet discharged from LTC. Analyses were not adjusted for date of death during the year, thus persons alive at the start of a year contributed a value of 1 to the denominator for that year.

Outcome definition

Osteoporotic fractures were identified using an algorithm developed by the Public Health Agency of Canada [19]. Fractures were identified from emergency department and inpatient records on the basis of the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA) diagnosis codes (listed in Appendix 2). Physician billing records were also searched for evidence of fractures not found in the hospital-based data; the algorithm required at least two physician claims for the same fracture type, dated within 91 days of one another.

[1]This algorithm was chosen as nearly all prescriptions in LTC contain a 30-day supply or less.

Fracture rates were calculated separately for each major osteoporotic fracture type: hip, spine, humerus (shoulder/upper arm), wrist/forearm, and pelvis. Individuals with multiple fractures of the same type were counted once within a given year; however, a refracture of the same type was counted in a following year. Patients with multiple fractures of different types (including those stemming from the same fall) contributed to the numerator of each fracture sub-type. Records with over lapping dates were combined. "Any osteoporotic" fracture indicated the occurrence of any of the above osteoporotic fractures; a patient was counted only once in the numerator of this indicator even if multiple fractures occurred during that year.

Statistical analysis

Crude incident fracture rates per 10,000 persons were calculated by pre-fracture residence (LTC versus community) and stratified by gender and age (65–74 years, 75–84 years, and 85+years). Direct standardization was used to calculate annual age/sex-adjusted incident fracture rates using the 2002 Ontario LTC cohort as the reference population. Standardization allows comparisons between the two cohorts by removing any changes in rates introduced by the aging of the population over the time period. The gamma method was used to calculate confidence intervals for standardized rates [20]. Age-standardized rate ratios were computed to compare fracture rates in LTC relative to the community.

We used joinpoint regression analysis[2] to examine temporal trends in fracture rates over the study period. This software calculates the number and temporal location of points where a statistically significant change in trend occurred (i.e., a "joinpoint"). The program starts with a model with 0 joinpoints (i.e., a straight line) and tests whether 1 or more joinpoints should be added to the final model. The grid search method was selected for fitting the model and the permutation test (number of randomly permuted data sets=4499) for determining the optimal number of joinpoints; Bonferroni adjustment was used to correct for multiple testing. We selected the heteroscedastic random error option and specified the standard error at each time period.[3] Log transformation was selected in order to calculate annual percent change (APC), which was the average rate of change in a fracture rate per year during the study period. APCs are scale invariant and useful for comparing across populations or sub-groups with very different rates. The APC was tested against the null hypothesis that the percent change was zero (i.e., neither increasing nor decreasing over time). Tests of parallelism (null hypothesis that the two lines are parallel) were performed to examine whether the rate of change differed between groups. For all analyses, a two-tailed p value of less than 0.05 was taken to indicate a statistically significant effect.

Results

At baseline, the mean ages in LTC and the community, respectively, were 85.0 years (standard deviation (SD), 7.4) and 74.8 years (SD, 7.0) in women and 81.5 years (SD, 7.7) and 73.5 years (6.4) in men. Age remained stable over the study period in both cohorts.

[2]Joinpoint Regression Program, version 4.1.1.5—February 2015; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute.
[3]Heteroscedasticity in joinpoint is handled using weighted least squares regression. For model $\ln(y) = xb$, weights are $w = (y^2)/v$.

Approximately 72 % of LTC residents and 56 % of community-dwelling residents were women.

Fracture burden

Between 2002 and 2012, the population of Ontario seniors increased from approximately 55,000 to 72,000 in LTC and from 1.4 to 1.8 million in the community (Appendix 3, Appendix 4), During this 11-year period, 348,205 osteoporotic fractures occurred in Ontario residents age 65 and over, with 9.5 % (n = 33,218) occurring in residents living in LTC. LTC residents contributed to 17 % of all hip fractures and 11 % of all pelvis fractures occurring in Ontario seniors 65 years and older. Consistent with the increasing number of seniors in the community, there was a steady increase in the absolute number of osteoporotic fractures, from 25,480 in 2002 to 32, 899 in 2012 (Fig. 1; Appendix 4). In LTC, although the overall population also increased, the absolute number of fractures remained relatively stable from 2004 onwards (approximately 3000 annually; Appendix 3).

Figure 1 displays the percentage contribution of each fracture type to the total number of fractures in each cohort. Of 33,218 fractures in LTC, the percentages were hip (49 %), pelvis (19 %), wrist (13 %), humerus (11 %), and spine (8 %). Of 314,987 fractures in the community, the percentages were wrist (28 %), hip (26 %), pelvis (16 %), humerus (15 %), and spine (14 %).

Fracture incidence

Table 1 displays the age-standardized incidence rate ratios for all fracture sub-types. Compared with similarly aged seniors residing in the community, the rate of hip fractures in LTC was 1.6 times greater in women and 2.2 times greater in men. Women residing in LTC had similar age-adjusted rates of pelvis and humerus fractures and significantly lower age-adjusted rates of spine and wrist fractures as women residing in the community (Table 1). Men residing in LTC had higher age-adjusted rates of pelvis and humerus fractures and lower age-adjusted rates of spine fractures compared with community-dwelling men.

Figure 2 displays the stratum specific fracture rates in 2012. In the community, there was a uniform increase in fracture rates with each age strata, whereas in LTC, less of an age gradient existed. In LTC, similar fracture rates were observed in the two oldest age strata (75–84 and 85+). After age 85 years, community-dwelling individuals had comparable rates to seniors residing in LTC. Men in LTC had high rates of hip fracture, approaching the rate for women in LTC (Fig. 2). In LTC, hip fracture rates were highest for both men and women across age strata. In the community, hip fracture rates were highest for men after age 75 and for women after age 85.

Temporal trends

From 2002 to 2012, the age/sex-standardized incidence rate of any osteoporotic fracture decreased from 4.3 % (95 % confidence interval (CI), 4.08, 4.42) to 3.5 % (95 % CI, 3.33, 3.61) in LTC and from 3.3 % (95 % CI, 3.22, 3.35) to 2.9 % (95 % CI, 2.87, 2.97) in the community. Corresponding numbers for hip fractures were 2.6 % (95 % CI, 2.49, 2.76) to

1.9 % (95 % CI, 1.76, 1.97) in LTC and from 1.4%(95% CI, 1.36, 1.45) to 1.0 % (95 % CI, 1.04, 1.10) in the community.

As displayed in Fig. 3, there was no evidence of a significant joinpoint for any of the fracture sub-types, indicating that the observed changes in rates were linear over time. Overall, there was a more rapid decline for any osteoporotic fracture in LTC (APC, −2.04 (95 % CI, −2.40, −1.68)) than in the community (APC, −1.19 (95 % CI, −1.53, −0.85); $p<$ 0.0001 for difference in slopes). In LTC, there was no difference between men and women in the rate of decline (APC, −1.93 (95 % CI, −2.28, −1.59)); however in the community, there was a more rapid decrease in any osteoporotic fracture rates for women (APC, −1.15 (95 % CI, −1.49, −0.82)) than men (APC, −0.59 (95 % CI, −1.15, −0.03); $p<0.05$ for difference in slopes).

When we examined temporal trends separately by sub-type (Fig. 3), hip fracture rates had the most marked decline, which occurred more rapidly in LTC compared with the community ($p<0.05$ for difference in slopes). Humerus fracture rates also decreased more rapidly in LTC than in the community ($p<0.01$ for difference in slopes). Wrist fracture rates decreased over time but at a similar rate in LTC and the community. An opposite trend occurred for pelvis and spine fractures; fracture rates increased over time, at a similar rate in both cohorts.

Discussion

In this population-based study, we examined trends in fracture rates in Ontario, Canada from 2002 to 2012 and examined differences between LTC and community-dwelling cohorts. Our study included all major osteoporotic fractures, whereas the majority of previous studies in elderly cohorts have focused on hip fractures. Our study identifies that any excess burden of fracture in LTC residents compared with similarly aged community dwellers was dependent on the type of fracture. By the end of the study period, incident hip fracture rates were 1.6 times higher for women and 2.2 times higher for men residing in LTC versus the community. Pelvis and humerus fracture rates were similar between cohorts for women, but higher for men residing in LTC. Wrist and spine fracture rates were lower in LTC than in the community. Hip fractures were most common in LTC, accounting for 49 % of all fractures; wrist fractures were most common in the community and accounted for 28 % of all fractures. When we examined temporal trends over 11 years of observation, the absolute number of fractures increased over time in the community, whereas in LTC, it remained relatively stable from 2004 onwards. Age/sex-standardized incidence rates for hip, wrist, humerus, and any osteoporotic fractures declined linearly over time for both LTC and community residents, with the most marked decline for hip fractures. Rates of pelvis and spine fractures increased during the study period. There was a faster rate of decline in LTC versus the community for hip, humerus, and any osteoporotic fractures.

We observed a leveling in fracture rates across age strata in LTC, particularly after age 75, which may reflect that residents who enter LTC already have a high degree of frailty [16] and approximately three quarters have moderate to severe limitations in activities of daily living [17]. Given that there is a strong relationship between frailty and fractures that is independent of age [2], these residents are at high risk for fractures due to frailty-related risk factors. Residents of LTC who had a fracture while living in the community have been found to be at greater risk of both entering LTC [9] and having a future hip fracture [18, 21].

After age 85, differences between the LTC and community cohorts diminished with similar rates of hip and pelvis fractures, particularly for women. This is an indication that the most elderly cohort likely has a similar risk profile and/or degree of frailty irrespective of where they are living.

Similar to others [15], we observed less of a gender difference in fracture rates in LTC than in the community, particularly for hip fractures. Crilly et al. [15] suggest that more older men than women have spouses who care for them in the community until they are particularly frail or ill and that those who are institutionalized may therefore be frailer than their female counterparts. Few studies have examined the demographics of frailty in LTC, although a high prevalence is reported for both men and women [22, 23]. In contrast, we have found that among community dwellers, women are frailer than men across all age decades [2].

Estimates in the literature vary substantially regarding the magnitude of the increased fracture risk in LTC versus the community. For hip fractures, our age-adjusted risk ratios for LTC versus community residents were similar to those reported by Crilly et al. [15] for women and lower for men. In 2012, LTC residents had up to double the relative risk for hip fractures, which is lower than what was reported in older studies [24–27]. Older studies reported the highest risk ratios in the youngest senior age strata [15, 25]. For the LTC cohort, our incidence rates were similar to [15, 27, 28] or lower than [29, 30] other published studies on institutionalized populations, particularly Chandler et al. who reported a rate of 109 osteoporotic fractures per 1000 person-years [31]. Our reported rates in the community were higher than the community-based Canadian Multicentre Osteoporosis Study (CaMos) [32] although there are differences in study methodologies with CaMOS relying on patient self-report.

Our observed temporal trends are consistent with previous studies [13, 14, 33]. A Canadian study [13] spanning 1985 to 2005 observed a significant change in hip fracture trends occurring in 1996 (APC of −1.2 % from 1985 to 1996 and −2.4 % between 1996 and 2005). In a similar American study [33], age-adjusted hip fracture rates fell by 20 % between 1993 and 2003; however, in the cohort 75 years and older, age-adjusted rates fell by 4.0 % in women but increased by 6.8 % in men. An Ontario study spanning 1992 to 2000 [14] observed a decline in hip and wrist fracture rates beginning in 1997, correlating with an increase in bone mass density (BMD) testing and osteoporosis medications.

Our observed increase in spine fracture rates over time is consistent with a population-based Swiss study, which observed significant increases in hospitalization rates for spine fractures between 2000 and 2008 (33). Given that spine fractures are often asymptomatic and under-reported [34], the observed increase may reflect improvements in reporting and diagnosing these fractures. Using dual X-ray absorptiometry (DXA)-based vertebral fracture assessment, Rodondi et al. [35] estimated one third of LTC residents had a prevalent vertebral fracture, although they commonly go undetected in elderly residents and may be a substantial source of pain and agitation [36]. The increase we observed in pelvic fractures was also found in a Dutch study between 1986 and 2011 [37] and may reflect better detection with increased use of computed tomography (CT) and magnetic resonance imaging (MRI) examinations [28].

The downward trend in overall fracture rates is likely partly attributable to the rapid increase in osteoporosis medication use in the last half of the 1990s (e.g., alendronate for osteoporosis was approved in 1995 in the USA and Canada) [14]. However, low rates of treatment in high-risk individuals [38], particularly for men, and evidence of a decreasing trend prior to the approval of bisphosphonates for treating osteoporosis, suggest other factors are also responsible. The role of other potential factors, such as population-level changes in health, nutrition, body mass index (BMI), smoking, and hormone levels is not entirely clear [13]. Both smoking cessation and an increase in body weight, in particular, have been suggested as lifestyle factors that may have a demonstrable impact on fracture risk [39]. In LTC, vitamin D supplementation is the only intervention that has been shown to decrease the rate of falls [40] and is recommended for fracture prevention, particularly those at high risk [41]; we have previously reported a considerable increase in vitamin D prescribing in LTC across the province during the study time period [42].

A provincial government-funded initiative that has been ongoing since 2005 has also likely impacted fracture rates in Ontario seniors [43]. The *Ontario Osteoporosis Strategy* is targeted at reducing morbidity, mortality, and costs from osteoporosis and related fractures through an integrated and comprehensive approach aimed at health promotion and disease management. In LTC (www.osteoporosislongtermcare.ca), the Ontario Osteoporosis Strategy has been focused on knowledge translation (KT) activities, including ongoing educational outreach and dissemination of *Fracture Prevention Tool-Kits* [42]. Other more intensive KT initiatives have successfully incorporated clinical tools and process changes in Ontario LTC homes [42]. Falls prevention has been a key priority of the Ontario Ministry of Health and Long-Term Care and is supported by a number of initiatives including the Registered Nurses Association of Ontario, Long-Term Care Best Practices Program [44].

Although overall fracture rates declined during our study period, an osteoporosis care gap (i.e., gap between recommendations and practice) has been well documented in both community-dwelling and LTC seniors [38, 45]. The osteoporosis care gap in LTC reflects the uncertainty many clinicians have regarding fracture risk assessment and optimal management of osteoporosis in LTC residents [46]. To address these concerns, osteoporosis guidelines targeting care for the frail elderly living in LTC were recently completed [41]. Improving uptake of evidence-based care in both the community and LTC is imperative to realizing further declines in fracture rates.

There are several strengths and limitations to our study. One of our main strengths is that there was no selection bias as this was a population-based study that utilized administrative databases that included all residents of the province of Ontario. We used a standardized approach for identifying fracture outcomes developed by the Public Health Agency of Canada [19]. Linkage with several databases enabled us to accurately determine separate cohorts for LTC and community-dwelling residents. The ability to include data from day surgery, outpatient clinics, and emergency department visits allowed us to more completely identify non-hip fractures and not rely only on hospitalization and physician billing data which a Canadian validation study found underestimated rates of wrist and spine fracture [47].

One of the limitations of our study was not being able to include other fracture risk factors such as prior fracture, frailty, and BMI. Another limitation was that the analyses were not adjusted for the date of death within a fiscal year. For example, if someone died earlier in the year, they would have less chance to develop a fracture during that year. Given the high rates of mortality in LTC compared with the community [48], it is possible the fracture rates for the LTC cohort are underestimated compared with the community, although others [15] have suggested that they may be overestimated because there is high turnover in LTC and there is excess risk associated with people newly admitted to LTC [30]. It is possible that spine fractures may have been under-reported in LTC (for example, fractures noted on a chest x-ray taken in the LTC home but not specifically billed for); however in both community and LTC settings spine fractures are likely to have been under-reported [34, 49]. Given the considerable variation in fracture trends worldwide [12], it is not certain whether our results are applicable to institutionalized or community cohorts in other regions.

In summary, we demonstrated that hip and any osteoporotic fracture rates declined over time and at a faster rate in LTC than in the community. Despite some of the observed differences between cohorts, relatively similar rates of hip fractures were observed for LTC women and men and for community-dwelling women after age 85. The declining trend in fracture rates is encouraging and signals the need to continue with initiatives targeting fracture reduction for all seniors and particularly those groups at highest risk.

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Appendix 1: Description of databases

Discharge Abstract Database

Created by the Canadian Institute for Health Information (CIHI), this database contains demographic, administrative and clinical data records for each inpatient discharge from an acute care hospital. All acute care facilities in Ontario are required to report this information.

National Ambulatory Care Reporting System

Also from CIHI, this database contains data for all hospital-based and community-based ambulatory care including visits to day surgery, outpatient clinics, and emergency departments.

Physician billing claims (Ontario Health Insurance Plan)

This database contains all claims made by physicians for insured services provided to Ontario residents. Records include the type of service provided and diagnostic information. Although not mandatory until 2009, claims for services provided in an institution may have an associated institution number.

Ontario Drug Benefit Plan

This database records all prescriptions paid for under the Ontario Drug Benefit Plan (ODB), which includes all prescriptions for people aged 65 years and older.

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Chronic Care Reporting System

This database contains demographic, clinical, functional and resource utilization data for individuals living in continuing care or LTC facilities. During the study period, not all LTC facilities reported patient assessments to the chronic care reporting system (CCRS).

Registered Persons Database

Maintained by the Ministry of Health and Long-Term Care, this database contains basic demographic information (date of birth, sex, postal code) for each healthcare number.

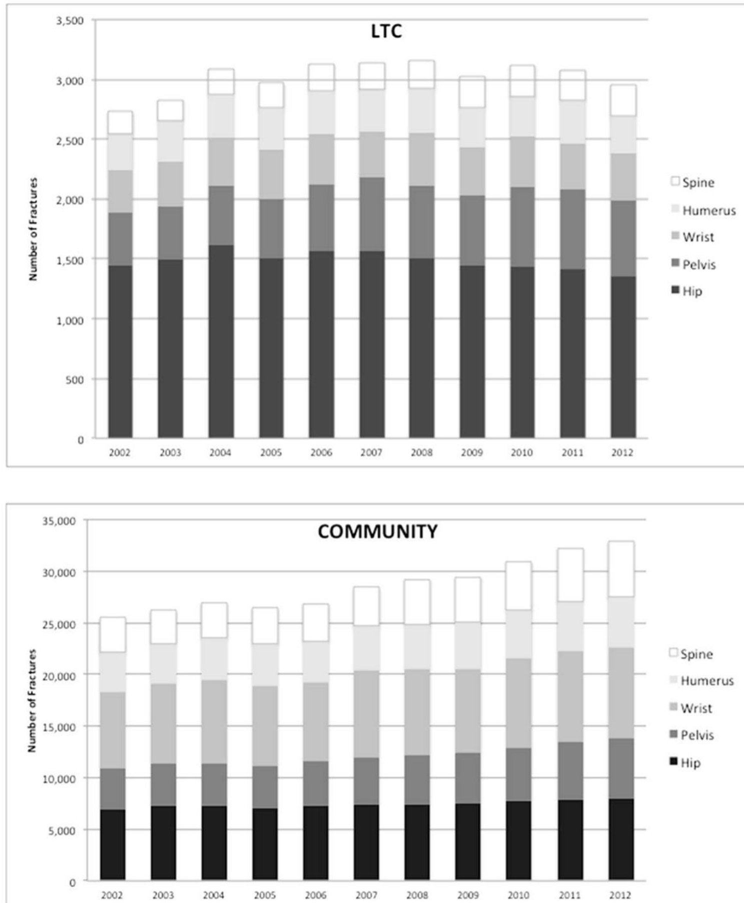

Fig. 1.
Annual number of fractures for LTC and community residents, 2002/2003 to 2012/2013

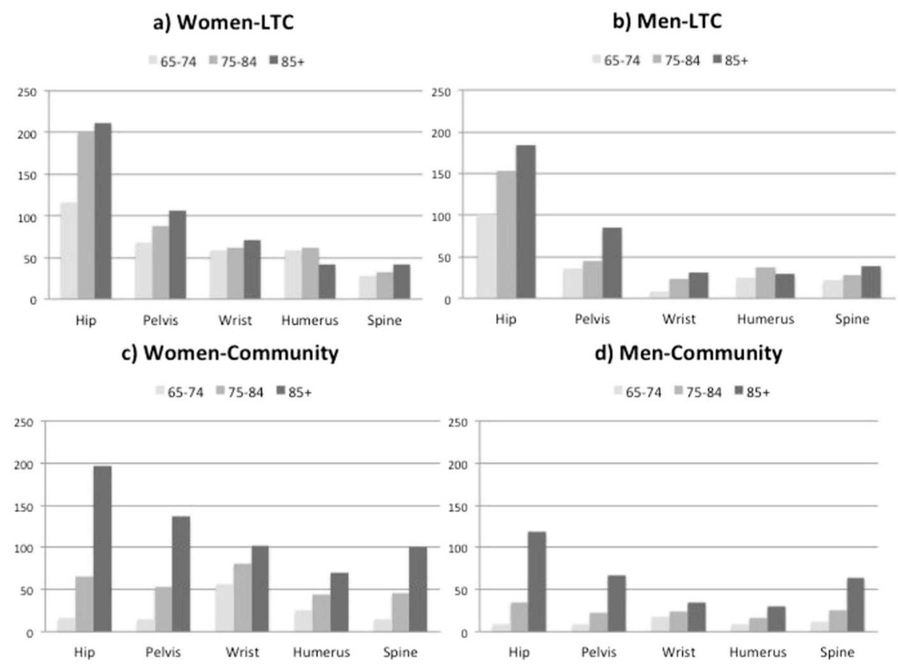

Fig. 2.

Age/sex-specific fracture rates per 10,000 in LTC and community cohorts, 2012/2013

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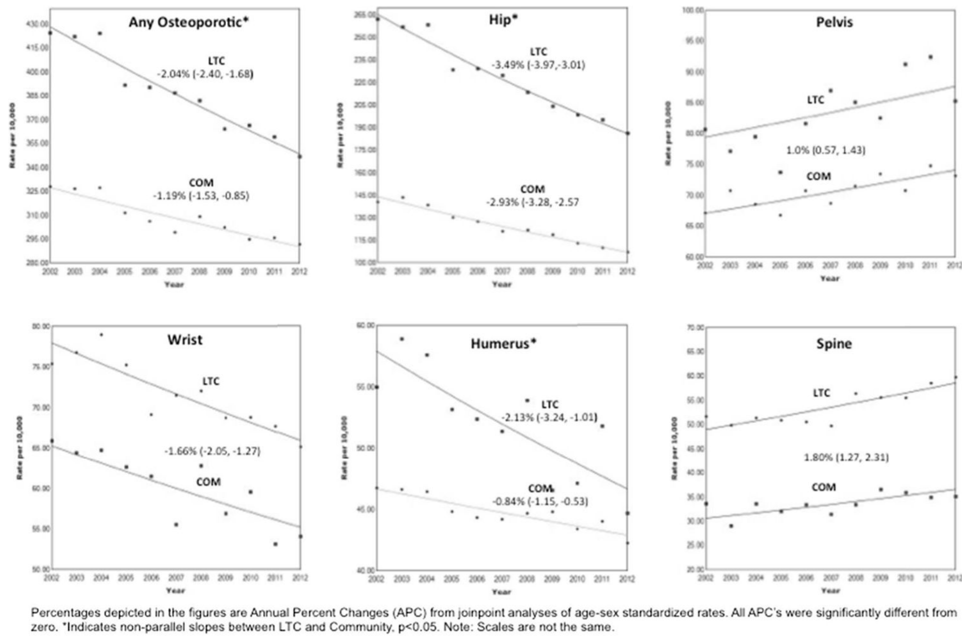

Fig. 3.

Join point analysis of age/sex-standardized fracture rates per 10,000, LTC versus community, 2002/2003 to 2012/2013

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Table 1

Age-standardized incident fracture rates per 10,000 by sex, years 2002/2003 and 2012/2013

	Women			Men		
	LTC	COM	Rate ratio[a] (95 % CI)	LTC	COM	Rate ratio[a] (95 % CI)
2002						
Hip	267.2 (251.5, 283.6)	167.4 (161.5, 173.4)	1.60 (1.49, 1.71)	251.7 (225.0, 280.8)	89.4 (83.2, 95.8)	2.82 (2.47, 3.21)
Pelvis	86.7 (77.9, 96.2)	84.4 (80.3, 88.7)	1.03 (0.91, 1.15)	62.5 (49.6, 77.8)	34.1 (30.5, 38.0)	1.83 (1.43, 2.36)
Humerus	64.8 (57.1, 73.3)	58.4 (55.2, 61.8)	1.11 (0.97, 1.27)	32.0 (22.9, 43.4)	26.0 (23.0, 29.4)	1.23 (0.87, 1.73)
Spine	36.7 (31.0, 43.1)	61.4 (58.0, 65.0)	0.60 (0.5, 0.71)	25.2 (17.5, 35.2)	33.4 (29.8, 37.3)	0.75 0.52, 1.09)
Wrist	78.8 (70.4, 88.0)	100.6 (96.5, 104.9)	0.78 (0.70, 0.88)	29.5 (20.9, 40.4)	30.9 (27.7, 34.4)	0.95 (0.67, 1.35)
Any[b]	455.3 (434.8, 476.7)	404.7 (395.7, 413.2)	1.13 (1.07, 1.18)	342.9 (311.7, 376.5)	188.1 (179.6, 197.1)	1.82 (1.64, 2.03)
2012						
Hip	196.2 (184.1, 208.9)	126.4 (122.5, 130.4)	1.55 (1.45, 1.67)	162.9 (145.4, 181.9)	74.6 (70.5, 78.8)	2.18 (1.93, 2.47)
Pelvis	95.0 (86.7, 103.9)	90.9 (87.6, 94.2)	1.05 (0.95, 1.15)	63.9 (53.0, 76.3)	43.2 (40.2, 46.4)	1.48 (1.22, 1.80)
Humerus	51.0 (44.7, 57.9)	54.5 (52.2, 57.0)	0.94 (0.82, 1.07)	31.8 (24.5, 40.7)	22.7 (20.6, 24.9)	1.40 (1.07, 1.84)
Spine	36.5 (31.4, 42.1)	69.8 (67.0, 72.7)	0.52 (0.45, 0.61)	32.3 (24.8, 41.4)	43.2 (40.3, 46.4)	0.75 (0.57, 0.98)
Wrist	67.2 (66.1, 59.1)	88.6 (85.7, 91.6)	0.76 (0.71, 0.81)	25.8 (19.1, 34.2)	28.5 (26.2, 30.8)	0.91 (0.67, 1.23)
Any[b]	378.7 (361.8, 396.2	360.7 (354.1, 366.8	1.05 (1.00, 1.10)	275.6 (252.7, 300.0)	180.3 (174.2, 186.6)	1.53 (1.39, 1.68)

[a]Community was the reference

[b]Includes hip, pelvis, wrist, humerus, and spine fractures

Appendix 2 Table 2

ICD-10-CA diagnosis codes and physician claims codes used to identify osteoporotic fractures in administrative data

Fracture type	ICD-10-CA diagnosis codes (emergency department visit and hospital admission records)		Diagnosis code (physician claims records)
Hip[a]	S72.0	Fracture of neck of femur	n/a
	S72.1	Pertrochanteric fracture	
	S72.2	Subtrochanteric fracture	
Spine[b]	S22.0	Fracture of thoracic vertebra	805—vertebral fracture without spinal cord damage
	S22.1	Multiple fractures of thoracic spine	
	S32.0	Fracture of lumbar vertebra	
	S32.7[c]	Multiple fractures of lumbar spine and pelvis	
	S32.8[c]	Fracture of other and unspecified parts of lumbar spine and pelvis	
Shoulder, upper arm Wrist, forearm	S42.2	Fracture of upper end of humerus	812—fracture of humerus
	S52.0–S52.6	Fracture of forearm	813—fracture of radius or ulna
	S52.7	Multiple fractures of forearm	
	S52.8	Fracture of other parts of forearm	
	S52.9	Fracture of forearm, part unspecified	
Pelvis	S32.1	Fracture of sacrum	808—fracture of the pelvis
	S32.3	Fracture of ilium	
	S32.4	Fracture of acetabulum	
	S32.5	Fracture of pubis	
	S32.7[c]	Multiple fractures of lumbar spine and pelvis	
	S32.8[c]	Fracture of other and unspecified parts of lumbar spine and pelvis	

[a] Only inpatient diagnosis codes were used

[b] Thoracic and lumbar

[c] Diagnosis codes S32.7 and S32.8 appear in the definitions for both pelvic and spinal fractures. For purposes of counting total fractures, they are considered to represent a single fracture

Appendix 3 Table 3

Annual number of fractures in long-term care seniors aged 65 and older, 2002/2003 to 2012/2013

Year	Total pop[a]	Women						Total pop[a]	Men					
		Fracture (*n*)							Fracture (n)					
		Any[b]	Hip	Pelvis	Wrist	Humerus	Spine		Any[b]	Hip	Pelvis	Humerus	Spine	Wrist
2002	40,418	1860	1096	358	321	258	149	14,494	472	344	85	44	36	41
2003	42,540	2003	1179	373	340	287	137	15,512	449	313	75	55	32	34
2004	45,424	2130	1269	417	346	301	163	16,909	518	343	78	59	47	59
2005	47,807	2072	1152	386	377	292	176	18,146	515	357	101	59	36	37
2006	49,202	2123	1204	448	380	295	178	18,865	543	363	109	62	50	40
2007	50,098	2167	1220	495	345	300	181	19,247	530	348	114	56	39	42
2008	50,384	2172	1151	503	396	316	198	19,479	518	356	99	60	38	45
2009	50,667	2042	1092	485	361	269	200	19,742	540	355	100	59	61	42
2010	51,205	2107	1107	534	366	282	198	20,023	533	328	126	56	62	59
2011	51,230	2056	1065	540	324	317	201	20,230	532	347	131	49	52	54
2012	51,499	1980	1032	504	346	251	194	20,498	545	323	124	65	64	50
All years	530,474	22,712	12,567	5043	3902	3168	1975	203,145	5695	3777	1142	624	517	503

[a] Overall number of women/men residing in long-term care over age 65 years alive on first day of fiscal year (denominator)

[b] Any osteoporotic fracture (one or more); each patient was counted only once in the numerator for a given year even if multiple fractures occurred

Appendix 4 Table 4

Annual number of fractures in community-dwelling seniors aged 65 and older, 2002/2003 to 2012/2013

Year	Total pop[a]	Women						Total pop[a]	Men					
		Fracture (*n*)							Fracture (*n*)					
		Any[b]	Wrist	Hip	Pelvis	Humerus	Spine		Any[b]	Hip	Wrist	Spine	Pelvis	Humerus
2002	794,650	17,236	6024	5203	2989	2977	2372	619,326	5310	1769	1404	951	924	867
2003	807,357	17,517	6194	5452	3128	3093	2235	633,360	5434	1834	1487	961	959	861
2004	820,125	18,149	6612	5409	3146	3139	2332	647,327	5609	1876	1503	1024	961	919
2005	831,969	17,732	6276	5258	3092	3174	2489	659,935	5454	1866	1411	990	990	888
2006	850,602	17,722	6163	5320	3314	3086	2507	678,815	5747	1939	1418	1134	1059	928
2007	866,211	18,771	6788	5404	3368	3347	2570	695,152	6124	2046	1639	1149	1129	975
2008	882,139	19,070	6694	5356	3541	3311	2987	713,793	6433	2087	1638	1355	1187	1055
2009	901,553	19,301	6567	5460	3679	3545	3007	732,873	6268	2059	1542	1351	1232	964
2010	942,310	20,137	6980	5566	3911	3572	3297	760,012	6644	2156	1624	1404	1337	1063
2011	968,101	20,907	7052	5661	4257	3744	3577	783,917	6888	2177	1686	1552	1458	1075
2012	1,007,297	21,326	7095	5738	4370	3776	3680	822,674	7203	2230	1745	1674	1483	1108
All years	9,672,314	207,868	72,445	59,827	38,795	36,764	31,053	7,747,184	67,114	22,039	17,097	13,545	12,719	10,703

[a] Overall number of community-dwelling women/men, over age 65 years alive on first day of fiscal year (denominator)

[b] Any osteoporotic fracture (one or more); each patient was counted only once in the numerator for a given year even if multiple fractures occurred