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Population-based Canadian hip fracture rates with international comparisons

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For the Osteoporosis Surveillance Expert Working Group**Abstract**

Summary—We identified hospitalizations throughout Canada during 2000–2005 in which the most responsible diagnosis was a proximal femoral fracture. Use of the US fracture risk assessment tool (FRAX) would be inappropriate for Canada as it would overestimate fracture risk in Canadian women and older men.

Introduction—It is recommended that the WHO fracture risk assessment tool should be calibrated to the target population.

Methods—We identified hospitalizations for women and men throughout Canada during the study period 2000–2005 in which the most responsible diagnosis was a proximal femoral fracture (147,982 hip fractures). Age-standardized hip fracture rates were compared between Canadian provinces, and national rates were compared with those reported for the USA and Germany.

Results—There were relatively small differences in hip fracture rates between provinces, and most did not differ appreciably from the Canadian average. Hip fracture rates for women in Canada in 2001 were substantially lower than in the USA (population-weighted rate ratio 0.70) and were also lower than in Germany for 2004 (population-weighted rate ratio 0.74).

Conclusions—Overall hip fracture rates for Canadian women were found to be substantially lower than those for the USA and Germany. This study underscores the importance of assessing country-specific fracture patterns prior to adopting an existing FRAX tool.

Keywords

Epidemiology; Hip fractures; Osteoporosis

Introduction

Osteoporosis is a common condition in Canada predisposing individuals to skeletal fractures, and affects up to 16% of women and 7% of men over age 50 [1]. The presence of osteoporosis is a major risk factor for the development of fractures of the hip, proximal humerus, vertebra, and forearm but all skeletal sites (other than craniofacial) are at increased risk of fracture [2]. Worldwide, the number of individuals in 2000 estimated to have suffered a prior osteoporotic fracture was 56 million with approximately 9 million new osteoporotic fractures each year [3].

Recently, the World Health Organization (WHO) released a fracture risk assessment tool (FRAX) that can be used to derive individualized estimates of 10-year fracture risk for the hip and other sites typically affected by osteoporosis (i.e., hip, spine, proximal humerus, and distal forearm) [4]. FRAX was developed from studying population-based cohorts from Europe, North America, Asia, and Australia. It is based on individual patient models that

integrate the risks associated with several clinical risk factors as well as bone mineral density (BMD) at the femoral neck.

As osteoporotic fracture rates can vary greatly between countries, the FRAX system needs to be calibrated to the target population [5]. The initial version of the FRAX website (<http://www.shef.ac.uk/FRAX/>) provided tools calibrated for nine different countries in addition to four different US ethnicities. It was not clear whether any of the available choices was directly applicable to the Canadian population. Previous reports of hip fracture rates in Canada included data from only a subset of the country and are more than 15 years old, [6–8] therefore a FRAX tool calibrated on current Canadian fracture rates was considered desirable. National hip fracture statistics for Canada were obtained and compared to recently published hip fracture rates from two other countries (USA [9] and Germany [10]) to assist in determining the need for developing a specific Canadian FRAX tool. We simultaneously looked at regional differences between Canadian provinces.

Materials and methods

Data sources

The Canadian Institute for Health Information (CIHI) collects and analyzes information on health and health care in Canada and makes this publicly available. The Hospital Morbidity Database (HMDB), a database housed at CIHI, includes administrative, clinical, and demographic information on hospital inpatient events and provides national discharge statistics from Canadian health care facilities by diagnoses and procedures. The HMDB is comprised of a subset of the Discharge Abstract Database (DAD) data and it appends data from provinces/territories that are not participating in DAD in order to provide a national database. CIHI ensures a high quality of information in the HMDB through a data quality enhancement program [11, 12].

Hospital discharges in the HMDB are coded using the International Classification of Diseases (ICD). ICD-9/ICD-9-CM was used until 2000 throughout Canada with staggered introduction of ICD-10-CA starting in 2001. Not all provinces/territories transitioned between ICD-9/ICD-9-CM and ICD-10-CA in the same year; however, all provinces/territories followed standardized and mandatory coding methods [11, 12]. The Canadian territories (Northwest Territories, Yukon, and Nunavut; 0.3% of the Canadian population) were not included in this analysis as data were not submitted in the earlier years.

Canadian hip fracture rates

We identified all hospitalizations from the HMDB between 2000 and 2005 in which the most responsible diagnosis was a hip (proximal femoral) fracture. Hip fractures were identified using the following diagnosis codes: ICD-9-CM 820.x and ICD-10-CA S72.0-S72.2. These same codes have been used internationally for studying the epidemiology of hip fractures [10]. We did not attempt to identify or exclude hip fractures related to non-osteoporotic etiologies (e.g., violent trauma, cancer). The annual number of hip fractures was tabulated for the years of 2000–2005, stratified by province, sex, and age (5-year

intervals). The denominator was stratified in the same fashion using national census data with interpolated estimates for between-census years.

Annual unadjusted (crude) age-specific fracture rates per 100,000 with 95% confidence intervals (CI) were calculated for the overall population and by sex. To look for regional differences, average hip fracture rates for 2000–2005 were determined for each of the ten Canadian provinces standardized to the Canadian population using direct standardization methods, and rates were compared with adjustment in the *P* value for multiple comparisons (Bonferonni corrected $P=0.05/30\approx0.002$). Provincial rate ratios relative to the Canadian average were computed.

International comparisons

The most recent detailed national figures for the USA (2001) [9] and Germany (2004) [10] were compared with Canadian hip fracture rates for 2001 and 2004, respectively. For each age and sex stratum, rate ratios were constructed. Overall rate ratios for women and men were derived as the population-weighted means of the age-specific values. For the USA, hip fractures were identified in the 2001 Nationwide Inpatient Sample (NIS) database, a large US hospital discharge database, and hip fracture incidence rates were defined using primary ICD-9 codes 820.0x, 820.2x, and 820.8x and excluded trauma-related cases [9]. For Germany, data came from the national hospital discharge diagnosis register which provides data on hospital discharges covering more than 99% of hospitals in Germany [10]. Hip fractures were identified from an ICD-9 diagnosis 820.x up to 1999 and by ICD-10 diagnosis S72.0–S72.2 after 2000 (the same ICD-10 codes as used to identify hip fractures for Canada as stated previously).

Results

Canadian hip fracture rates

During the 5 years of data reported, 147,982 hospitalized hip fractures were seen in the ten Canadian provinces. Slightly less than three quarters of the hip fractures (period average 71.8%) occurred in women (Table 1). As expected, the incidence of hip fractures was strongly associated with age with only 3.9% occurring prior to age 50, 21.0% occurring in individuals aged 50–74 years, and the majority (75.0%) in individuals aged 75 and older.

For the period 2000–2005, there were relatively small differences in hip fracture rates between provinces and most rate ratios were within 10% of the Canadian average (Table 2). The only province that showed a significant difference from the Canadian average was Nova Scotia with rate ratios 15–19% below the Canadian average (only statistically significant for women and men overall).

International comparisons

Age-specific and sex-specific hip fracture rates for Canada were compared with the USA for 2001 and Germany for 2004. All three countries showed almost the same steep increase in hip fracture incidence with advancing age in both women and men. Table 3 indicates the rate ratio of Canada to USA and Canada to Germany by sex and age. The rate ratios in women

were lowest for those aged 50–54 years (0.55 for Canada/USA and 0.45 for Canada/Germany), and were closer to unity for women aged 65 years and older (rate ratios 0.77–0.89 and 0.78–1.08, respectively). Overall hip fracture rates for women in Canada in 2001 were substantially lower than in the USA (population-weighted rate ratio 0.70) and were also lower than in Germany for 2004 (population-weighted rate ratio 0.74).

The age relationships were quite different for men, with the Canada/USA rate ratios declining from 1.17 among those aged 50–54 years to 0.74 in those aged 85 years and older. In contrast, the Canada/Germany rate ratio increased from 0.47 in men aged 50–54 years to 1.17 among those aged 85 years and older. The overall rate in Canada for men was similar to the USA for 2001 (population-weighted rate ratio 1.08) but was considerably lower than for Germany in 2004 (population-weighted rate ratio 0.71).

Discussion

This population-based analysis of hip fracture rates in Canada provides important insights to the burden of osteoporosis and the importance of calibrating the WHO FRAX tool to the Canadian population. Approximately 30,000 hip fractures occur each year nationally, and the great majority occur in women, though more than one quarter occurs in men. As expected, hip fracture rates increase with age, with three quarters occurring in those aged 75 and older. With direct first year costs following a hip fracture of approximately \$34,946 (2008 Canadian dollars), hip fractures are a source of considerable health care expenditures [13].

In 2000–2005, few regional differences in the rate of hip fractures were noted. Only the province of Nova Scotia differed significantly from the Canadian average (overall hip fracture rate 16% below the national average) whereas neighboring provinces (New Brunswick, Prince Edward Island, Newfoundland and Labrador) showed overall rates within 2% of the national average. The fracture rates were age-standardized to the Canadian population and therefore cannot be explained on the basis of differences in age structure. Recently, the Canadian Multicentre Osteoporosis Study (CaMos) reported regional differences in bone density and fragility fractures for a randomly selected population-based longitudinal cohort of 2,484 men and 6,093 women aged 50 and older, recruited from within 50 km of nine cities across Canada [14]. Consistent with our findings, the lowest incidence of low-trauma fractures (age-standardized) among women was for the capital city of Nova Scotia (Halifax) at 25% below the national average (11.5 per 1,000 person-years, 95% CI, 8.5–15.1 vs 15.3 per 1,000 person-years, 95% CI, 14.1–16.7). This difference was not explained by regional variation in bone density. Although fragility fracture rates in Halifax men did not differ from the national average, the study may have been underpowered to detect an effect. Whether differences in demographic factors (e.g., ethnicity), practice patterns (e.g., prevention and treatment of osteoporosis), or unmeasured risk factors (e.g., falls, prior fracture, and vertebral deformity) contribute to the regional variation cannot be assessed with these data.

The importance of using country-specific data when calibrating a FRAX tool is underscored in the comparisons with the USA and Germany. The proportion of the population that

exceeds the Canadian high-risk threshold for osteoporotic fracture (20% or greater) is very sensitive to risk calculations and the cutoff used [15, 16]. The overall fracture rate in Canadian women was 30% lower than US women in 2001 and 26% less than for German women in 2004. These rate ratios are strongly influenced by the large proportion of younger women who also have the lowest age-specific rate ratios, whereas most hip fractures occur among elderly women where the rate ratios are closer to unity. The expected effect of using the US (Caucasian) FRAX tool for the Canadian population would therefore be to significantly overestimate fracture risk. Canadian men showed similar overall hip fracture rates to American men prior to age 80, but 26–27% lower rates after age 80 (where 45% of fractures occurred). In contrast, Canadian men had significantly lower hip fracture rates than German men overall, and most of the difference was found to be in the younger age groups, with minimal differences after age 70. As each of these national data sources is felt to be complete and used similar ICD diagnostic codes, it is surprising and unexplained why there are variations between age groups. However, this highlights the need for caution in taking a FRAX tool calibrated against fracture rates in one population and applying this to a second population.

There are some limitations to this study. Data are collected by provinces individually and then are forwarded to CIHI. Variations in data coding, completeness, and consistency are avoided through the CIHI Data Quality Enhancement Program, which indicates that provincial reporting for acute care facilities 2001–2005 was of consistently high quality [17]. There were differences in provincial adoption of the ICD-10-CA classification during the study period (2000–2005), but diagnostic codes for hip fractures are easily identified under both systems (i.e., ICD-9/ICD-9-CM and ICD-10-CA) and the total number of hip fractures did not change significantly from 2000 (when all provinces were using ICD-9/ICD-9-CM) to 2005 (when all provinces except Quebec were using ICD-10-CA). The US comparator study excluded high trauma fractures. As a result, it is anticipated that the US hip fracture data for the entire population would be even greater since almost 10% of osteoporotic fractures are known to occur in the context of severe trauma [18]. Therefore, the discrepancy between Canadian and US hip fracture rates may be even greater than we have reported. A final limitation is that hip fracture rates could be confounded by osteoporosis treatment as medication data were not available, though treatment effects would also be present in the US and German comparator studies which would mitigate any effect on the rate ratios.

Since one of the primary objectives of this study was to measure the hip fracture rates for calibrating the FRAX tool for Canada, we have concentrated on hip fracture data for 2000–2005 which are the most recent available. In some populations [19–21] but not others [10, 22–24] a secular decrease in hip fracture rates has been observed. This implies that calibration of FRAX tools should ideally be based upon the most recent fracture data available. In areas where secular change is observed, the FRAX tools may need periodic updating to reflect changes in fracture rates.

In conclusion, hip fracture rates for Canadian women were found to be substantially lower than those for the USA and Germany. Use of the US (Caucasian) FRAX tool would be inappropriate in the Canadian population as it would overestimate fracture risk in both men

and women. This demonstrates the necessity of using Canadian fracture data in developing a FRAX tool for Canada. Our study underscores the importance of assessing national fracture patterns prior to adopting an existing FRAX tool.

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Table 1

Annual total numbers (%) of hip fractures by sex in Canada, 2000–2005

	Women	Men	Total
2000	20,853 (72.1)	8,060 (27.9)	28,913
2001	20,951 (72.3)	8,021 (27.7)	28,972
2002	20,952 (71.9)	8,206 (28.1)	29,158
2003	21,507 (72.1)	8,339 (27.9)	29,846
2004	21,515 (71.4)	8,608 (28.6)	30,123
2005	21,316 (71.3)	8,567 (28.7)	29,883

Table 2
Age-standardized hip fracture incidence rates by province and sex in Canada, 2000–2005 average

Province	Women			Men			Overall		
	Rate per 100,000 (95% CI)	Rate ratio versus Canadian average	P versus Canadian average	Rate per 100,000 (95% CI)	Rate ratio versus Canadian average	P versus Canadian average	Rate per 100,000 (95% CI)	Rate ratio versus Canadian average	P versus Canadian average
British Columbia	87.5 (81.0;94.0)	1.01	1.000	55.0 (50.6;59.4)	1.02	1.000	74.8 (69.1;80.5)	1.01	1.000
Alberta	86.9 (83.2;90.6)	1.01	1.000	58.1 (55.2;61.0)	1.08	0.891	76.1 (73.0;79.2)	1.02	1.000
Saskatchewan	91.5 (89.8;93.2)	1.06	0.797	62.9 (59.7;66.0)	1.17	0.055	80.7 (78.7;82.6)	1.08	0.271
Manitoba	79.2 (69.9;88.5)	0.92	0.318	53.5 (47.3;59.6)	0.99	1.000	69.7 (62.9;76.5)	0.94	0.668
Ontario	84.2 (80.3;88.2)	0.97	0.999	51.4 (48.7;54.0)	0.95	0.996	72.0 (68.6;75.4)	0.97	0.995
Quebec	90.6 (86.1;95.1)	1.05	0.928	56.8 (53.5;60.0)	1.05	0.993	78.9 (74.9;82.9)	1.06	0.743
New Brunswick	89.3 (83.4;95.1)	1.03	0.995	53.2 (47.1;59.2)	0.99	1.000	76.1 (70.3;81.8)	1.02	1.000
Nova Scotia	73.6 (67.1;80.0)	0.85	0.002	43.9 (40.6;47.3)	0.81	0.018	62.4 (57.2;67.5)	0.84	<0.001 ^b
Prince Edward Island	86.8 (82.6;90.9)	1.00	1.000	53.1 (47.2;59.0)	0.98	1.000	74.4 (71.5;77.2)	1.00	1.000
Newfoundland and Labrador	94.0 (90.5;97.5)	1.09	0.258	46.1 (37.0;55.1)	0.85	0.138	75.0 (72.0;78.1)	1.01	1.000
All of Canada ^a	86.4 (82.5;90.4)	N/A	N/A	53.9 (51.9;56.0)	N/A	N/A	74.4 (71.1;77.8)	N/A	N/A

^aExcluding territories

^bSignificant P value (Bonferroni corrected)

Table 3

Relative hip fracture incidence rates for Canada vs US [9] (2001 data) and Canada vs Germany [10] (2004 data)

Age subgroup	<u>Canada/US (2001)</u>		<u>Canada/Germany (2004)</u>	
	Women	Men	Women	Men
50–54	0.55	1.17	0.45	0.47
55–59	0.62	1.23	0.57	0.58
60–64	0.66	1.13	0.78	0.78
65–69	0.77	1.06	1.00	0.82
70–74	0.80	0.95	0.92	0.85
75–79	0.82	0.89	0.86	1.03
80–84	0.79	0.73	0.86	0.85
85 and older	0.89	0.74	1.08	1.17
Population-weighted mean	0.70	1.08	0.74	0.71