Current and projected rates of hip fracture in Canada

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Abstract

Objective: To determine the current values and estimate the projected values (to the year 2041) for annual number of proximal femoral fractures (PFFs), age-adjusted rates of fracture, rates of death in the acute care setting, associated length of stay (LOS) in hospital, and seasonal variation by sex and age in elderly Canadians.

Design: Hospital discharge data for fiscal year 1993–94 from the Canadian Institute for Health Information were used to determine PFF incidence, and Statistics Canada population projections were used to estimate the rate and number of PFFs to 2041.

Setting: Canada.

Participants: Canadian patients 65 years of age or older who underwent hip arthroplasty.

Outcome measures: PFF rates, death rates and LOS by age, sex and province.

Results: In 1993–94 the incidence of PFF increased exponentially with increasing age. The age-adjusted rates were 479 per 100 000 for women and 187 per 100 000 for men. The number of PFFs was estimated at 23 375 (17 823 in women and 5552 in men), with a projected increase to 88 124 in 2041. The rate of death during the acute care stay increased exponentially with increasing age. The death rates for men were twice those for women. In 1993–94 an estimated 1570 deaths occurred in the acute care setting, and 7000 deaths were projected for 2041. LOS in the acute care setting increased with advancing age, as did variability in LOS, which suggests a more heterogeneous case mix with advancing age. The LOS for 1993–94 and 2041 was estimated at 465 000 and 1.8 million patient-days respectively. Seasonal variability in the incidence of PFFs by sex was not significant. Significant season–province interactions were seen ($p < 0.05$); however, the differences in incidence were small (on the order of 2% to 3%) and were not considered to have a large effect on resource use in the acute care setting.

Conclusions: On the assumption that current conditions contributing to hip fractures will remain constant, the number of PFFs will rise exponentially over the next 40 years. The results of this study highlight the serious implications for Canadians if incidence rates are not reduced by some form of intervention.

Résumé

Objectif : Déterminer les valeurs actuelles et évaluer les valeurs prévues (jusqu'en l'an 2041) des éléments suivants : nombre annuel de fractures fémorales proximales (FFP), taux comparatifs de fractures selon l'âge, taux de mortalité en milieu de soins de courte durée, durée du séjour (DS) connexe à l'hôpital et écarts saisonniers par sexe et par âge chez les personnes âgées au Canada.

Conception : Les données sur les sorties de l'hôpital pour l'exercice 1993–1994 de l'Institut canadien de l'information sur la santé ont servi à déterminer l'incidence des FFP, et les projections de la population de Statistique Canada ont permis d'évaluer les taux et les nombres de FFP jusqu'en 2041.

Contexte : Canada.

Participants : Patients canadiens âgés de 65 ans ou plus ayant subi une arthroplastie de la hanche.

Mesures des résultats : Taux de FFP, taux de mortalité et DS par âge, sexe et province.

Résultats : Il y a eu en 1993–1994 une croissance exponentielle de l'incidence des FFP avec l'âge. Les taux comparatifs selon l'âge sont de 479/100 000 chez les

Evidence

Études

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This article has been peer reviewed.

Can Med Assoc J 1997;157:1357-63

femmes et de 187/100 000 chez les hommes. Le nombre de FFP est évalué à 23 375 (17 823 chez les femmes et 5552 chez les hommes) et il devrait atteindre 88 124 en 2041. Le taux de mortalité au cours du séjour en milieu de soins de courte durée a connu une croissance exponentielle avec l'âge. Les taux de mortalité chez les hommes sont deux fois plus élevés que chez les femmes. Le nombre de décès en 1993–1994 en milieu de soins de courte durée est évalué à 1570 et devrait atteindre 7000 en 2041. La DS en milieu de soins de courte durée augmente avec l'âge, ainsi que sa variabilité. Cette constatation laisse entendre que l'ensemble des cas est plus hétérogène avec l'âge. La DS en 1993–1994 et en 2041 est estimée à 465 000 et à 1,8 million de jours-patients respectivement. La variabilité saisonnière de l'incidence des FFP par sexe n'est pas remarquable. On constate par ailleurs des interactions saison–province importantes ($p < 0,05$). Les écarts d'incidence sont cependant minimes (de l'ordre de 2 % à 3 %) et ne devraient pas avoir de grandes répercussions sur l'utilisation des ressources en milieu de soins de courte durée.

Conclusion : Dans l'hypothèse où les conditions actuelles occasionnant des fractures de la hanche restent constantes, le nombre de FFP augmentera exponentiellement au cours des 40 prochaines années. Les résultats de cette étude révèlent les répercussions graves pour les Canadiens si les taux d'incidence ne sont pas réduits grâce à une forme ou une autre d'intervention.

Osteoporosis is an important public health problem, especially in postmenopausal women. Fractures of the wrist, vertebra and hip are attributed to this disease. Osteoporosis is also very costly: in 1988 the cost associated with its treatment in Canada was $280 million.[1] Recently Goeree and colleagues[2] estimated the cost of treating this disease in Canada at $1.3 billion for 1993. Similar estimates of the annual costs for the treatment of osteoporosis in the United States range from US$5.2 billion to US$7.2 billion (Can$7 billion to Can$10 billion), a difference that reflects to some extent the larger population base.[3,4] Decreasing budgets for publicly funded programs have prompted a re-evaluation of expenditures in all areas of health care, particularly the costly treatment of proximal femoral fractures (PFFs, also known as hip fractures) in "aging" industrialized countries.[5–7]

A greater understanding of the pathophysiology of osteoporosis has led to the development of treatment regimens. The use of hormone replacement therapy has resulted in an arrest of the osteoporotic process in most postmenopausal women receiving this treatment.[8–12] Other treatment strategies include therapy with calcium, vitamin D, bisphosphonates, calcitonin or fluoride and load-bearing exercise as well as other treatments that are still investigational, such as therapy with selective estrogen receptor modulators or parathyroid hormone.[13–21]

Published projections of the number of PFFs in Canada,[6] we hypothesize, have underestimated their occurrence. The previously reported age-adjusted incidence rates of PFFs for Canada are lower than those for other industrialized countries;[6] however, the reason for this difference is not clear. Since these earlier projections a more comprehensive hospital discharge database has evolved (Canadian Institute for Health Information [CIHI], Ottawa, Ont.). The development of the CIHI's database as well as recent population projections by Statistics Canada[22,23] prompted a re-evaluation of this issue. The purpose of this study was to determine current PFF rates and to estimate the projected number of such fractures in elderly Canadians (those 65 years of age or older) to the year 2041.

Methods

We obtained data on all hospital discharges for femoral fracture that were reported to the CIHI for fiscal year 1993–94. Four provinces and the 2 territories in Canada currently provide full discharge reporting to the CIHI. We extracted these data from the master database using ICD-9[24] codes 820 (fracture of neck of femur [PFF]) and 821 (fracture of other and unspecified parts of the femur) for patients aged 65 years or older. A recent analysis of the CIHI database covering acute care discharges for Ontario between 1981 and 1992 showed that there was no change in the rate of PFF over this period.[25]

The incidence of PFF was determined for the 3 largest provinces that fully report to the CIHI (Ontario, British Columbia and Alberta). Other provinces, including Quebec, Manitoba, Saskatchewan and some of the Atlantic provinces, do not provide full reporting; consequently their reported PFF data were not used in this analysis. To project national PFF rates we estimated weighted (by population) PFF incidence rates for Canada on the basis of the rates for Ontario, British Columbia and Alberta. We assumed that these provinces are generally represen-

tative of the country, since in the 1991 census 58% of the Canadian population was regionally and multiculturally distributed in them.[22]

We used the annual PFF data for each of the 3 provinces to evaluate the relation between age and PFF rate and to describe this relation mathematically. These data were then collapsed to 5-year age groups (i.e., 65–69 years, 70–74 years, etc.) by sex and by province for further analysis and comparison, since PFF rates are generally discussed this way in the literature. We calculated the average number of PFFs in each of the 5-year groups at the corresponding median age (i.e., 67.5, 72.5, etc.). Equations were then generated that described PFF rates, by age and sex, on the basis of a weighted PFF rate. We calculated the weighted rates by adjusting the provincial PFF rate for each 5-year age group by the population of the province.[26] Variability in the weighted PFF rate was calculated on the assumption that the 3 provinces used as a base were "randomly" selected. We also calculated projections of all femoral fractures for Canada using the same weighting procedure outlined above.

We obtained demographic information and population projections to 2041 from Statistics Canada and 1991 census data for Canada.[22,23] Four demographic projections were produced by Statistics Canada on the basis of a number of assumptions relating to rates of birth, immigration and death. We chose the median projection (Statistics Canada projection 2) as the baseline projection for our analysis since it provided an estimate based on current trends and since it assumes a constant fertility rate of 1.7 births per woman and a constant immigration rate of 250 000 combined with a low life-expectancy assumption of 78.5 years for men and 84 years for women by 2016.[23] Other projections (low-growth assumption [projection 1] and high-growth assumption [projection 4]) were included in our sensitivity analysis of the projected number of PFFs.

We calculated the age-adjusted PFF rate for Ontario for comparison with rates reported for Rochester, Minn.[5] Age-adjusted PFF rates reported in the literature are based on data for men and women 50 years of age or older. Since the CIHI database provided information for Canadians 65 years of age or older, we obtained the femoral fracture rate reported by Statistics Canada for people aged 45 to 64 years[27] and used this rate in calculating the rate for people aged 50 to 64 years.

Inpatient death rates and length of stay (LOS) while in the acute care setting, as well as seasonality of fractures, were also evaluated from the CIHI data. We multiplied the average LOS for each of the 5-year age groups by the estimated number of patients with PFFs in each group to calculate the total projected LOS (in patient-days). Seasonality was defined as the number of PFFs that occurred during a season (e.g., the number of PFFs that occurred during the summer was calculated by adding together one-fourth of the fractures that occurred in June, all those in July and August, and three-fourths of those in September). All the seasons were compared simultaneously to evaluate differences in PFF incidence. We also evaluated these variables for each of the 3 provinces and used the data as a basis for the projection to the rest of Canada.

We used regression analysis to define best-fit relations, based on greatest R^2, and conducted one-way and two-way analysis of variance for each of these variables by province and sex to examine whether significant main effects existed. We determined differences among means using Tukey's honestly significant difference test ($\alpha = 0.05$).

The CIHI discharge abstract data were transferred to a personal computer, and Statistical Application Software (SAS-Windows version 6.08, SAS Institute Inc., Cary, NC) was used for the analysis.

Results

Current incidence

We found an exponential increase in PFFs with increasing age and a significant effect of age for both women ($F_{1,78} = 1638$, $p < 0.0001$) and men ($F_{1,78} = 868$, $p < 0.0001$). There was no significant interaction with province for women ($F_{2,78} = 0.84$, $p = 0.4367$); however, a significant interaction was noted for men ($F_{2,78} = 4.14$, $p < 0.02$), lower PFF rates with increasing age being noted in British Columbia than in Ontario and Alberta. The weighted PFF rates for Canada, by age and sex, are shown in Fig. 1. The total number of PFFs in people aged 65 years or older in 1993–94 was calculated as 17 823 for women and 5552 for men.

Age-adjusted rates

The age-adjusted PFF rate for Ontario in 1993–94 was 479 per 100 000 for women and 187 per 100 000 for men (Table 1). These rates are higher than those previously reported for Ontario[6] but similar to those from elsewhere.[5,28]

Projected incidence

Currently 12% and 1% of Canada's population is aged 65 years or older and 85 years or older respectively. Demographic projections by Statistics Canada indicate that by 2041 the corresponding proportions will be 25% and 4% respectively.[23] Using weighted current PFF rates (as described in the methods section), we estimated the total number of PFFs in older Canadians in 2041 at 88 124 (projection 2), with a range of 78 649 (projection 1) to 103 954 (projection 4). The projected incidence reflects

changes in both population size and projected mean survival. Our results indicate that previous Canadian projections[6,29] have underestimated the number of PFFs (Fig. 2).

Mortality

The CIHI data for 1993–94 indicated that death rates for older inpatients increased exponentially with increasing age. We used logistic regression to model the probability of inpatient death after a fracture, with effects for sex, age and province. There were no significant interactions between these explanatory variables. Men were at significantly higher risk for death after PFF than women ($p < 0.001$) (Fig. 3). We estimated that there were 1570 deaths (999 in women and 571 in men) in the acute care setting after PFF in 1993–94, and we project that the number of deaths will increase to 7000 (4404 in women and 2596 in men) by 2041.

Length of stay in acute care setting

LOS increased with increasing age until age 85 to 89 years for women and 80 to 84 years for men (Fig. 4). Of interest was the finding that variability in LOS also increased with increasing age. An estimated 465 000 patient-days were used in 1993–94 to treat these PFF patients (estimate based on current mean LOS by age and sex). The projected LOS for patients with PFFs in 2041 was estimated at 1.8 million patient-days.

Seasonality

Analysis of the data for Ontario, British Columbia and Alberta did not demonstrate a significant main effect of season on the incidence of PFFs for women ($F_{5,6} = 3.20$, $p = 0.0947$) or men ($F_{5,6} = 2.82$, $p = 0.1196$). We did find significant season–province interactions for both women ($F_{1,2} = 12.38$, $p = 0.0125$) and men ($F_{1,2} = 7.28$, $p = 0.0356$); however, the differences in incidence were on the order of 2% to 3% and were not considered to have had a large effect on resource use in the acute care setting.

Table 1: Reported age-adjusted rates of proximal femoral fracture for people 50 years of age or older

Region	Year	Incidence rate per 100 000		Female: male ratio
		Women	Men	
Oslo, Norway[28]	1978–79	766.6	299.3	2.56
Funen, Denmark[28]	1973–79	511.1	191.0	2.68
Rochester, Minn.[5]	1979	487.4	175.5	2.78
Picardy, France[28]	1987	305.3	126.6	2.41
Ontario[6]	1981	413	133	3.10
Ontario (current study)	1993–94	478.7	187.1	2.56

Discussion

Previous Canadian projections of PFF incidence[6] have suggested a lower rate than that for the United States and other industrialized countries. However, we found that these projections underestimated the incidence of PFF. A comparison of the provincial incidence of PFF for Ontario, British Columbia and Alberta, as recorded in the CIHI database, revealed an exponential increase in fracture rates with age. Differences between provincial rates of PFF were not significant for women; however, there was a significant different in fracture rates between men in Ontario and Alberta and those in British Columbia. Fracture rates in older British Columbia men were lower than for the men in the other 2 provinces. The use of the weighted provincial PFF rate as representative of the

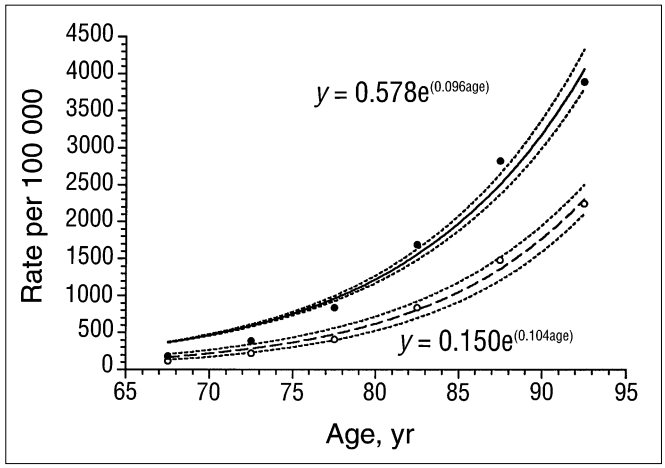

Fig. 1: Weighted rate of proximal femoral fracture (PFF), with 95% confidence intervals (dotted lines), for Canadian women (solid line) and men (dashed line) 65 years of age or older by age group, based on full reporting from Ontario, British Columbia and Alberta for fiscal year 1993–94.

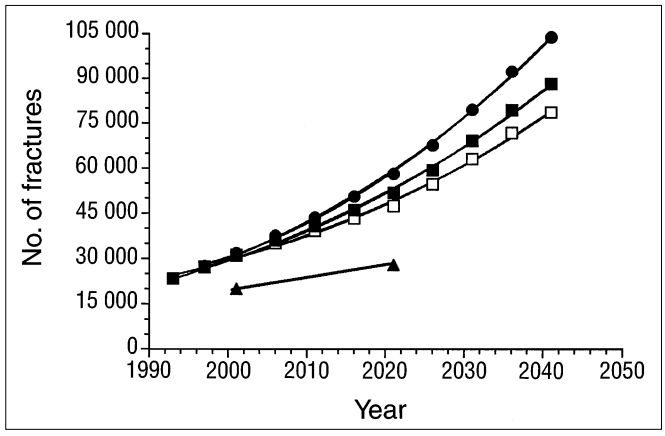

Fig. 2: New and previously projected[6] (▲) number of PFFs in Canadians 65 years of age or older from 1993 to 2041, under 3 assumptions of population growth (maximum [●], median [■] and minimal [□]).

Canadian population yielded exponential equations that were in good agreement with the interprovincial rates (R^2 = 0.93–0.96). Using the exponential equations, we calculated that there were 29 293 femoral fractures (23 375 PFFs and 5918 fractures of other parts of the femur) among Canadians aged 65 years or older in 1993–94. We calculated the overall number of femoral fractures because Statistics Canada does not report these fractures by type. We estimated approximately 4500 fractures more than Statistics Canada reported (24 687) for fiscal year 1992–93. The discrepancy is most likely due to the source of Statistics Canada's data (the CIHI database) and the potential for under-reporting.

Recently the Institute for Clinical Evaluative Sciences summarized a number of published and unpublished studies on the quality of health care administrative databases in Canada.[30] The conclusion reached for hospital discharge summaries was that for primary procedures the levels of agreement were 90% or greater between the procedures recorded on the charts and those entered into the database. The CIHI database, however, does not have full reporting from several provinces, including Quebec, which accounts for 25% of the elderly Canadian population. It is likely that the number of hip fractures is underestimated in the data from Statistics Canada, since no adjustments for missing data are made to the CIHI database, in contrast to the adjustments that were made in the current study.

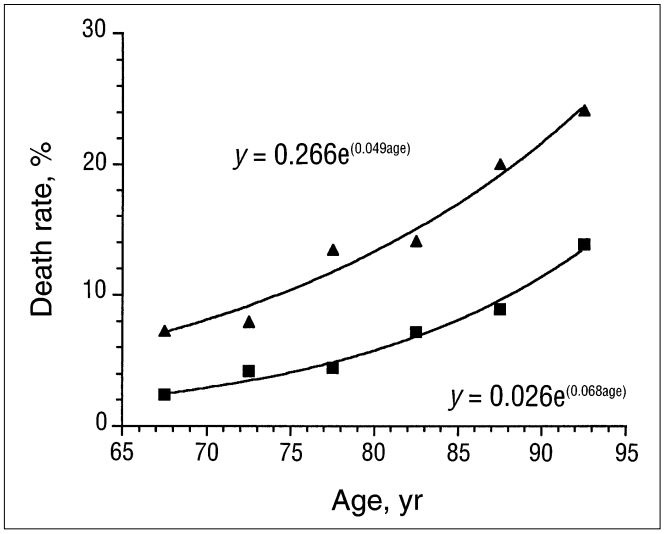

Fig. 3: Rate of death in the acute care setting for men (▲) and women (■) 65 years of age or older with PFFs in Ontario for 1993–94 by age group.

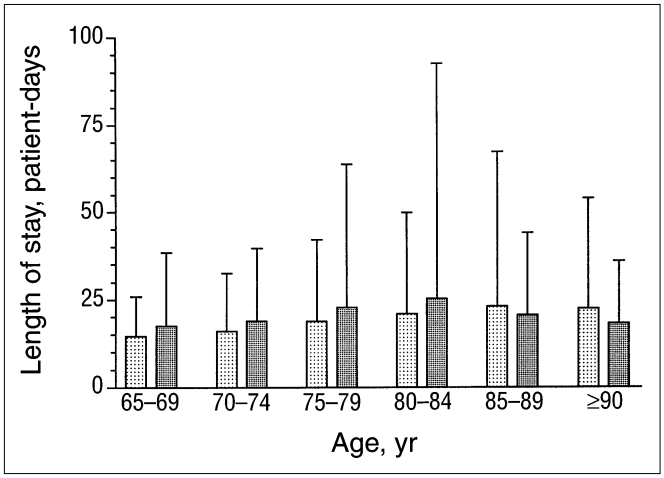

Fig. 4: Mean length of stay for Canadian women (dotted bars) and men (shaded bars) 65 years of age or older with PFFs in the acute care setting in 1993–94 by age group. Error bars represent standard deviation.

Reanalysis of the CIHI data, selecting for PFFs, allowed us to calculate the age-adjusted PFF rates for Ontario. The rates for both women and men compared favourably to the values reported for Rochester, Minn.,[5] and for Funen, Denmark.[28] In our study approximately 70% and 85% of femoral fractures were PFFs in women 65 to 69 years of age and those 90 years of age or older respectively. Similar findings were observed for men. Elimination of the PFF rate for women 90 years of age or older from the regression shown in Fig. 1 resulted in an exponential relation with greater R^2, which indicates that in advanced age other mechanisms may be involved in modulating the incidence of PFF.

Potential implications

Our projections are greater than those of Narod and Spasoff[6] and of Martin and associates[29] because of differences in the assumptions used in the calculations. We believe that the more comprehensive database currently maintained by the CIHI and the demographic projections from Statistics Canada provide a more accurate basis for our projections. The rise in potential rates of PFFs as well as other diseases in older Canadians is intimidating and provides a strong impetus for establishing programs that will reverse the trend in this group. All demographic projections provided by Statistics Canada were used to calculate best-case and worst-case scenarios. The results indicate that 40 years from now the Canadian health care system will have to deal with approximately 4 times the current number of hip fractures. This number is conservative, since advances in medicine may increase longevity, which would lead to an increase in the number of hip fractures if acceptable treatment strategies to maintain bone mineral density are not implemented. Increasing longevity also has long-term implications for the use of health care resources in the treatment of other age-related conditions.

Fractures of the femur carry an increased risk of death, especially in men.[31–35] Death rates in the acute care setting after PFF in Canada do not differ greatly from those in

other industrialized countries, and the risk of death for patients with PFFs by age and sex in this country has not changed since last reported for 1980–81.[6,25] This finding is disturbing since clinical advances over the last decade should have led to decreases in the death rate for age- and sex-matched patients with hip fractures.

The reported average LOS in the acute care setting for patients with PFFs in Canada in 1981 was about 31 days.[6] Our work suggests that the current average LOS is about 21 days and presumably will decrease further still.[25] We found an increasingly variable LOS with increasing age (Fig. 4). It is possible that as people age the probability of concomitant conditions increases, which results in a longer and more variable hospital stay. A progressive reduction in LOS with age greater than 85 years was observed for men. Perhaps these patients were already living in nursing homes and were discharged sooner than younger patients still living independently, or death played a role, or both. For women, LOS increased with increasing age and then plateaued after age 89. The reduction in LOS by almost 10 days over a 10-year period may have influenced the reported death rate, since deaths during this 10-day period (when patients are no longer in hospital) are not captured in the current database.

The increased risk of fracture in inclement weather (when ice or snow is present) and during the winter months has been documented.[36–38] We did not find any significant main effect of season on PFF rates in Ontario, British Columbia and Alberta. Jacobsen and collaborators[36] reported that the incidence of hip fractures generally increases by about 15% in the winter months. Factors that have been implicated in increased fracture rates during the winter season in the northern hemisphere include poor vitamin D status and a number of environmental hazards (such as increased slipping due to ice and snow, and tripping).[39–42] According to the Ontario Weather Office, the winter of 1993–94 was typical, both in the number of millimetres of precipitation and in temperature. It would be prudent to re-evaluate the seasonal incidence of PFFs with the CIHI data from other fiscal periods to confirm our finding.

Limitations of analysis

The projections presented in this paper are based on the full reporting of 3 provinces on the assumptions that they are representative of Canada as a whole and that annual PFF incidence does not vary significantly. Seasonal, cultural, racial and demographic differences can influence the health of a population; consequently, our analysis is limited from this perspective. We assumed that the CIHI database is robust in terms of validity and reliability and that miscoding of fractures did not occur at the hospital level. Unlike databases in the United States,[43–45] the CIHI does not collect racial or ethnic information. Our projections are therefore based on the assumption that the racial mix of Canadians will not change and hence that this factor will not alter PFF incidence and associated death rates and LOS in the acute care setting. Finally, since our projections assume the status quo with regard to dietary habits and supplementation, clinical treatment (e.g., LOS), lifestyle and longevity, we cannot comment on how changes in these variables would influence future projections.

Given that current conditions contributing to hip fractures remain constant, the number of PFFs will rise exponentially over the next 40 years. Our results highlight the serious implications for Canadians if incidence rates are not decreased by some form of intervention.

This work was supported in part by Ortho-McNeil Inc. Dr. Greenwood is supported by the Natural Sciences and Engineering Research Council of Canada. Dr. Coyte is supported by grants from the Ontario Ministry of Health to the Institute for Clinical Evaluative Sciences, to the Arthritis Community Research and Evaluation Unit, and to the Hospital Management Research Unit.

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