Demographic Risk Factors for Fracture in First Nations People

William D. Leslie, MD, MSc¹

Shelley A. Derksen, MSc²

Colleen Metge, PhD²

Lisa M. Lix, PhD²

Elizabeth A. Salamon, MD¹

Pauline Wood Steiman, BA³

Leslie L. Roos, PhD²

ABSTRACT

Background: Recently, First Nations people were shown to be at high fracture risk compared with the general population. However, factors contributing to this risk have not been examined. This analysis focusses on geographic area of residence, income level, and diabetes mellitus as possible explanatory variables since they have been implicated in the fracture rates observed in other populations.

Methods: A retrospective, population-based matched cohort study of fracture rates was performed using the Manitoba administrative health data (1987-1999). The First Nations cohort included all Registered First Nations adults (20 years or older) as indicated in either federal and/or provincial files (n=32,692). Controls (up to three for each First Nations subject) were matched by year of birth, sex and geographic area of residence. After exclusion of unmatched subjects, analysis was based upon 31,557 First Nations subjects and 79,720 controls.

Results: Overall and site-specific fracture rates were significantly higher in the First Nations cohort. Income quintile, geographic area of residence, and diabetes were fracture determinants but the excess fracture risk of First Nations ethnicity persisted even after adjustment for these factors.

Conclusion: First Nations people are at high risk for fracture but the causal factors contributing to this are unclear. Further research is needed to evaluate the importance of other potential explanatory variables.

MeSH terms: Ethnic group; fractures; Indians, North American; medical records systems, computerized; osteoporosis

La traduction du résumé se trouve à la fin de l'article.

1. Department of Medicine, University of Manitoba, Winnipeg, Manitoba

2. Manitoba Centre for Health Policy, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba

3. Assembly of Manitoba Chiefs' Health Information and Research Committee

Correspondence and reprint requests: Dr. William D. Leslie, Department of Medicine (C5121), 409 Taché Avenue, Winnipeg, MB R2H 2A6, Tel: 204-237-2311, Fax: 204-237-2007, E-mail: bleslie@sbgh.mb.ca

Acknowledgements of Sources of Support: Supported by a grant from the Health Sciences Centre Foundation. The authors are indebted to Health Information Services and Manitoba Health for providing the data used in this study, to the First Nations and Inuit Health Branch and Indian and Northern Affairs Canada for permission to use the Status Verification System, and to the Health Information Research Committee of the Assembly of Manitoba Chiefs for actively supporting this work. The results and conclusions are those of the authors, and no official endorsement by Manitoba Health is intended or should be inferred. Special thanks to Ms. Doreen Sanderson, Dr. John O'Neil and Dr. Patricia Martens for their assistance in this project.

Skeletal fractures are common events that are associated with significant morbidity, loss of function and excess mortality.¹⁻³ The economic implications for hip fracture care alone in Canada were estimated to be 650 million dollars per year in 1995 with a projection of 2.4 billion dollars by 2041,⁴ and it is estimated that the number of deaths related to hip fracture will more than quadruple by 2041.⁵ To date, most of the epidemiologic data describing fractures have been derived from White populations,⁶ though it is known that there is ethnic variation in the epidemiology of fractures.⁷⁻⁹

Canadian First Nations people are known to suffer from a heavy burden of medical and social problems.¹⁰ Recently, fracture rates were found to be significantly greater among the First Nations people after adjustment for the effects of age and sex.¹¹ Factors contributing to this increased fracture burden are currently undefined. Residence in northern or urban areas and lower socio-economic status have been implicated in higher fracture rates in other populations.¹²⁻¹⁷ Diabetes mellitus, which is known to be epidemic in Aboriginal populations, also has a putative role in bone metabolism and higher fracture risk.^{18,19} The current report assesses the effect of geographic area of residence, income level and diabetes as possible explanatory variables for the higher fracture rates seen in First Nations people.

MATERIALS AND METHODS

Study design

We performed a retrospective matched-cohort study in Registered First Nations adults who were resident in the province of Manitoba and aged 20 years or older during the 1987 calendar year. (We have elected to use the term Registered First Nations person in place of comparable terms such as Status First Nations person, First Nations person with Status, or First Nations person with Treaty Status.) First Nations ethnicity was primarily determined from the Canadian government's 1994-1999 Status Verification System maintained by First Nations and Inuit Health Branch and Indian and Northern Affairs Canada (n=31,029).^{20,21} The presence of a Treaty Status code in the Manitoba Health Registry File was taken to be a secondary indicator of First

Nations ethnicity (n=25,682). The complete dataset of First Nations adults contained 32,692 men and women once the two data sources were combined.

The control (non-First Nations) cohort was defined by randomly matching each First Nations subject with up to three persons not identifiable as having First Nations ethnicity. Controls were matched to each First Nations subject by year of birth, sex and geographic area of residence (as a surrogate for socio-economic status). Residence-matching was primarily defined from the postal code (90.4%) but in areas where there were insufficient controls, matching was based upon a larger geographic area and mean household income in the subject's postal code area (9.6%) as described below. If no controls could be matched, then that First Nations subject was excluded from the residence-matched cohort (n=1,135). The final residence-matched cohorts therefore contained 31,557 First Nations subjects and 79,720 controls.

This study was reviewed and approved by the Health Research Ethics Board for the University of Manitoba, the Health Information and Privacy Committee of Manitoba Health, and the Health Information Research Committee of the Assembly of Manitoba Chiefs.

Medical data

Fracture events were identified from the previously described population-based administrative data repository housed at the Manitoba Centre for Health Policy at the University of Manitoba.²² This data repository captures virtually all provincially reimbursed physician services and hospitalizations, patient demographics, the date and type of service, and diagnoses from the *International Classification of Disease-9-Clinical Modification* (ICD-9-CM) codes, but does not include personal identifiers such as name and address. However, the repository includes an encrypted identifier allowing linkage across data sets and the creation of longitudinal records of health service use over time for each individual. The accuracy of these administrative data has been established for a wide range of clinical disorders, including outcomes following hip fracture.^{23,24}

Each longitudinal record of health services from April 1, 1987 to December 31, 1999 was assessed for the presence of any

TABLE 1

Cohort Demographics and Number of Fracture Endpoints Observed (Percentages Based on Cohort Membership are Given Parentheses)

	First Nations n=31,557	Controls n=79,720
Age (years) on December 31, 1987:		
< 40	20,896 (66.2)	53,550 (67.2)
40-59	7,695 (24.4)	19,122 (24.0)
60	2,966 (9.4)	7,048 (8.8)
Men	15,610 (49.5)	39,204 (49.2)
Residence*:		
Urban	7,713 (24.4)	23,699 (29.7)
Rural south	11,799 (37.4)	36,426 (45.5)
North	12,045 (38.2)	19,775 (24.8)
Income quintile*:		
Quintile 1 (lowest)	17,839 (56.5)	23,959 (30.0)
Quintile 2	6,814 (21.6)	17,149 (21.5)
Quintile 3	2,688 (8.5)	10,895 (13.7)
Quintile 4	1,743 (5.5)	11,485 (14.4)
Quintile 5 (highest)	1,945 (6.2)	14,615 (18.3)
Not available	528 (1.7)	1,617 (2.0)
Diabetes*	2,165 (6.9)	1,534 (1.9)
Follow up (person-years)	370,351	875,573
Numbers of fractures:		
Any site*	10,750 (33.9)	13,779 (17.3)
Hip*	317 (1.0)	391 (0.5)
Wrist*	484 (1.5)	466 (0.6)
Spine*	604 (1.9)	870 (1.1)
Craniofacial*	2,297 (7.3)	1,406 (1.8)

* p<0.0001

Figure 1. Standardized incidence ratios for fractures in the First Nations cohort compared with age, sex and residence-matched controls (error bars are 95% confidence intervals). The reference line corresponds to equal fracture rates in First Nations and non-First Nations people.

ICD-9-CM fracture code (ICD-9-CM 800-829). Vertebral fractures without cord injury (ICD-9-CM code 805), wrist fracture (ICD-9-CM code 813) and hip fracture (ICD-9-CM code 820-821) have been consistently associated with osteoporosis and were analyzed as specific fracture subcategories.²⁵ To enhance the specificity of this coding, wrist and hip fracture codes

had to be accompanied by a physician claim for site-specific fracture reduction or fixation (either open or closed). Craniofacial fractures (ICD-9-CM codes 800-804) have not been associated with osteoporosis and were used here as an index of trauma.²⁵

The cohorts were subgrouped into three large geographic areas: urban (Winnipeg),

TABLE II

Rate Ratios for Fracture in the First Nations Cohort Compared with Age, Sex and Residence-matched Controls (95% confidence intervals are given in parentheses)

	Base Model*	Full Model†
Any fracture	2.09 (2.04-2.15)	2.06 (2.00-2.12)
Hip fracture	2.07 (1.78-2.40)	2.03 (1.72-2.38)
Wrist fracture	2.49 (2.20-2.83)	2.31 (2.01-2.65)
Spine fracture	1.67 (1.51-1.86)	1.70 (1.52-1.90)
Craniofacial fractures	4.01 (3.75-4.29)	3.90 (3.64-4.19)

* Base regression model included ethnicity, age, sex, and age*sex.

† Full regression model included terms in the base model in addition to income quintile, geographic area and income*geographic area.

rural south (south of 53 degrees latitude) and north (north of 53 degrees latitude). Mean household income for enumeration areas was obtained from 1996 Canada census public use files and subsequently used to define quintiles (five groupings of about 20% of the population in each, which are assigned an income quintile grouping from 1 to 5, stratified separately for urban and rural residency).²⁶ Diabetes was based on a previously validated definition of two physician office visits within three years or a single hospitalization with the diagnosis of diabetes (ICD-9-CM code 250).²⁷

Statistical analysis

Standardized incidence ratios (SIR) and 95% confidence intervals (CI) were calculated for each fracture type using the matched First Nations with non-First Nations cohorts. Poisson regression was used to model counts of each fracture type as a function of demographic, geographic, income, and ethnicity explanatory variables. The number of person-years to fracture or end of study (December 31, 1999) was included as an offset in the model to obtain estimates of rates of fracture.

The base regression model included the explanatory variables of ethnicity, age (defined in 10-year groups), and sex, as well as the age*sex interaction. Age and sex were included in the base model even though they were defined as matching variables in the cohort selection. These demographic variables are known to be associated with fracture rates, and preliminary analyses indicated a statistically significant improvement in model fit when these variables were included in the model. A second regression model – the ‘full’ model – included all terms from the base model in addition to income quintile, geographic area and the income*geographic area interaction. A third regression model included all of the previous variables and two-way

interaction terms, as well as two- and three-way interactions with ethnicity.

The regression coefficients for the base model and the full model were used to test hypotheses about differences in fracture rate ratios for First Nations and non-First Nations populations.²⁸ The ‘interaction’ regression model was used to test specific hypotheses about the effect of ethnicity in the lowest income stratum for each geographic area. Rate ratios, obtained by exponentiation of the regression coefficients, and 95% confidence intervals are reported.

The difference in the deviance between the base model and either the full or interaction models was used to assess model fit. The statistical significance of changes in model fit were assessed using a likelihood ratio statistic, which follows a χ^2 distribution with degrees of freedom equal to the difference in degrees of freedom for two models.²⁹ All statistical analyses were performed with the GENMOD procedure of SAS Release 8.02 (SAS Institute Inc., Cary, NC). All significance tests were performed at $\alpha = 0.05$.

RESULTS

Populations

The composition and demographics of the cohorts are summarized in Table I. The groups were well matched for age and sex, but residence-matching did not completely eliminate differences in geographic area ($p < 0.0001$) or income quintile ($p < 0.0001$). Diabetes was also significantly more prevalent in the First Nations cohort ($p < 0.0001$). This reflects the demographics of First Nations peoples in the province, most of whom live outside of urban centres, have lower socio-economic status and a higher prevalence of diabetes.

Fracture rates

The First Nations cohort provided 370,351 person-years of follow up with

875,573 person-years of follow up in the matched controls. The numbers of fracture endpoints are summarized in Table I. There were sufficient numbers of hip ($n=708$), wrist ($n=950$), spine ($n=1,474$) and craniofacial ($n=3,703$) fractures for site-specific analysis. The First Nations cohort experienced significantly more fracture endpoints than the controls, and this affected men and women similarly for all sites assessed (Figure 1).

Determinants of fractures

First Nations ethnicity emerged as a significant predictor in the base and full models (Table II). Likelihood ratio tests revealed that this variable improved the fit of the base and full models ($p < 0.0001$ for all tests) for each fracture definition. The inclusion of income quintile, geographic area and the income*geographic area interaction term resulted in a statistically significant improvement in model fit, although the proportion of variation explained by these three variables was small (i.e., 1-7%). The rate ratios derived from the Poisson regression model results are similar to the corresponding SIR measures.

Geographic area, income quintile, and a diagnosis of diabetes were also statistically significant markers for any fracture (Table III) and for the specific fracture definitions (Table IV), independent of their ethnicity effect as given in Table II. The urban area, highest income stratum and non-diabetics were taken as the reference groups. Diabetics were at increased risk for any fracture (rate ratio 1.26, CI 1.19-1.34), hip fracture (rate ratio 1.52, CI 1.23-1.89) and spine fracture (rate ratio 1.64, CI 1.32-2.03). A diagnosis of diabetes was not associated with an increased risk of wrist fracture (rate ratio 0.86, CI 0.65-1.15) while there was an apparent reduction in craniofacial fracture risk with this diagnosis (rate ratio 0.71, CI 0.55-0.92). Any fracture, spine and craniofacial fractures varied by both geographic area and income quintile ($p < 0.0001$), while hip ($p=0.72$) and wrist fractures ($p=0.36$) did not. Lower income was associated with a higher rate of wrist fractures (rate ratio 1.51, CI 1.03-2.21) but not hip fractures (rate ratio 1.17, CI 0.80-1.69). Wrist fractures were more common in rural areas (rate ratios north 2.02, CI 1.37-2.97, rural south 1.50, CI 1.02-2.21), while hip fractures were more

common in urban areas (rate ratios north 0.63, CI 0.42-0.96, rural south 0.73, CI 0.50-1.06).

The fracture analysis showed a statistically significant First Nations effect in the northern region (rate ratio 1.34, CI 1.20-1.50), rural southern region (rate ratio 1.97, CI 1.83-2.13) and urban region (rate ratio 2.61, CI 2.43-2.81). In addition, pairwise tests for differences between geographic areas revealed rate ratios for the three geographic areas to be significantly different from one another ($p < 0.001$). The same trends were observed in the hip, wrist, spine and craniofacial fracture sub-analyses, but there was low statistical power to detect an ethnicity effect because of the smaller number of fracture events (data not shown).

DISCUSSION

This study confirms our previous report that Canadian First Nations people are at substantially increased fracture risk.¹¹ Although age, sex, income level, geographic residential area, and diabetes also affect fracture rates, they do not account for this excess risk. Our case definition for First Nations ethnicity relies on the national Status Verification System supplemented with the provincial Health Registry file. The controls are much more ethnically diverse and more difficult to characterize. Canada census data indicate that most are of European extraction, but some Aboriginal people who do not meet the case definition for Registered First Nations would also be included. In particular, this would apply to Non-Registered First Nations people, Métis and Inuit. Because bias introduced would work against finding a difference, our rate ratio estimates are, if anything, possible underestimates. This may be a factor in the lower contrast rate ratios found in the more northern regions where Non-Registered First Nations and Non-First Nations Aboriginals probably contribute substantially to the control groups.

Fracture ascertainment from administrative health data has known limitations. Minor fractures or fractures that produce few symptoms may not lead to a physician interaction. This is particularly likely with vertebral compression fractures, since the majority are not clinically recognized.

TABLE III

Rate Ratios for any Fracture from the Full Poisson Regression Model (95% confidence intervals are given in parentheses)*

Diabetic	Any Fracture 1.26 (1.19-1.34)
Non-diabetic (reference)	1.00
Geographic area of residence:	
North	1.37 (1.19-1.59)
Rural south	1.12 (0.97-1.30)
Urban (reference)	1.00
Income:	
Quintile 1 (lowest)	1.51 (1.31-1.74)
Quintile 2	1.22 (1.06-1.42)
Quintile 3	1.08 (0.92-1.27)
Quintile 4	1.07 (0.90-1.28)
Quintile 5 (highest: reference)	1.00
Geographic area*Income:	
North	
*Quintile 1	0.52 (0.45-0.61)
*Quintile 2	0.74 (0.63-0.86)
*Quintile 3	0.79 (0.65-0.96)
*Quintile 4	0.90 (0.74-1.09)
*Quintile 5 (reference)	1.00
Rural south	
*Quintile 1	0.68 (0.58-0.79)
*Quintile 2	0.81 (0.69-0.96)
*Quintile 3	0.95 (0.80-1.13)
*Quintile 4	0.82 (0.67-1.00)
*Quintile 5 (reference)	1.00
Urban	
*All quintiles (reference)	1.00

* Rate ratios for age, sex and age*sex are not shown. The ethnicity rate ratios are given in Table II. Rate ratios that differ significantly from one are bold.

TABLE IV

Rate Ratios for Specific Fractures from the Full Poisson Regression Model (95% confidence intervals are given in parentheses)*

	Hip	Wrist	Spine	Craniofacial
Diabetic	1.52 (1.23-1.89)	0.86 (0.65-1.15)	1.64 (1.32-2.03)	0.71 (0.55-0.92)
Non-diabetic (reference)	1.00	1.00	1.00	1.00
Geographic area of residence:				
North	0.63 (0.42-0.96)	2.02 (1.37-2.97)	1.63 (1.25-2.13)	1.51 (1.27-1.79)
Rural south	0.73 (0.50-1.06)	1.50 (1.02-2.21)	1.30 (0.99-1.69)	1.03 (0.86-1.23)
Urban (reference)	1.00	1.00	1.00	1.00
Income:				
Quintiles 1-2	1.17 (0.80-1.69)	1.51 (1.03-2.21)	1.59 (1.23-2.06)	1.66 (1.41-1.95)
Quintiles 3-5 (reference)	1.00	1.00	1.00	1.00
Geographic area*Income interaction:				
North				
*Quintiles 1-2	0.90 (0.56-1.44)	0.70 (0.45-1.09)	0.40 (0.29-0.55)	0.55 (0.45-0.67)
*Quintiles 3-5 (reference)	1.00	1.00	1.00	1.00
Rural south				
*Quintiles 1-2	0.84 (0.54-1.29)	0.82 (0.53-1.27)	0.64 (0.47-0.87)	0.64 (0.52-0.78)
*Quintiles 3-5 (reference)	1.00	1.00	1.00	1.00
Urban				
*All quintiles (reference)	1.00	1.00	1.00	1.00

* Rate ratios for age, sex and age*sex are not shown. The ethnicity rate ratios are given in Table II. Rate ratios that differ significantly from one are bold.

There is no reason to suspect a large differential reporting bias in Registered First Nations, however. A greater limitation is the inability to establish the mechanism for whether increased fracture risk relates to reduced bone density, increased risk for falls, or other unidentified factors. Similarly, other potential risk factors such as diet, smoking, alcohol intake and inactivity could not be considered. Finally, the observed association between fracture rates and the demographic factors studied

does not necessarily imply a causal relationship.

The high rate of intentional and non-intentional trauma among Canadian First Nations people clearly contributes to the observed increased risk for fractures.¹⁰ Whether there is a higher prevalence of osteoporosis among First Nations people is uncertain, and population-based studies of bone density and metabolism are needed. Studies of osteoporosis in Aboriginal people are infrequent and typically involve

very few subjects. Bone mineral density (BMD) in an Aboriginal population in Argentina³⁰ found greater bone density in the femur compared to a White population, and this correlated with greater physical activity and higher levels of vitamin D secondary to sun exposure, despite a lower calcium intake. Bone densities of the lumbar spine did not differ significantly. Bone mineral density in rural Mayan Indian women has been assessed, and despite an early menopause (average age 41–45 years) and bone density of the distal radius that declined markedly with age, elderly women do not appear to develop vertebral or other fractures.³¹ The potential importance of early menopause has not received adequate attention,³² possibly due to a relative lack of symptoms.³¹ A cross-sectional study from the Sac and Fox Nation in rural Oklahoma reported that peak BMD may be higher in Native Americans, and the postmenopausal rate of bone loss greater, than that in White women.³³ A subgroup of participants in the Women's Health Initiative who were of Native American ethnicity were found to have significantly reduced bone density of the spine and total body when compared with Whites, though hip bone density was not reduced.³⁴

Our results have potential implications beyond the Canadian context. We have confirmed diabetes to be a significant risk factor for overall fracture rates and some specific fracture subtypes.^{18,19} Any putative benefit of Type II diabetes in terms of enhanced bone mass, non-skeletal protection from falls, and endocrine changes appears to be overwhelmed by other adverse consequences of this disorder.^{35,36} Further studies that control for the duration of diabetes may help in distinguishing between these opposing factors. It is unclear why diabetes appears to protect against craniofacial fractures, but diabetics may be less likely to expose themselves to circumstances that predispose to injury. The prevalence of diabetes observed in our non-First Nations controls (1.9%) is lower than in a previous report from Manitoba²⁷ (6.7% among adults over age 25). This is most likely attributable to the use of age as a criterion for matching controls to First Nations subjects; diabetes prevalence increases dramatically with age but the elderly make a smaller contribution to the

First Nations population pyramid than in the general population.²⁰

Area of residence and socio-economic status have been shown to be important determinants of fractures risk, but the relationship may be complicated by significant interaction effects. We were unable to confirm other reports related to the importance of socio-economic status in hip fractures,^{12–14} but did see a significant increase in wrist fractures with lower income. As observed by others,^{15,16} hip fractures were more common in the urban region. Wrist fractures were more common in northern areas, a finding consistent with the latitude gradient seen for hip fractures in Sweden,¹⁷ though issues related to ethnicity in the northern controls noted earlier could also be a factor. The cause of these divergent effects is unclear, but different fracture determinants may be important for different sites.

The observation that Registered First Nations people in Manitoba are at high risk for fractures justifies undertaking similar studies in other Aboriginal groups. These studies must adjust for socio-economic status, geographic residency, and diabetes wherever possible. Our study did not evaluate a number of additional determinants of fracture risk, including other social factors and prescription drugs; these should be the subject of further research. Prospective longitudinal studies would help to specifically identify the social, medical and environmental factors contributing to these events. An understanding of the causal factors is required in order to implement an effective fracture prevention strategy.

REFERENCES

- Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: An observational study. *Lancet* 1999;353(9156):878–82.
- Forsen L, Sogaard AJ, Meyer HE, Edna T, Kopjar B. Survival after hip fracture: Short- and long-term excess mortality according to age and gender. *Osteoporos Int* 1999;10(1):73–78.
- Meyer HE, Tverdal A, Falch JA, Pedersen JJ. Factors associated with mortality after hip fracture. *Osteoporos Int* 2000;11(3):228–32.
- Wiktorowicz ME, Goeree R, Papaioannou A, Adachi JD, Papadimitropoulos E. Economic implications of hip fracture: Health service use, institutional care and cost in Canada. *Osteoporos Int* 2001;12(4):271–78.
- Papadimitropoulos EA, Coyte PC, Josse RG, Greenwood CE. Current and projected rates of hip fracture in Canada. *CMAJ* 1997;157(10):1357–63.
- van Staa TP, Dennison EM, Leufkens HG, Cooper C. Epidemiology of fractures in England and Wales. *Bone* 2001;29(6):517–22.
- Grisso JA, Kelsey JL, Strom BL, O'Brien LA, Maislin G, LaPann K, et al. Risk factors for hip fracture in black women. The Northeast Hip Fracture Study Group. *N Engl J Med* 1994;330(22):1555–59.
- Calder SJ, Anderson GH, Harper WM, Gregg PJ. Ethnic variation in epidemiology and rehabilitation of hip fracture. *BMJ* 1994;309(6962):1124–25.
- Looker AC, Wahner HW, Dunn WL, Calvo MS, Harris TB, Heyse SP, et al. Updated data on proximal femur bone mineral levels of US adults. *Osteoporos Int* 1998;8(5):468–89.
- MacMillan HL, MacMillan AB, Offord DR, Dingle JL. Aboriginal health. *CMAJ* 1996;155(11):1569–78.
- Leslie WD, Derksen S, Merge C, Lix L, Salamon EA, Wood Steiman P, Roos LL. Fracture risk among First Nations people: A retrospective matched cohort study. *CMAJ* 2004;171(8):869–73.
- Farahmand BY, Persson PG, Michaelsson K, Baron JA, Parker MG, Ljunghall S. Socioeconomic status, marital status and hip fracture risk: A population-based case-control study. *Osteoporos Int* 2000;11(9):803–8.
- Varenni M, Binelli L, Zucchi F, Ghiringhelli D, Gallazzi M, Sinigaglia L. Prevalence of osteoporosis by educational level in a cohort of postmenopausal women. *Osteoporos Int* 1999;9(3):236–41.
- Bacon WE, Hadden WC. Occurrence of hip fractures and socioeconomic position. *J Aging Health* 2000;12(2):193–203.
- Kaastad TS, Meyer HE, Falch JA. Incidence of hip fracture in Oslo, Norway: Differences within the city. *Bone* 1998;22(2):175–78.
- Sernbo I, Johnell O, Andersson T. Differences in the incidence of hip fracture. Comparison of an urban and a rural population in southern Sweden. *Acta Orthop Scand* 1988;59(4):382–85.
- Johnell J, Oden A, Rosengren B, Mellstrom D, Kanis J. National variation in hip fracture rate in Sweden depends on latitude and season - A cohort study of 26 million observation years. *Osteoporosis Int* 2002;13(Suppl. 1):S8.
- Schwartz AV, Sellmeyer DE, Ensrud KE, Cauley JA, Tabor HK, Schreiner PJ, et al. Older women with diabetes have an increased risk of fracture: A prospective study. *J Clin Endocrinol Metab* 2001;86(1):32–38.
- Forsen L, Meyer HE, Midthjell K, Edna TH. Diabetes mellitus and the incidence of hip fracture: Results from the Nord-Trøndelag Health Survey. *Diabetologia* 1999;42(8):920–25.
- Martens PJ, Bond R, Jebamani LS, Burchill CA, Roos NP, Derksen SA, et al. *The Health and Health Care Use of Registered First Nations People Living in Manitoba: A Population-Based Study*. Winnipeg: Manitoba Centre for Health Policy, 2002.
- Jebamani L, Burchill C, Martens P. Using data linkage to identify First Nations Manitobans: Technical, ethical and political issues. *Can J Public Health* 2005;96(Suppl. 1):S28–S32.
- Roos NP, Shapiro E. Revisiting the Manitoba Centre for Health Policy and Evaluation and its population-based health information system. *Med Care* 1999;37(Suppl. 6):JS10–JS14.
- Roos LL, Sharp SM, Wajda A. Assessing data quality: A computerized approach. *Soc Sci Med* 1989;28(2):175–82.
- Roos LL, Walld RK, Romano PS, Roberecki S. Short-term mortality after repair of hip fracture. Do Manitoba elderly do worse? *Med Care* 1996;34(4):310–26.
- Stone KL, Seeley DG, Lui LY, Cauley JA, Ensrud K, Browner WS, et al. BMD at multiple sites and

- risk of fracture of multiple types: Long-term results from the Study of Osteoporotic Fractures. *J Bone Miner Res* 2003;18(11):1947-54.
26. Income Quintiles Based on the 1996 Census. Winnipeg, MB. Manitoba Centre for Health Policy, 2003. Available on-line at http://www.umanitoba.ca/academic/centres/mchp/concept/diet/income/income_quintile.html (Accessed September 3, 2003)
 27. Blanchard JF, Ludwig S, Wajda A, Dean H, Anderson K, Kendall O, Depew N. Incidence and prevalence of diabetes in Manitoba, 1986-1991. *Diabetes Care* 1996;19(8):807-11.
 28. McCulloch CE, Searle SR. *Generalized, Linear, and Mixed Models*. New York: John Wiley & Sons, 2001.
 29. Fox J. *Applied Regression Analysis, Linear Models, and Related Methods*. Thousand Oaks, CA: Sage, 1997.
 30. Spindler A, Lucero E, Berman A, Paz S, Vega E, Mautalen C. Bone mineral density in a native population of Argentina with low calcium intake. *J Rheumatol* 1995;22(11):2148-51.
 31. Beyene Y, Martin MC. Menopausal experiences and bone density of Mayan women in Yucatan, Mexico. *Am J Human Biol* 2001;13(4):505-11.
 32. Hamman RF, Bennett PH, Miller M. The effect of menopause on serum cholesterol in American (Pima) Indian women. *Am J Epidemiol* 1975;102(2):164-69.
 33. Perry HM, III, Bernard M, Horowitz M, Miller DK, Fleming S, Baker MZ, et al. The effect of aging on bone mineral metabolism and bone mass in Native American women. *J Am Geriatr Soc* 1998;46(11):1418-22.
 34. Chen Z, Maricic MJ, Going SB, Lohman TG, Altamari BR, Bassford TL. Comparative findings in bone mineral density among postmenopausal Native American women and postmenopausal White women residing in Arizona. *Bone* 2003;23(Suppl. 1):S592.
 35. van Daele PL, Stolk RP, Burger H, Algra D, Grobbee DE, Hofman A, et al. Bone density in non-insulin-dependent diabetes mellitus. The Rotterdam Study. *Ann Intern Med* 1995;122(6):409-14.
 36. Stolk RP, van Daele PL, Pols HA, Burger H, Hofman A, Birkenhager JC, et al. Hyperinsulinemia and bone mineral density in an elderly population: The Rotterdam Study. *Bone* 1996;18(6):545-49.

RÉSUMÉ

Contexte : On a récemment démontré que le risque de fracture était plus élevé chez les membres des Premières nations que dans la population générale. Cependant, les facteurs pouvant contribuer à ce risque n'ont pas été examinés. La présente étude porte sur la région de résidence, le niveau de revenu et le diabète sucré, qui pourraient être des variables explicatives, car elles jouent un rôle dans les taux de fracture observés dans d'autres populations.

Méthode : À l'aide des données administratives sur la santé du Manitoba (1987-1999), nous avons mené une étude de cohortes représentative et rétrospective portant sur les taux de fracture. La cohorte des Premières nations comprenait tous les membres des Premières nations d'âge adulte (20 ans et plus) désignés comme étant « inscrits » dans les bases de données fédérales et/ou provinciales (n = 32 692). Les témoins (jusqu'à trois pour chaque sujet des Premières nations) ont été assortis aux cas selon l'année de naissance, le sexe et la région de résidence. Après avoir exclu les cas non assortis, notre analyse s'est fondée sur 31 557 sujets des Premières nations et 79 720 témoins.

Résultats : Les taux de fracture globaux et par site étaient sensiblement plus élevés dans la cohorte des Premières nations. Le quintile de revenu, la région de résidence et le diabète étaient des déterminants du taux de fracture, mais il subsiste un risque de fracture plus élevé chez les membres des Premières nations, même après ajustement selon ces trois facteurs.

Conclusion : Les membres des Premières nations présentent un risque de fracture élevé, mais les facteurs causals de cette situation ne sont pas clairs. Il faudrait pousser la recherche pour évaluer l'importance d'autres variables explicatives possibles.