Fracture risk among First Nations people: a retrospective matched cohort study

William D. Leslie, Shelley Derksen, Colleen Metge, Lisa M. Lix, Elizabeth A. Salamon, Pauline Wood Steiman, Leslie L. Roos

Abstract

Background: Canadian First Nations people have unique cultural, socioeconomic and health-related factors that may affect fracture rates. We sought to determine the overall and site-specific fracture rates of First Nations people compared with non-First Nations people.

Methods: We studied fracture rates among First Nations people aged 20 years and older (n = 32 692) using the Manitoba administrative health database (1987–1999). We used federal and provincial sources to identify ethnicity, and we randomly matched each First Nations person with 3 people of the same sex and year of birth who did not meet this definition of First Nations ethnicity (n = 98 076). We used a provincial database of hospital separations and physician billing claims to calculate standardized incidence ratios (SIRs) and 95% confidence intervals (CIs) for each fracture type based on a 5-year age strata.

Results: First Nations people had significantly higher rates of any fracture (age- and sex-adjusted SIR 2.23, 95% CI 2.18–2.29). Hip fractures (SIR 1.88, 95% CI 1.61–2.14), wrist fractures (SIR 3.01, 95% CI 2.63–3.42) and spine fractures (SIR 1.93, 95% CI 1.79–2.20) occurred predominantly in older people and women. In contrast, craniofacial fractures (SIR 5.07, 95% CI 4.74–5.42) were predominant in men and younger adults.

Interpretation: First Nations people are a previously unidentified group at high risk for fracture.

CMAJ 2004;171(8):869-73

Most of the epidemiologic data describing fractures have been derived from white populations,[1] although it is known that there is ethnic variation in the epidemiology of fractures.[2–4] Canadian First Nations people are known to suffer from a heavy burden of medical and social problems that may affect fracture rates.[5] To date, however, there have been no satisfactory studies of fracture rates among North American Aboriginal groups. We sought to determine the overall and site-specific fracture rates of First Nations people compared with non-First Nations people in Manitoba.

Methods

We studied registered First Nations people aged 20 years or older to determine overall and site-specific fracture rates. First Nations status was primarily determined from the Canadian government's 1994–1999 Status Verification System, a national database maintained by First Nations and Inuit Health Branch and Indian and Northern Affairs Canada (n = 31 029). The database is used to identify registered First Nations people and recognized Innu and Inuit clients and to determine eligibility for services such as non-insured health benefits. The presence of a Treaty Status code in the Manitoba Health Registry File was taken to be a secondary indicator of First Nations status (n = 25 682). The complete dataset of First Nations adults used for this study contained 32 692 men and women aged 20 years or older in 1987. The control (non-First Nations) cohort was chosen by randomly matching each First Nations subject with 3 subjects not identifiable as having First Nations status but having the same sex and year of birth (n = 98 076).[6] The study was reviewed and approved by the Health Research Ethics Board of the University of Manitoba, the Health Information Privacy Committee of Manitoba Health and the Health Information and Research Committee of the Assembly of Manitoba Chiefs.

Manitoba Health maintains computerized databases of physician billing claims and hospital separations for all residents of the province eligible to receive health services. Each health system contact includes information on a patient's demographic characteristics, date and type of service, and diagnoses, which are coded using the International Classification of Diseases 9th Clinical Modification (ICD-9-CM). Through a unique personal health

Table 1: Characteristics of and fracture incidence in First Nations cohort and age-matched non-First Nations control group

Characteristic	Group; no. (%) of subjects*	
	First Nations cohort *n = 32 692*	Control subjects *n = 98 076*
Age, yr†		
< 40	21 949 (67.1)	65 847 (67.1)
40–59	7 712 (23.6)	23 136 (23.6)
≥ 60	3 031 (9.3)	9 093 (9.3)
Sex, male	16 069 (49.2)	48 207 (49.2)
Follow-up, person-years	384 012	1 085 778
No. of fractures		
Any site	11 118 (34.0)	16 252 (16.6)
Hip	322 (1.0)	554 (0.6)
Wrist	497 (1.5)	492 (0.5)
Spine	618 (1.9)	933 (1.0)
Craniofacial	2 408 (7.4)	1 397 (1.4)

*Unless stated otherwise.
†As of Dec. 31, 1987.

DOI:10.1503/cmaj.1031624

Table 2: Standardized incidence ratios (SIRs) for fractures in the First Nations cohort compared with age-matched control group

Fracture	SIR (95% CI)		
	Men*	Women*	All†
Hip	2.13 (1.68–2.63)	1.75 (1.41–2.05)	1.88 (1.61–2.14)
Wrist	2.83 (2.29–3.39)	3.16 (2.68–3.79)	3.01 (2.63–3.42)
Spine	1.75 (1.54–2.08)	2.12 (1.88–2.51)	1.93 (1.79–2.20)
Craniofacial	4.89 (4.51–5.29)	5.48 (4.88–6.19)	5.07 (4.74–5.42)
Any	2.19 (2.12–2.27)	2.26 (2.20–2.36)	2.23 (2.18–2.29)

Note: CI = confidence interval.
*Adjusted for age only.
†Adjusted for age and sex.

identification number, this data repository allows for the creation of a longitudinal record of a person's health service use. The accuracy of these administrative data has been established for a wide range of clinical disorders, including outcomes following hip fracture.[7,8]

Each subject's longitudinal health service record from Apr. 1, 1987, to Dec. 31, 1999, was assessed for the presence of any ICD-9-CM fracture code (ICD-9-CM 800–829). Vertebral fractures without cord injury (ICD-9-CM 805), wrist fracture (ICD-9-CM 813), hip fracture (ICD-9-CM 820–821) and craniofacial fractures (ICD-9-CM 800–804) were analyzed as specific subcategories. 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).

Fracture rates were calculated for each ethnicity, sex and 5-year age group as the number of people with fractures divided by the

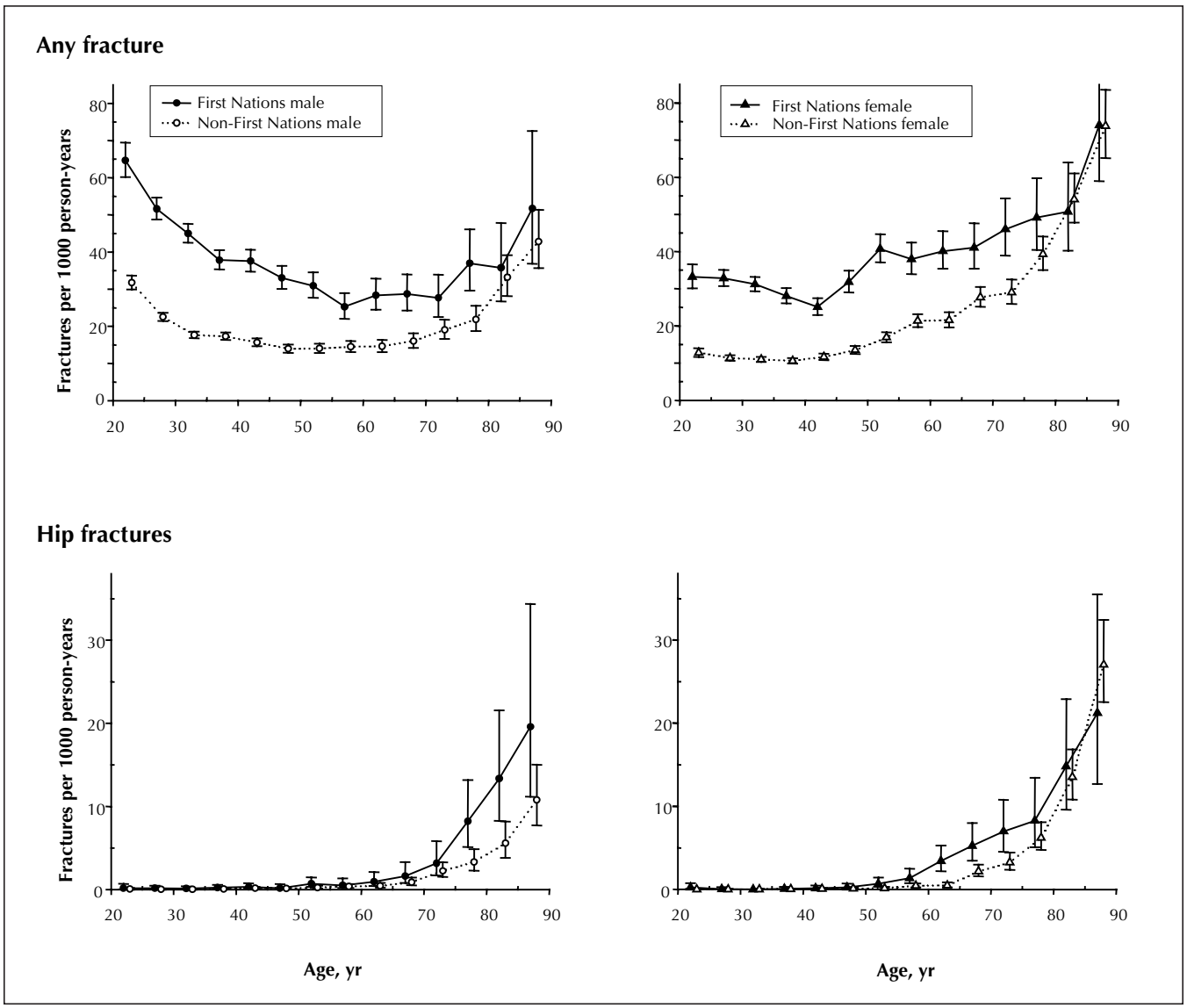
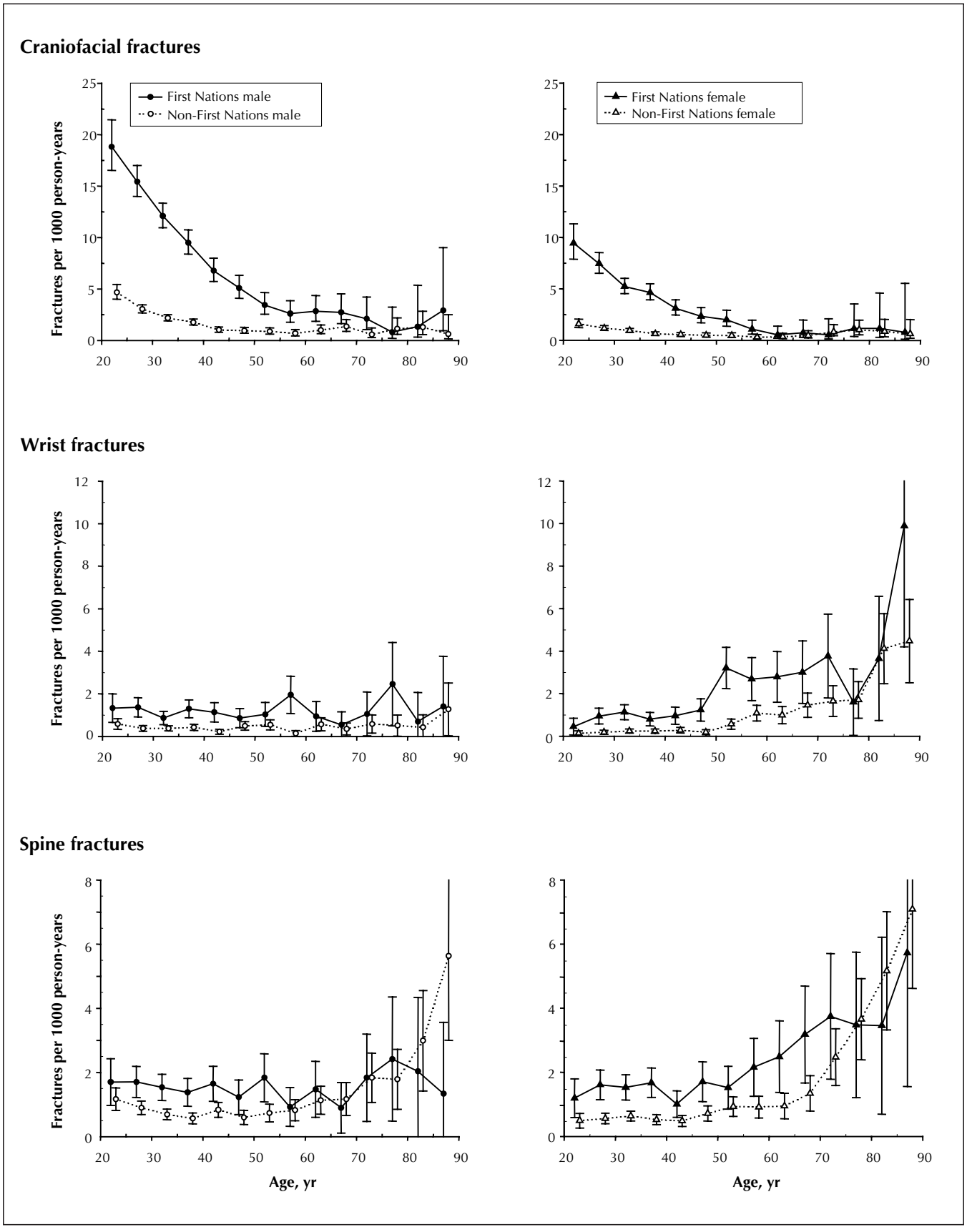


Fig. 1: Fracture rates among men (circles) and women (triangles) for any fracture and hip, craniofacial, wrist and spine fractures. 95% confidence interval bars are shown.


Craniofacial fractures
First Nations male
Non-First Nations male
First Nations female
Non-First Nations female
Fractures per 1000 person-years
Wrist fractures
Spine fractures
Age, yr

number of person-years of follow-up (expressed per 1000 person-years). Standardized incidence ratios (SIRs) with 95% confidence intervals (CIs) were calculated for each fracture type using the First Nations cohort with the non-First Nations cohort matched for sex and age.[9] We adjusted by age and sex even though these were matching variables in the cohort selection because these demographic variables are known to be associated with fracture rates.[10] All significance tests were performed at $\alpha = 0.05$.

Results

The demographic characteristics and fracture incidence of the cohorts are summarized in Table 1. The age- and sex-matched cohort provided 384 012 person-years of follow-up and 1 085 778 person-years of follow-up in the matched control group. Among the age- and sex-matched First Nations cohort, 34.0% met the definition for a fracture, as compared with 16.6% of the control subjects. There were sufficient numbers of hip, wrist, spine and craniofacial fractures for site-specific analysis.

The men and women in the First Nations cohort experienced significantly higher fracture rates than the control subjects did. The risk for hip fracture and spine fracture was almost double among the First Nations cohort (Table 2). The relative rates for any fracture, wrist fracture and craniofacial fracture were even greater. Age was strongly associated with hip fractures, with very few hip fractures before age 60 and a rapid increase in later life for men and women in both cohorts (Fig. 1). The opposite relation was seen for craniofacial fractures, which were more frequent before age 60 and were predominant in men. Wrist fractures and spine fractures showed a clear age-related increase in women, but this effect was much less evident in men. When all fracture types were combined, among women there was a strong pattern of increasing risk with advancing age, whereas among men there was a bimodal U-shaped relation, with the lowest point at 55–60 years of age (Fig. 1).

Interpretation

We found a substantially increased fracture risk among Canadian First Nations people. This is consistent with other reports that show that ethnicity can affect fracture rates. For example, compared with white people, people of black and Asian ethnicity tend to exhibit a lower risk for hip fracture,[2,11,12] whereas people from the Indian subcontinent may have more hip fractures.[3]

A major limitation in relying on administrative health data is the inability to establish the factors responsible for the observed fracture rates. A higher rate of accidental and nonaccidental trauma among Canadian First Nations people clearly contributes to the observed increased risk for fractures, especially the very high rates of craniofacial fractures.[5] The age-related increase in hip, wrist and spine fractures seen predominantly in women follows a different profile. These sex patterns are broadly similar to those reported from the General Practice Research Database in the United Kingdom, which showed a bimodal U-shaped relation in adult men with a progressive age-related increase in adult women.[1] In this 10-year study, skull fractures were most prevalent among young men, whereas fractures of the femur or hip, vertebra, and radius or ulna increased with age and were experienced mostly by older women.

First Nations people also differed from the control subjects in terms of socioeconomic status, area of residence and prevalence of diabetes, each of which may affect fracture rates. Socioeconomic status has been identified as a factor in hip fractures.[13–15] Hip fractures are also reported to be more common in urban areas[16,17] and more northern latitudes.[18] Diabetes is a significant risk factor for fractures,[19,20] and any putative benefit of type 2 diabetes in terms of enhanced bone mass appear to be overwhelmed by other adverse consequences of this disorder.[21,22]

Whether a higher prevalence of osteoporosis contributes to higher fracture rates among First Nations people in Manitoba is uncertain and would require studies designed to assess bone density. A cross-sectional study from the Sac and Fox Nation in rural Oklahoma reported that peak body mass index may be higher among Native Americans and that the postmenopausal rate of bone loss may be greater than that among white women.[23] 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 white people, although hip bone density was not reduced.[24]

Our case definition for First Nations ethnicity relies on the national Status Verification System and the provincial Health Registry file. This definition is highly specific for First Nations ethnicity. Statistics Canada data from 1996 indicated that only 4% of the Manitoba Aboriginal population were non-Status First Nations people.[25] The majority (63.5%) of the Manitoba Aboriginal population are Status First Nations people. Therefore, our study should be representative of Manitoba First Nations people. The largest non-Status Aboriginal group in Manitoba is the Métis, who account for 31.9% of the Aboriginal population in the province. The control subjects were much more ethnically diverse and more difficult to characterize. Canada census data indicate that most were of European extraction, but some Aboriginal people who do not meet the case definition for Status First Nations would also have been included. Any bias introduced would work against finding a difference, and therefore our rate ratio estimates are, if anything, possible underestimates.

In summary, the incidence of all fracture types among Manitoba First Nations people is considerably greater than that among non-First Nations people in the province. Although the pathophysiology underlying this finding remains to be clarified, we have been able to identify a group

at high risk for fractures that had not previously been recognized. Our findings add to the growing literature on the significance of ethnicity as a marker of fracture risk.

This article has been peer reviewed.

Department of Medicine (Leslie, Salamon), Manitoba Centre for Health Policy, Department of Community Health Sciences (Derken, Metge, Lix, Roos), University of Manitoba, and Four Arrows Health Authority, Island Lake Tribal Council (Wood Steiman), Winnipeg, Man.

Competing interests: None declared.

Contributors: William D. Leslie drafted the article, Shelley Derksen acquired the data and all authors contributed to the study's conception, design, analysis and interpretation and approved the final draft.

Acknowledgements: This study was supported by a grant from the Health Sciences Centre Foundation. The authors are indebted to Health Information Services of 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 and Research Committee of the Assembly for 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 Doreen Anderson, John O'Neil and Patricia Martens for their assistance with this project.

References

1. Van Staa TP, Dennison EM, Leufkens HG, Cooper C. Epidemiology of fractures in England and Wales. *Bone* 2001;29:517-22.
2. 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;330:1555-9.
3. Calder SJ, Anderson GH, Harper WM, Gregg PJ. Ethnic variation in epidemiology and rehabilitation of hip fracture. *BMJ* 1994;309:1124-5.
4. 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;8:468-89.
5. MacMillan HL, MacMillan AB, Offord DR, Dingle JL. Aboriginal health. *CMAJ* 1996;155(11):1569-78.
6. Kleinbaum DG, Kupper LL, Morgenstern H. *Epidemiologic research*. New York: Van Nostrand Reinhold; 1982. p. 396.
7. Roos LL, Sharp SM, Wajda A. Assessing data quality: a computerized approach. *Soc Sci Med* 1989;28:175-82.
8. Roos LL, Walld RK, Romano PS, Roberecki S. Short-term mortality after repair of hip fracture: Do Manitoba elderly do worse? *Med Care* 1996;34:310-26.
9. Selvin S. *Epidemiologic analysis*. New York: Oxford University Press; 2001.
10. Rothman KJ, Greenland S. *Modern epidemiology*. 2nd ed. Philadelphia: Lippincott-Raven; 1998. p. 160.
11. Ross PD, Norimatsu H, Davis JW, Yano K, Wasnich RD, Fujiwara S et al. A comparison of hip fracture incidence among native Japanese, Japanese Americans, and American Caucasians. *Am J Epidemiol* 1991;133:801-9.
12. Lau EM, Lee JK, Suriwongpaisal P, Saw SM, Das DS, Khir A, et al. The incidence of hip fracture in four Asian countries: the Asian Osteoporosis Study (AOS). *Osteoporos Int* 2001;12:239-43.
13. 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;11:803-8.
14. Varenna 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;9:236-41.
15. Bacon WE, Hadden WC. Occurrence of hip fractures and socioeconomic position. *J Aging Health* 2000;12:193-203.
16. Kaastad TS, Meyer HE, Falch JA. Incidence of hip fracture in Oslo, Norway: differences within the city. *Bone* 1998;22:175-8.
17. 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;59:382-5.
18. 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. *Osteoporos Int* 2002;13:S8.
19. 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;86:32-8.
20. Forsen L, Meyer HE, Midthjell K, Edna TH. Diabetes mellitus and the incidence of hip fracture: results from the Nord-Trondelag Health Survey. *Diabetologia* 1999;42:920-5.
21. 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;122:409-14.
22. 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;18:545-9.
23. 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;46:1418-22.
24. Chen Z, Maricic MJ, Going SB, Lohman TG, Altimari BR, Bassford TL. Comparative findings in bone mineral density among postmenopausal Native American women and postmenopausal White women residing in Arizona. *Bone* 2003;23:S592.
25. Hallett B, Nemeth M, Stevens H, Stewart D. Aboriginal people in Manitoba 2000. Available: www.gov.mb.ca/ana/apm2000/apm2000.pdf (accessed 2004 Apr 21).

Correspondence to: *Dr. William D. Leslie, Department of Medicine (C5121), 409 Tache Ave., Winnipeg MB R2H 2A6; fax 204 237-2007; bleslie@sbgh.mb.ca*