

# Imbalance of Prevalence and Specialty Care for Osteoarthritis for First Nations People in Alberta, Canada

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**ABSTRACT. Objective.** To estimate the population-based prevalence and healthcare use for osteoarthritis (OA) by First Nations (FN) and non-First Nations (non-FN) in Alberta, Canada.

**Methods.** A cohort of adults with OA ( $\geq 2$  physician claims in 2 yrs or 1 hospitalization with ICD-9-Clinical Modification code 715x or ICD-10-Canadian Adaptation code M15-19, 1993–2010) was defined with FN determination by premium payer status. Prevalence rates (2007/8) were estimated from the cohort and the population registered with the Alberta Health Care Insurance Plan. Rates of outpatient primary care and specialist visits (orthopedics, rheumatology, internal medicine), arthroplasty (hip and knee), and all-cause hospitalization were estimated.

**Results.** OA prevalence in FN was twice that of the non-FN population [16.1 vs 7.8 cases/100 population, standardized rate ratio (SRR) adjusted for age and sex 2.06, 95% CI 2.00–2.12]. The SRR (adjusted for age, sex, and location of residence) for primary care visits for OA was nearly double in FN compared with non-FN (SRR 1.88, 95% CI 1.87–1.89), and internal medicine visits were increased (SRR 1.25, 95% CI 1.25–1.26). Visit rates with an orthopedic surgeon (SRR 0.49, 95% CI 0.48–0.50) or rheumatologist (SRR 0.62, 95% CI 0.62–0.63) were substantially lower in FN with OA. Hip and knee arthroplasties were performed less frequently in FN with OA (SRR 0.48, 95% CI 0.47–0.49), but all-cause hospitalization rates were higher (SRR 1.59, 95% CI 1.58–1.60).

**Conclusion.** We estimate a 2-fold higher prevalence of OA in the FN population with differential healthcare use. Reasons for higher use of primary care and lower use of specialty services and arthroplasty compared with the general population are not yet understood. (First Release Dec 1 2014; J Rheumatol 2015;42:323–8; doi:10.3899/jrheum.140551)

## Key Indexing Terms:

OSTEOARTHRITIS

EPIDEMIOLOGY

HEALTH SERVICES RESEARCH

AMERICAN NATIVE CONTINENTAL ANCESTRY GROUP

Osteoarthritis (OA), the most common form of arthritis, affects an estimated 4.4 million Canadians<sup>1</sup> and results in impairment in physical and mental health, work disability, and reduced social participation<sup>2</sup>. Healthcare interactions

attributable to OA include 3% of all medical and 13% of all surgical hospitalizations. Further, up to 14% of the Canadian population visits a physician for any arthritis condition in any given year<sup>2</sup>.

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In population surveys, indigenous populations [also referred to as Aboriginal in Canada, inclusive of First Nations (FN), Métis, and Inuit] report high rates of arthritis. In both on-reserve (Regional Health Survey)<sup>3</sup> and off-reserve (Aboriginal Peoples Survey)<sup>2</sup> populations, it is the most commonly self-reported chronic illness, surpassing estimates in the non-indigenous population using similar study methodology. Alarming, higher levels of disability from arthritis are reported, particularly in younger age groups<sup>2</sup>. Beyond this self-reported data, only limited information has been published on the prevalence of specific forms of arthritis in the indigenous population, even less on disease severity, health outcomes, or healthcare use. These are critical to evaluate to inform future health services planning, given that population demographics indicate a high at-risk population, and with system inertia in addressing determinants of health that affect arthritis risk.

Using population-based data that permit the determination of FN status, our study objective was to estimate the prevalence of OA in the FN population of Alberta, Canada, and to compare variations in access to specialty care services for OA in FN and the general population. Identifying disparities in disease prevalence and healthcare use will provide a basis to understand and identify where future service needs exist.

## MATERIALS AND METHODS

**Setting and study design.** We performed secondary analysis on 4 administrative databases maintained by Alberta Health for the Alberta Health Care Insurance Plan (AHCIP), covering about 3.7 million Alberta residents, including hospitalizations (the Inpatient Discharge Abstract Database), outpatient physician visits (Ambulatory Care and Practitioner Payments databases), and demographic information (Population Registry). Databases were linked using the Alberta Provincial Health Number, a unique individual identifier. The number of individuals registered with AHCIP differed from census data by only 0.1%<sup>4</sup>. The time period of our study included fiscal years 1993/1994 to 2009/2010.

**OA case determination.** Case ascertainment was based on physician billing claims coded according to the International Classification of Diseases Clinical Modification, 9th ed (ICD-9-CM) system (715.x) or hospitalization data [16 discharge diagnoses fields with ICD-9-CM prior to April 2002, 25 discharge diagnoses fields with ICD-10-CA (Canadian Adaptation, M15-19) after April 2002]. Validated case definitions were applied based on the work by Lix, *et al*<sup>5,6</sup> with  $\geq 2$  billing codes by any physician within 2 years, or 1 hospitalization discharge diagnosis used to define the prevalent cohort.

**Population determination.** FN status was determined using validated methodology developed by Alberta Health for health services research and adopted by the Alberta research community<sup>7,8,9</sup>. This methodology uses the provincial health premium payment history to identify individuals whose premiums were paid by the First Nations and Inuit Health Branch (Health Canada) at any timepoint since 1994, thus indicating Treaty Status as per the Indian Act. All others were classified as non-FN. According to AHCIP, 3.7% of the 2007 Alberta population were FN, consistent with Statistics Canada census data<sup>10</sup>.

**Main outcomes and statistical analysis.** All analyses were completed with FoxPro (version 9.0, FOXPRO Inc.) and Excel 2007 (Microsoft Corp.).

**Prevalence.** All surviving individuals meeting the case definition during the run-in period (starting in 1993/1994) and registered with AHCIP at the

midpoint of the 2007/2008 fiscal year constituted the prevalent population with OA (numerator). The 2007/2008 fiscal year was selected for our estimates to ensure all potential cases identified through physician billing codes would be within a 2-year window at the end of our study period (2009/2010). The denominator was all registered individuals with AHCIP at the midpoint of the 2007/2008 fiscal year. Age- and sex-adjusted rates for the FN population were calculated using the total Alberta population as the reference.

**Primary care and specialist physician visits for OA.** The Practitioner Payments database of Alberta Health identifies outpatient and hospital visits. Primary care as well as specialist visits (rheumatologist, internist, orthopedic surgeon) are available in this database. In Alberta, some rheumatology specialists bill as internists for remuneration purposes. We identified all visits by individuals meeting the case definition with the diagnostic code for OA in the primary position, indicating the primary reason for the visit. For each of the fiscal years between 2004/2005 and 2007/2008, the mean number of outpatient visits for the prevalent OA cohort specifically to either a primary care physician or a specialist physician was calculated by FN status. Standardized rate ratios (SRR) were calculated with age, sex, and location of residence adjustments relative to the Alberta population with OA. The rates for these 4 fiscal years were averaged and expressed as a rate per 100 person-years with OA.

**Arthroplasty surgeries.** Procedure codes were used to identify hip and knee arthroplasties (primary and revision surgeries for total or partial replacements) from the Inpatient Discharge Abstract Database, with ICD-9-CM procedure codes used to March 30, 2002, and the Canadian Classification of Health Interventions used thereafter (ICD-9-CM codes 81.50, 81.51, 81.53, or CCI 1.VA.53 for hip; ICD-9-CM codes 81.54, 81.55, or CCI 1.VG.53 for knee), similar to the method used by the Manitoba Centre for Health Policy in their analysis of joint replacement surgeries for the Métis population<sup>11</sup>. For each fiscal year between 2004/2005 and 2007/2008, an annual rate for arthroplasty per 100 person-years with OA was calculated. SRR were calculated with age, sex, and location of residence adjustments relative to the Alberta population with OA. Rates were also calculated separately for individuals with and without comorbidities listed in the Charlson index<sup>12</sup>, and with validated algorithms for diabetes<sup>13</sup> and hypertension (HTN)<sup>14</sup>, determined if any single code for the included conditions was reported in the 3 years prior to the index date, defined as the first visit with the ICD-9-CM or ICD-10-CA codes of interest.

**Hospitalization.** Each individual separation in the Inpatient Discharge Abstract Database with a primary or nonprimary diagnosis for OA was counted as a unique hospitalization. Each individual hospital separation was considered for those meeting the case definition between fiscal years 1997/1998 and 2010/2011, with an average calculated annually and expressed as a rate per 100 person-years with OA and stratified by FN status. The rates were calculated for the presence or absence of comorbidities<sup>12</sup>, including diabetes<sup>13</sup> and HTN<sup>14</sup>, as described above.

**Covariates.** Demographic data including age, sex, and the first 3 digits of the postal code (to define rural or urban residence<sup>15</sup>) were extracted from the Population Registry.

**Ethics approval.** The University of Calgary Conjoint Research Health Ethics Board approved the study, following confirmation from the Alberta First Nations community that principles of ownership, control, access, and possession were respected (Ethics ID E-23620).

## RESULTS

**Cohort demographics.** We identified 289,928 non-FN and 10,745 FN patients with prevalent OA during the study period (1993/94 to 2009/2010). Women represented 57.6% of the non-FN ( $n = 166,895$ ) and 53.2% of the FN cases ( $n = 5719$ ). The majority of non-FN individuals were urban residents (80.0%,  $n = 232,014$ ) in contrast to FN (40.6%,

n = 4367). Diabetes was coded for 5.1% of non-FN and 8.6% of FN, reflecting the known high burden of this comorbidity in FN. Considering the comorbidities of HTN, diabetes, and conditions in the Charlson index<sup>12</sup>, 28.1% of non-FN and 32.7% of FN had at least 1 comorbid condition.

**OA prevalence.** The crude OA prevalence was 7.8 cases per 100 persons in non-FN and 16.0 cases per 100 persons in FN (Figure 1). After adjusting for differences in population structure by age and sex, the SRR for OA prevalence in FN was double that of non-FN at 2.06 (95% CI 2.00–2.12). The SRR remained higher in FN compared with non-FN in both rural and urban populations. Rural FN had an OA prevalence of 18.7 cases per 100 population compared with rural non-FN at 8.9 cases per 100 population with an SRR of 2.10 (95% CI 2.03–2.19). The urban rates were 13.6 cases per 100 FN persons and 7.6 cases per 100 non-FN persons with an SRR of 1.78 (95% CI 1.70–1.87).

**Primary care use.** OA accounted for 14.4% of outpatient visits to primary care physicians for non-FN persons with OA, with a crude mean of 1.6 visits (SD 1.0) per person annually (Figure 2A). This was compared with 20.3% of primary care visits for FN persons, and a mean of 3.4 (SD 2.5) visits per person annually. The SRR (adjusted for age, sex, and location of residence) for primary care visits for OA was nearly double in FN compared with non-FN at 1.88 (95% CI 1.87–1.89).

**Specialty care.** After adjustment for age, sex, and location of residence, because no effect modification was found by these factors in the crude analysis, FN persons with OA had a lower rate of visits to orthopedics (SRR 0.49, 95% CI 0.48–0.50) and rheumatology services (SRR 0.62, 95% CI 0.62–0.63) compared with non-FN with OA (Figure 2B).

Some rheumatologists bill services as an internist; we did see an increased internal medicine visit rate in FN compared with non-FN (SRR 1.25, 95% CI 1.25–1.26).

**Joint arthroplasty.** Compared with non-FN, FN with OA were less likely to have hip or knee arthroplasty, particularly if residing in a rural location (Figure 3). The overall rate of total joint arthroplasty per 100 person-years was 0.71 (95% CI 0.47–0.94) for FN compared with 1.47 (95% CI 1.46–1.47) for non-FN, yielding an SRR adjusted for age and sex of 0.48 (95% CI 0.47–0.49). The adjusted SRR for urban FN relative to urban non-FN was 0.54 (95% CI 0.54–0.55), and for rural FN relative to rural non-FN was 0.22 (95% CI 0.22–0.23). Comorbidities did not appear to affect the rate of arthroplasty. FN with diabetes had an arthroplasty rate of 0.86 (95% CI 0.63–1.08) per 100 person-years, and in the presence of any comorbidity, the arthroplasty rate was 0.88 (95% CI 0.77–1.00) per 100 person-years. In non-FN, the estimates were 2.35 (95% CI 2.25–2.45) per 100 person-years for diabetics, and 2.57 (95% CI 2.53–2.61) in the presence of any comorbidity.

**All-cause hospitalization.** Overall, 61.3% of FN women, 54.0% of non-FN women, 55.3% of FN men, and 54.3% of non-FN men with prevalent OA had at least 1 hospitalization during the study period (Figure 4). All-cause hospitalization rates for FN people with OA were higher than for non-FN after adjustment for age, sex, and location of residence, with an SRR of 1.59 (95% CI 1.58–1.60). If any comorbidity were present, the all-cause hospitalization rate in FN was 34.1 per 100 person-years (95% CI 30.5–37.7) compared with 26.5 per 100 person-years (95% CI 26.2–26.8) in non-FN. If no comorbidity was present, the all-cause hospitalization rate in FN was 16.4 per 100

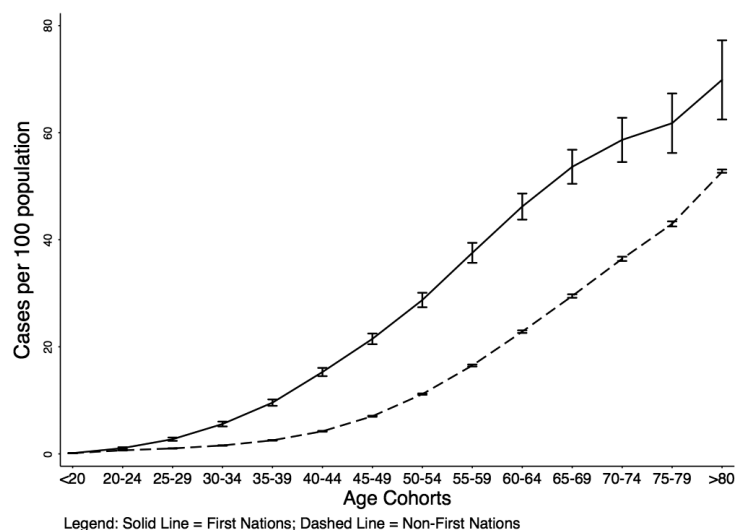


Figure 1. Prevalence of osteoarthritis by age group and First Nations status (per 100 population, fiscal years 2007/2008). Solid line: First Nations. Dashed line: non-First Nations. Bars represent the 95% CI.

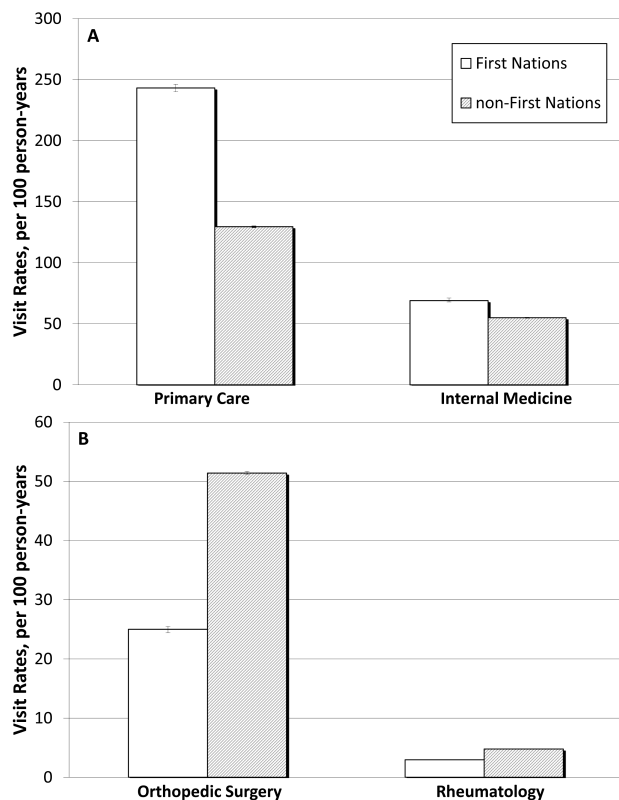


Figure 2. Visit rates (per 100 person-yrs) to primary care and internal medicine (A) and specialty care physicians (B) for osteoarthritis, adjusted for age, sex, and location of residence, for First Nations and non-First Nations people.

person-years (95% CI 15.5–17.2) compared with 12.9 per 100 person-years (95% CI 12.8–13.0) in non-FN.

## DISCUSSION

Our population-based analysis of OA prevalence and healthcare use in Alberta, Canada, has identified differences in disease burden and access to care between FN and non-FN populations. We confirmed the self-reported survey findings<sup>2,3</sup> of a 2-fold higher age-adjusted and sex-adjusted prevalence of OA in FN persons compared with non-FN. Primary care physicians, who are the principal community care providers for OA, were accessed at nearly twice the rate by FN persons as compared with non-FN. At the specialist service level, FN persons had 51% and 38% lower use of outpatient orthopedic and rheumatology consultations, respectively. Joint replacement surgeries represent the optimal management strategy for endstage OA, yet were accessed by half as many FN patients compared with non-FN patients. Finally, FN persons with OA were hospitalized at more than twice the frequency of non-FN with OA, regardless of underlying health status.

Our estimate of OA prevalence in the general population (7.8%) was higher than reported rates from the neighboring province of British Columbia (5.9%), likely reflecting in

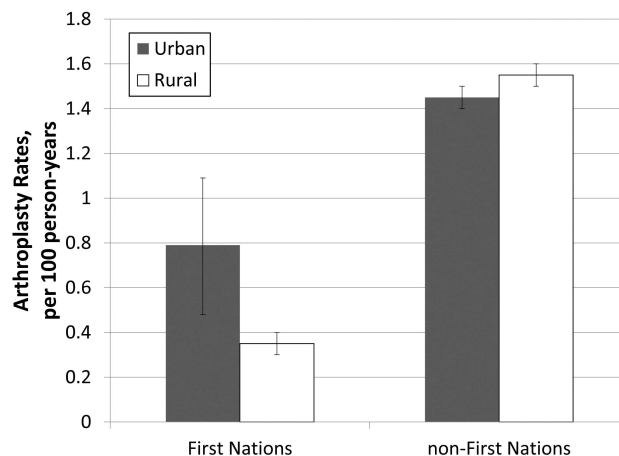


Figure 3. Hip or knee arthroplasty rates (per 100 person-yrs) for osteoarthritis by location of residence, and adjusted for age and sex, for First Nations and non-First Nations people.

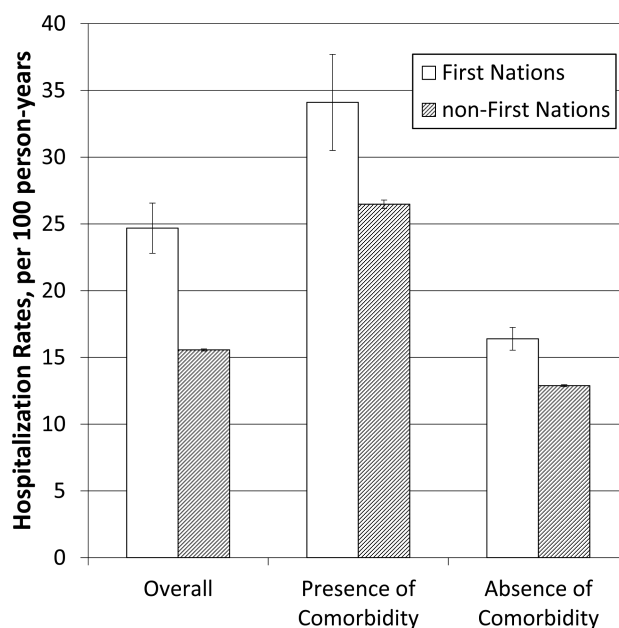


Figure 4. All-cause hospitalization rates (per 100 person-yrs) in First Nations and non-First Nations persons with osteoarthritis, adjusted for age, sex, and location of residence.

part our use of a longer period for case ascertainment, allowing for more cases to be identified and included in our estimates<sup>16</sup>. Our arthroplasty rate estimates were similar to those reported in British Columbia (overall 1.4 vs 1.3 per 100 person-years)<sup>17</sup>. A report on healthcare use in Ontario documented a total of 4.3 physician visits for OA per 100 population, and a similar mean number of visits annually per individual (1.9 visits) as our study (1.6 visits)<sup>18</sup>. None of these studies could identify estimates for FN Canadians because Alberta and Manitoba are the only provinces that have an FN identifier in their databases. In the Manitoba



study, OA prevalence in FN Canadians was also twice that of the general population<sup>19</sup>.

Outpatient orthopedic consultation remains the gateway to arthroplasty surgery. Our findings suggest that a differential rate of orthopedic consultation between FN patients compared to non-FN patients is a major influence on the arthroplasty rates. Reasons for reduced visits to orthopedic surgeons are unclear. We do not have clinical data to determine OA disease severity for our study, and to the best of our knowledge, there is no available literature on disease severity in OA in other FN. While it is possible that the severity of OA was milder with less need for referral in FN persons, this seems unlikely based on reported levels of disability in indigenous people with arthritis<sup>20</sup>. Congruent findings in Manitoba reported high rates of physician contact overall, but low rates of specialist referral for chronic disease in spite of worse health indicators. These findings, however, were not fully explained by geographic proximity to specialists<sup>21</sup>.

To our knowledge, no previous analyses exist on the healthcare use for FN with OA in Canada. One study reported that Manitoba Métis people have a higher proportion of ambulatory care visits for musculoskeletal conditions relative to the non-Métis population<sup>11</sup>. That study also considered arthroplasty rates, finding variation based on urban or rural location of residence and variation within urban areas (low in core, higher in suburbs). The Métis population in that cohort received more knee replacement surgeries compared to the non-Métis population; however, rates for hip replacements were similar.

In contrast to our findings, a recent publication on primary care management of OA in Australia found that indigenous patients with OA were managed at half the rate of non-indigenous patients, regardless of site of OA (3.2 vs 6.5 per 1000 encounters for knee, 1.2 vs 2.3 per 1000 encounters for hip, and 13.7 vs 27.5 per 1000 encounters for all OA)<sup>22</sup>. However, similar to our study, lower rates of joint arthroplasty in indigenous populations have been documented in other countries. People from disadvantaged and remote areas, immigrants to Australia, and indigenous people had significantly lower rates for joint replacements compared to other age-matched and sex-matched Australians<sup>23</sup>. For indigenous males in Australia, the rate of hip arthroplasties was one-third and knee arthroplasties half the rate of non-indigenous people. For indigenous females, the same trend was seen for knee arthroplasty, but was more pronounced at one-fifth the rate of hip arthroplasties compared to non-indigenous females. It is likely that the differential rates seen in both Australia and Alberta are multifactorial in nature. For instance, these gaps may be in part related to disease severity, reduced access to care, differences in beliefs around OA and joint replacement surgery, and the willingness to undergo surgery. We also hypothesize that the differences may reflect an increased

likelihood of case ascertainment based on the frequency of use of primary care services, and perhaps are attributable to the high rural distribution of FN residents in Alberta because most physicians in rural areas are primary care physicians. Earlier studies have argued that a higher burden of comorbidities in FN populations may preclude undergoing joint arthroplasty<sup>23,24</sup>. In our study, arthroplasty rates were not affected by the presence of comorbid diseases, although all-cause hospitalization rates were affected by the number of conditions.

An important consideration in the discussion on disparities in disease burden and health services use is that of cultural safety in the healthcare system. The Health Council of Canada report, "Empathy, Dignity, and Respect: Creating Cultural Safety for Aboriginal People in Urban Health Care"<sup>25</sup>, highlights how racism creates a systemic barrier that contributes to mistrust of the healthcare system. Healthcare professionals and services that do not create a culturally safe environment keep many from seeking care. Exploring this issue in OA care will require different methodology but is critical to understanding the factors responsible for our findings.

When interpreting administrative data for research, some caution is required. Though use of administrative data affords excellent power related to a large sample size and the population-based nature of the data, cases are not confirmed clinically on an individual basis. Narrow CI reflect the large sample size, but do not include misclassification error, which would almost certainly be orders of magnitude higher. We did use validated case and outcome definitions to reduce misclassification error. The higher prevalence rate observed in FN may reflect an increased likelihood of case ascertainment based on the frequency of use of primary care services. However, the systemic differences in access to healthcare for FN patients can also affect the estimates, and we have previously demonstrated that patient age, sex, socioeconomic status, level of education, and location of residence affect prevalence estimates obtained from administrative data<sup>17,26,27,28</sup>. The relationship between demographic factors and disease diagnosis may be augmented in the FN population and warrants further investigation. Residual confounding that occurred during the standardization of arthroplasty rates by age, sex, and rural residence may be present because other important differences between FN and the general population may exist beyond these demographic indicators<sup>29</sup>. Finally, the dataset cannot specifically identify white populations from ethnic minorities, and estimates for the non-FN population reflect the population composition in Alberta<sup>30</sup>. This may affect generalizability to other provinces with higher proportions of ethnic minorities.

We estimated higher prevalence rates of OA in the FN population of Alberta, as was first described in Manitoba<sup>19</sup>. We have also identified differences in healthcare use in OA

with primary care being accessed by the FN population at twice the rate compared to non-FN, but with lower use of orthopedics and rheumatology services, and half the rate of total joint arthroplasty. The next critical steps in the research will be building on existing literature to determine the factors responsible for disparities in OA burden and health services use, and evaluating whether and to what extent low rates of specialty care access affect OA health outcomes. A focus should be placed on health outcomes that are identified as important for indigenous populations.

## REFERENCES

1. Arthritis Alliance of Canada. The impact of arthritis in Canada: today and over the next 30 years. [Internet. Accessed October 17, 2014.] Available from: [www.arthritisalliance.ca/images/PDF/eng/Initiatives/20111022\\_2200\\_impact\\_of\\_arthritis.pdf](http://www.arthritisalliance.ca/images/PDF/eng/Initiatives/20111022_2200_impact_of_arthritis.pdf)
2. Public Health Agency of Canada. Life with arthritis in Canada: a personal and public health challenge. [Internet. Accessed October 17, 2014.] Available from: [www.phac-aspc.gc.ca/cd-mc/arthritis-arthrite/lwaic-vaac-10/pdf/arthritis-2010-eng.pdf](http://www.phac-aspc.gc.ca/cd-mc/arthritis-arthrite/lwaic-vaac-10/pdf/arthritis-2010-eng.pdf)
3. Assembly of First Nations. The First Nations regional longitudinal health survey (RHS) 2002/3. Results for adults, youth and children living in First Nations communities. [Internet. Accessed October 21, 2014.] Available from: [fnigc.ca/sites/default/files/ENpdf/RHS\\_2002/rhs2002-03-technical\\_report.pdf](http://fnigc.ca/sites/default/files/ENpdf/RHS_2002/rhs2002-03-technical_report.pdf)
4. Alberta Health and Wellness. Comparison of Alberta population counts between the AHCIP registry and the 2006 census. [Internet. Accessed October 17, 2014.] Available from: [www.health.alberta.ca/documents/Population-2006-Comparison-2009.pdf](http://www.health.alberta.ca/documents/Population-2006-Comparison-2009.pdf)
5. Lix L, Yogendran M, Burchill C, Metge C, McKeen N, Moore D, et al. Defining and validating chronic diseases: an administrative data approach. [Internet. Accessed October 20, 2014.] Available from: [mchp-appserv.cpe.umanitoba.ca/reference/chronic.disease.pdf](http://mchp-appserv.cpe.umanitoba.ca/reference/chronic.disease.pdf)
6. Lix L, Yogendran M, Mann J. Defining and validating chronic diseases: an administrative data approach. An update with ICD-10-CA. Winnipeg: Manitoba Centre for Health Policy; 2008.
7. Cardinal JC, Schopflocher DP, Svenson LW, Morrison KB, Laing L. First Nations in Alberta: a focus on health service use. [Internet. Accessed October 20, 2014.] Available from: [www.health.alberta.ca/documents/First-Nation-Service-Use-2004.pdf](http://www.health.alberta.ca/documents/First-Nation-Service-Use-2004.pdf)
8. Alberta Health and Wellness. First Nations health services study technical documentation. Edmonton: Alberta Health; 2004.
9. Gao S, Manns BJ, Culleton BF, Tonelli M, Quan H, Crowshoe L, et al. Access to health care among status Aboriginal people with chronic kidney disease. *CMAJ* 2008;179:1007-12.
10. Statistics Canada. 2006 Aboriginal population profile. [Internet. Accessed October 17, 2014.] Available from: [www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-594/](http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-594/)
11. Martens PJ, Bartlett J, Burland E, Prior H, Burchill C, Huq S, et al. Profile of Metis health status and healthcare utilization in Manitoba: a population-based study. [Internet. Accessed October 21, 2014.] Available from: [www.mmf.mb.ca/docs/metis\\_health\\_status\\_report.pdf](http://www.mmf.mb.ca/docs/metis_health_status_report.pdf)
12. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005;43:1130-9.
13. Hux JE, Ivis F, Flintoft V, Bica A. Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. *Diabetes Care* 2002;25:512-6.
14. Quan H, Khan N, Hemmelgarn BR, Tu K, Chen G, Campbell N, et al. Validation of a case definition to define hypertension using administrative data. *Hypertension* 2009;54:1423-8.
15. Statistics Canada. Section 4 technical specifications. [Internet. Accessed October 17, 2014.] Available from: [www.statcan.gc.ca/pub/92-153-g/2011002/tech-eng.htm](http://www.statcan.gc.ca/pub/92-153-g/2011002/tech-eng.htm)
16. Kopec JA, Rahman MM, Berthelot JM, Le Petit C, Aghajanian J, Sayre EC, et al. Descriptive epidemiology of osteoarthritis in British Columbia, Canada. *J Rheumatol* 2007;34:386-93.
17. Rahman MM, Kopec JA, Sayre EC, Greidanus NV, Aghajanian J, Anis AH, et al. Effect of sociodemographic factors on surgical consultations and hip or knee replacements among patients with osteoarthritis in British Columbia, Canada. *J Rheumatol* 2011;38:503-9.
18. MacKay C, Canizares M, Davis AM, Badley EM. Health care utilization for musculoskeletal disorders. *Arthritis Care Res* 2010;62:161-9.
19. Barnabe C, Elias B, Bartlett J, Roos L, Peschken C. Arthritis in Aboriginal Manitobans: evidence for a high burden of disease. *J Rheumatol* 2008;35:1145-50.
20. Health Canada. Arthritis in Canada. An ongoing challenge. [Internet. Accessed October 20, 2014.] Available from: [www.acreu.ca/pdf/Arthritis\\_in\\_Canada.pdf](http://www.acreu.ca/pdf/Arthritis_in_Canada.pdf)
21. Martens PJ, Bond R, Jebamani L, Burchill C, Roos NP, Derksen S, et al. The health and health care use of registered First Nations people living in Manitoba: a population-based study. [Internet. Accessed October 20, 2014.] Available from: [mchp-appserv.cpe.umanitoba.ca/reference/rfn\\_report.pdf](http://mchp-appserv.cpe.umanitoba.ca/reference/rfn_report.pdf)
22. Brand CA, Harrison C, Tropea J, Hinman RS, Britt H, Bennell K. Management of osteoarthritis in general practice in Australia. *Arthritis Care Res* 2014;66:551-8.
23. Dixon T, Urquhart DM, Berry P, Bhatia K, Wang Y, Graves S, et al. Variation in rates of hip and knee joint replacement in Australia based on socio-economic status, geographical locality, birthplace and indigenous status. *ANZ J Surg* 2011;81:26-31.
24. Hawker GA. The quest for explanations for race/ethnic disparity in rates of use of total joint arthroplasty. *J Rheumatol* 2004;31:1683-5.
25. Health Council of Canada. Empathy, dignity, and respect: creating cultural safety for Aboriginal people in urban health care. [Internet. Accessed October 17, 2014.] Available from: [www.healthcouncilcanada.ca/rpt\\_det.php?id=437](http://www.healthcouncilcanada.ca/rpt_det.php?id=437)
26. Barnabe C, Joseph L, Belisle P, Labrecque J, Edworthy S, Barr SG, et al. Prevalence of systemic lupus erythematosus and systemic sclerosis in the First Nations population of Alberta, Canada. *Arthritis Care Res* 2012;64:138-43.
27. Barnabe C, Joseph L, Belisle P, Labrecque J, Barr SG, Fritzler MJ, et al. Prevalence of autoimmune inflammatory myopathy in the First Nations population of Alberta, Canada. *Arthritis Care Res* 2012;64:1715-9.
28. Bernatsky S, Joseph L, Pineau CA, Belisle P, Hudson M, Clarke AE. Scleroderma prevalence: demographic variations in a population-based sample. *Arthritis Rheum* 2009;61:400-4.
29. Rothman KJ, Greenland S, Lash TL. *Modern epidemiology*. 3rd ed. New York: Lippincott Williams & Wilkins; 2008.
30. Statistics Canada. Population by selected ethnic origins, by province and territory (2006 Census) (Canada). [Internet. Accessed October 17, 2014.] Available from: [www.statcan.gc.ca/tables-tableaux/sum-som/I01/cst01/demo26a-eng.htm](http://www.statcan.gc.ca/tables-tableaux/sum-som/I01/cst01/demo26a-eng.htm)