

Cancer incidence, stage at diagnosis and outcomes among Manitoba First Nations people living on and off reserve: a retrospective population-based analysis

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Abstract

Background: Substantial cancer-related disparities exist between First Nations and non-Indigenous Canadians. The objectives of this study were to compare cancer incidence, stage at diagnosis and mortality outcomes between Status First Nations people living on reserve and off reserve in Manitoba.

Methods: We conducted a retrospective analysis of population-level administrative health databases in Manitoba. Cancers diagnosed between Apr. 1, 2004, and Mar. 31, 2011, were linked with the Indian Registry System and 5 provincial databases. We compared differences in baseline characteristics, cancer incidence, site and stage at diagnosis between Status First Nations patients living on and off reserve. Linear regression models examined trends in annual cancer incidence. Cox proportional hazard regression models examined mortality.

Results: There were 1524 newly diagnosed cancers among Status First Nations people in Manitoba between Apr. 1, 2004, and Mar. 31, 2011. First Nations people living on reserve were significantly older than those living off reserve ($p < 0.001$) and had higher Charlson Comorbidity Index scores at diagnosis ($p = 0.01$). A lower proportion of on-reserve patients than off-reserve patients were diagnosed with stage I cancers (21.7% v. 26.9%, $p = 0.02$). There were no differences in annual cancer incidence between groups. The adjusted incidence of cancer over the combined study years was higher in the off-reserve group than in the on-reserve group (287.9 v. 247.9 per 100 000, $p = 0.02$). No significant differences in mortality were found.

Interpretation: The lower proportion of on-reserve patients diagnosed with cancer at stage I is concerning, as it suggests less access to screening services or delays in diagnosis. Further research is needed to understand patterns in diagnosis and differences in cancer site and overall cancer incidence between First Nations people living on and off reserve.

Cancer and other chronic diseases are leading causes of morbidity and mortality among First Nations people in Canada, and addressing the cancer burden is a growing health priority among First Nations people.¹⁻⁴ Compared to non-Indigenous Canadians, First Nations people in Canada experience a higher incidence of cancers of the kidney,^{2,5-9} liver,^{2,7,10} gallbladder,^{6,9,10} cervix,^{2,5,7-12} and colon and rectum.^{2,7,8,10,13} Emerging evidence also indicates that First Nations people are more likely to be diagnosed with cancers at later stages than non-Indigenous Canadians¹³⁻¹⁶ and experience significantly lower survival.^{8,10,17-19} Multiple factors contribute to these disparities, including individual patient factors, environmental exposures, socioeconomic factors (particularly income) and access to health care services.^{2,8,20,21}

About half of First Nations people in Manitoba live on designated tracts of land known as reserves²² located throughout

the province. The funding and delivery of health care services to First Nations living on reserves is limited, and the effects on health outcomes of limited access to some health care services for First Nations peoples (both Status and non-Status) living on reserve are not clear. Differences in the funding and delivery of health care services to First Nations on and off reserve can have important impacts on individual and population health.

We report on the findings from a larger study of provincial health administrative data¹⁶ to address 3 objectives: 1) to

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describe the demographic characteristics, comorbidities, and site and stage of cancer at diagnosis in Status First Nations people living on and off reserve who received a cancer diagnosis between Apr. 1, 2004, and Mar. 31, 2011; 2) to compare annual cancer incidence rates for the 2 cohorts; and 3) to investigate mortality outcomes for the 2 cohorts.

Methods

Setting

Roughly 11% (130 505) of Manitoba residents self-identify as First Nations, with the majority (10% of Manitoba residents) identifying as Status First Nations²³ (people registered under the *Indian Act*, which entitles them to live on reserves²²). In 2016, 52% of Status First Nations people lived in a First Nations communities (known as reserves; $n = 63$) in Manitoba.²²

The provision of health care services is not entirely similar between Status First Nations people living on reserve and those living off reserve. In general, health care services in Canada are publicly funded, providing universal coverage for medically necessary hospital and generalist and specialist physician services to all residents. In addition, Status First Nations people are eligible for the federal Non-Insured Health Benefits Program, which provides a range of services not covered by other insurance programs. The federal government also funds or delivers public health services and limited primary health care to Status First Nations people living on reserve. However, many First Nations communities are located in remote areas of Manitoba with severely limited access to medically necessary services provided in hospitals and by physicians.

Study design and data sources

We conducted a retrospective study of cancer incidence and 5-year mortality among Status First Nations people living on and off reserve using administrative health data housed in the Manitoba Centre for Health Policy Population Research Data Repository. Data files in the repository do not contain names or other identifying information; an encrypted identifier allows linkage across files at the individual level while protecting privacy. We identified and included all Status First Nations people with any newly diagnosed cancer (excluding nonmelanoma and in situ skin cancers) between Apr. 1, 2004, and Mar. 31, 2011, in Manitoba. Seven data sets within the Manitoba Centre for Health Policy repository were used (Appendix 1, available at www.cmajopen.ca/content/7/4/E754/suppl/DC1).

Linkage of the Manitoba Health Insurance Registry and the Indian Registry System was used to create a file of First Nations patients and was approved through the research protocols of the Assembly of Manitoba Chiefs before 2014 and Nanaandawewigamig First Nations Health and Social Secretariat of Manitoba thereafter. The First Nations file was linked to the Manitoba Cancer Registry to identify all newly diagnosed cancers among Status First Nations people. The registry maintains a high degree of data completeness: Lix and colleagues²⁴ reported 100% linkage of anonymized patient-specific identification variables in both the Manitoba Cancer

Registry data and administrative data in the repository at Manitoba Centre for Health Policy. The First Nations file was then linked to hospital abstracts, medical claims, the 2006 Canada census and Vital Statistics Mortality Registry files.

Outcomes

The primary outcome examined was all-cause mortality. Patients were followed for 5 years from the date of cancer diagnosis. We explored 5-year cancer-specific mortality as a secondary outcome.

Variables

Variables measured at the time of diagnosis included age, sex, region of residence, area-level income, Charlson Comorbidity Index score, and cancer stage and site. We used 2 measures of region of residence: Regional Health Authority, and on or off reserve. Manitoba is divided geographically into 5 Regional Health Authority regions; each authority is responsible for the delivery of health services within its area. Patient residential postal code within the Indian Registry System data file identified residence as on or off reserve.

We categorized patients into area-level income quintiles based on average household incomes calculated for each census dissemination area. We calculated separate income quintiles for urban and rural residents using 2006 census data. For income quintiles, urban residents referred to those living in 1 of Manitoba's 2 largest cities (Winnipeg and Brandon), and rural residents referred to those living in all other areas. Both the method to assign urban or rural status and the Regional Health Authority method are based on patient residential postal codes and municipal codes.

We used the Charlson Comorbidity Index to determine each patient's health status at the time of diagnosis.²⁵ This instrument is a weighted index estimating 1-year mortality risk that accounts for the number and seriousness of comorbid conditions, including cancer and cardiac, vascular, renal, hepatic and neurologic diseases; higher scores indicate higher burden of disease and risk of death.²⁶ It is a valid and reliable measure of comorbidities based on a person's medical history.²⁷⁻²⁹ Each comorbidity category has specific codes of the clinical modification of the *International Classification of Diseases, 9th Revision* and the *10th Revision of the International Statistical Classification of Diseases and Related Health Problems*, enhanced Canadian version,³⁰ which we found in the hospital discharge abstract and medical claims databases during the 1-year period before cancer diagnosis.

We categorized cancer stage using the American Joint Committee on Cancer Staging system,³¹ which ranges from stage I (least severe) to IV (most severe) based on tumour characteristics. We also used a fifth category to categorize patients with cancers that could not be assessed. We determined cancer site from the Manitoba Cancer Registry, based on the *International Classification of Diseases for Oncology, Third Edition*.

Statistical analysis

We analyzed the data on the secure server at the Manitoba Centre for Health Policy using SAS statistical software, V9.4

(SAS Institute). We conducted descriptive analysis and comparisons of characteristics at time of cancer diagnosis between on- and off-reserve Status First Nations groups. We used χ^2 tests to test for significant differences in sex, urban/rural residency, Regional Health Authority residency, income quintile, cancer site and cancer stage at diagnosis, and *t* tests to compare group averages for age and Charlson Comorbidity Index score.

Cancer incidence

We calculated annual cancer incidence for each fiscal year from 2004/05 to 2010/11. We determined separate rates for on- and off-reserve populations by identifying the number of Status First Nations people with a cancer diagnosed each year divided by the annual population counts of on- and off-reserve First Nations people in Manitoba (using the Indian Registry System). We tested differences in annual crude incidence rates and the cumulative incidence rate over the 7-year period between on- and off-reserve Status First Nations populations for significance using χ^2 tests. To account for demographic differences between on- and off-reserve populations, we estimated adjusted rates using a generalized linear model with a negative binomial log link function. This model controlled for age, sex, income quintile and Regional Health Authority area of residence. We analyzed trends over time with linear regression models fit to the annual rates.

Mortality

We used Cox proportional hazard regression models to compare the risk of mortality between on- and off-reserve Status First Nations patients. We measured time to death in days from the date of cancer diagnosis to the date of death. Patient data were censored at 5 years if the patient was still alive or at the time of discontinuation of health insurance coverage, which usually indicates that the person has moved out of Manitoba. In the analysis of cancer-specific mortality, we censored patient data at the time of death for all non-cancer-related causes of death. Potential confounding variables accounted for in the analyses included age, sex, Charlson Comorbidity Index score, cancer stage, income quintile and Regional Health Authority area of residence. All effect estimates are reported as hazard ratios (HRs) with 95% confidence intervals (CIs). The significance level was set as $p < 0.05$.

Ethics approval

Ethics approval for this study was obtained from the University of Manitoba Education/Nursing Research Ethics Board, the Manitoba Health Information Privacy Committee, CancerCare Manitoba and the Health Information Research Governance Committee at Nanaandawewigamig.

Results

Patient characteristics

There were 1524 newly diagnosed cancers among Status First Nations people in Manitoba between Apr. 1, 2004, and

Mar. 31, 2011. On average, those living on reserve were older than those living off reserve (mean 60.6 v. 57.5 yr, $p < 0.001$) and had a higher mean Charlson Comorbidity Index score (1.4 v. 1.3, $p = 0.01$) (Table 1). In both groups, a higher proportion of women than of men were newly diagnosed with cancer.

Cancer diagnoses by stage and site

A significantly lower proportion of on-reserve patients than off-reserve patients were diagnosed at stage I (21.7% v. 26.9%, $p = 0.02$) (Table 2). No other significant differences in stage at diagnosis were found between the 2 groups. There were significantly lower proportions of patients with breast and cervical cancers, and significantly higher proportions of

Table 1: Characteristics of Status First Nations patients with cancer diagnosed between 2004/05 and 2010/11 living on and off reserve in Manitoba

Characteristic	No. (%) of patients*		<i>p</i> value
	On reserve <i>n</i> = 930	Off reserve <i>n</i> = 594	
Age, yr, mean \pm SD	60.6 \pm 14.5	57.5 \pm 14	< 0.001
Sex			
Male	456 (49.0)	223 (37.5)	< 0.001
Female	474 (51.0)	371 (62.5)	
Rural residency	846 (91.0)	266 (44.8)	
Regional Health Authority			< 0.001
Interlake Eastern	257 (27.6)	81 (13.6)	
Northern	428 (46.0)	107 (18.0)	
Southern	6 (0.6)	7 (1.2)	
Prairie Mountain	68 (7.3)	20 (3.4)	
Winnipeg	102 (11.0)	66 (11.1)	
Public Trustee	69 (7.4)	313 (52.7)	
Income quintile			< 0.001
NF	12 (1.3)	9 (1.5)	
R1 (lowest rural)	508 (54.6)	79 (13.3)	
R2	209 (22.5)	43 (7.2)	
R3	43 (4.6)	43 (7.2)	
R4	75 (8.1)	51 (8.6)	
R5 (highest rural)	11 (1.2)	50 (8.4)	
U1 (lowest urban)	49 (5.3)	170 (28.6)	
U2	12 (1.3)	67 (11.3)	
U3	\leq 5	38 (6.4)	
U4	\leq 5	32 (5.4)	
U5 (highest urban)	\leq 5	12 (2.0)	
Charlson Comorbidity Index score, mean \pm SD	1.4 \pm 1.4	1.3 \pm 1.3	0.01

Note: NF = not found, SD = standard deviation.
*Except where noted otherwise.

Table 2: Cancer stage at diagnosis and site by location

Variable	No. (%) of patients		p value
	On reserve	Off reserve	
Cancer stage			
I	202 (21.7)	160 (26.9)	0.02
II	207 (22.3)	133 (22.4)	0.95
III	176 (18.9)	109 (18.4)	0.8
IV	216 (23.2)	126 (21.2)	0.4
Unknown	129 (13.9)	66 (11.1)	0.1
Cancer site			
Bladder	≤ 5	8 (1.3)	0.09
Breast	99 (10.6)	111 (18.7)	< 0.001
Cervix	19 (2.0)	26 (4.4)	0.009
Chronic lymphocytic leukemia	≤ 5	≤ 5	0.08
Colorectal	153 (16.4)	87 (14.6)	0.3
Kidney	96 (10.3)	40 (6.7)	0.02
Lung and bronchus	131 (14.1)	74 (12.5)	0.4
Melanoma of the skin	≤ 5	≤ 5	≤ 5
Non-Hodgkin lymphoma	33 (3.5)	32 (5.4)	0.08
Ovary	25 (2.7)	7 (1.2)	0.04
Pancreas	19 (2.0)	13 (2.2)	0.8
Prostate	100 (10.8)	34 (5.7)	< 0.001
Stomach	18 (1.9)	11 (1.8)	0.9
Thyroid	10 (1.1)	10 (1.7)	0.3
Uterus	19 (2.0)	19 (3.2)	0.2
Other	197 (21.2)	113 (19.0)	0.3

patients with kidney, ovarian and prostate cancers in the on-reserve group than in the off-reserve group.

Cancer incidence and trends

There were no significant differences in yearly crude or adjusted incidence rates except for 2008/09, in which the off-reserve group had a higher adjusted annual incidence of cancer than the on-reserve group (291 v. 380 per 100 000, *p* = 0.04) (Table 3). The overall adjusted incidence of cancer over the study years was higher in the off-reserve group than in the on-reserve group (287.9 v. 247.9 per 100 000, *p* = 0.02). The adjusted models controlled for age, sex, income quintile and Regional Health Authority area of residence. There were no significant trends in cancer incidence over time in either group (Table 4).

Cancer mortality

The on-reserve group had a significantly higher risk of all-cause mortality than the off-reserve group (HR 1.28, 95% CI 1.11 to 1.26); however, there was no significant difference after adjustment for covariates (Table 5). We found no significant difference in the risk of cancer-specific mortality before or after adjustment.

Interpretation

Among Status First Nations people in Manitoba diagnosed with cancer between 2004/05 and 2010/11, we found that the on-reserve group was on average older and had higher Charlson Comorbidity Index scores than the off-reserve group. A lower proportion of on-reserve patients than off-reserve patients were diagnosed at stage I. With the exception of 2008/09, in which cancer incidence was higher in the off-reserve group, there were no significant differences in yearly cancer incidence between the 2 groups. However, the adjusted incidence of cancer over all 7 years was higher in the off-reserve group than in the on-reserve group. No differences in mortality were observed.

Table 3: Annual crude and adjusted cancer incidence by location

Year	Count		Crude IR per 100 000		p value	Adjusted IR per 100 000*		p value
	On reserve	Off reserve	On reserve	Off reserve		On reserve	Off reserve	
2004/05	116	75	308.9	301.8	0.9	245.1	280.1	0.4
2005/06	123	71	318.6	279.7	0.4	256.3	255.4	0.98
2006/07	131	71	330.7	273.1	0.2	260.8	247.3	0.7
2007/08	121	88	297.4	331.6	0.4	233.6	292.4	0.1
2008/09	154	119	367.2	440.0	0.1	291.0	380.3	0.04
2009/10	164	92	378.4	329.9	0.3	307.2	280.3	0.5
2010/11	159	100	355.0	347.9	0.9	283.3	294.8	0.8
Overall	968	616	337.8	330.4	0.7	247.9	287.9	0.02

Note: IR = incidence rate.

*Adjusted for age, sex, income quintile and Regional Health Authority area of residence.

Table 4: Trend analysis of annual crude and adjusted cancer incidence rates by location

Measure	Crude cancer incidence		Adjusted cancer incidence*	
	On reserve	Off reserve	On reserve	Off reserve
<i>R</i> ²	0.54	0.31	0.51	0.16
β coefficient (95% CI)	10.51 (−0.54 to 21.57)	14.49 (−10.39 to 39.63)	8.81 (−0.97 to 18.85)	8.1 (−13.13 to 29.34)

Note: CI = confidence interval.
*Adjusted for age, sex, income quintile and Regional Health Authority area of residence.

Table 5: Mortality hazard ratios

Outcome	HR (95% CI)*
All-cause mortality — crude	1.28 (1.11 to 1.26)
All-cause mortality 5 yr after diagnosis — adjusted	1.18 (0.98 to 1.41)
Cancer-specific mortality — crude	1.09 (0.98 to 1.22)
Cancer-specific mortality 5 yr after diagnosis — adjusted	1.03 (0.90 to 1.19)

Note: CI = confidence interval, HR = hazard ratio.
*Adjusted for age, sex, Charlson Comorbidity Index score, cancer stage at diagnosis, income quintile and Regional Health Authority area of residence.

We found lower proportions of breast and cervical cancers, both screen-detectable cancers, in the on-reserve group than in the off-reserve group. In Manitoba, there are well-established breast and cervical cancer screening programs (www.cancercare.mb.ca/screening/cancer-screening). Breast cancer screening via mammography is recommended every 2 years for women aged 50–74 years; however, it is available only in larger urban centres in the province; mobile breast cancer screening vans provide services to rural and remote areas on a rotating basis. The on-reserve population is disproportionately rural and remote (Table 2), which may contribute to poorer access to mammography screening and fewer diagnoses of breast cancer. However, compared to all other Manitobans, First Nations women are significantly less likely to have had mammography, regardless of urban or rural residency.³²

Cervical cancer screening via Papanicolaou testing is recommended every 3 years for women aged 21–69 years in Manitoba and is typically done by family physicians in primary care settings. There are notable difficulties in accessing Papanicolaou screening services among Status First Nations women living on reserve, including poor access to family physicians, delivery of health care services on reserve by registered nurses who are not trained to provide Papanicolaou screening, and lack of culturally safe, trauma-informed cervical cancer screening services.^{33–35} These challenges may contribute to lower rates of diagnosis of cervical cancer among Status First Nations women living on reserve.

The lower proportion of on-reserve than off-reserve First Nations people diagnosed with stage I cancers observed in the current study may be related to differential access to health care services.¹⁸ First Nations people living on reserve are

more likely to live in rural and remote areas and to experience difficulties in accessing cancer-related diagnostic and specialty care.^{36,37} Limited local availability of primary care providers, who are seen as essential to referral of patients into specialty oncology care, means that, for many Status First Nations patients, gaining entry “into the system at the ‘front end’ or diagnostic stage” is a major problem.³⁸ Diagnostic care is not available in or within driving distance of most First Nations communities in Manitoba, requiring patients to travel long distances, with considerable disruption to their day-to-day lives. Status First Nations patients living on reserve encounter additional bureaucratic “red tape” and challenges with securing transportation required to access diagnostic and specialty care,^{37–39} which may result in cancer diagnosis at a later stage.

In addition, for many First Nations people (regardless of status), access to health care and cancer services is determined not only by where those services are delivered but also how they are delivered at the point of care.^{40,41} In particular, lack of culturally safe services and frequent experiences of racism substantially affect how and when First Nations people access cancer services.⁴⁰ In contrast, culturally safe approaches to health care recognize the power imbalances within health care that impede access to care⁴¹ and are grounded in a relational approach to care, in which health care providers and patients work in a partnership and care is provided within environments that are physically and socially safe.⁴²

Notably, we found no differences in mortality between Status First Nations peoples living on reserve and those living off reserve. These findings were counterintuitive for our team, as we expected that Status First Nations patients living on reserve would have worse outcomes owing to distance from and accessibility of health care services. We assumed

that those living off reserve resided in more urban areas and in closer proximity to health care services, and therefore would have better access to health care services and other support services and programs. Our findings seem to suggest that proximity to health care services does not necessarily decrease mortality.

An alternative consideration, raised by our community partners, was that First Nations people tend to be transient, moving back and forth between reserve communities, or between First Nations communities and other communities. Although no definitive conclusions can be drawn based on this consideration, it is important to remember that, despite the listed place of residence (i.e., on v. off reserve), many Status First Nations people have similar experiences in accessing health care services, and our measure for on versus off reserve may not translate well into lived realities.

Limitations

Study findings are strengthened through our use of multiple population-based and well-validated administrative data sets, which minimized bias related to recall or small samples. We also benefitted from strong relationships with First Nations partners, which enriched our interpretation of findings.

Our findings should be considered in relation to several study limitations. First, we included only Status First Nations people registered under the *Indian Act*. At present, there is no mechanism to identify non-Status First Nations people in these data sets. Although Status First Nations people represent about 97% of all First Nations people in Manitoba,⁴³ the inclusion of non-Status First Nations people may have resulted in additional differences between groups. We were not able to analyze differences in mortality between First Nations people living on and off reserve by cancer site because of small samples, and there may be substantial differences in mortality depending on cancer site.

We measured income at the area level only, which does not account for individual and family differences. There are always potential inaccuracies involved when aggregate data are used when individual-level data are not available. However, studies in Canada have directly compared individual versus area-based measures and showed that area-level data revealed correlations with health outcomes that were similar to those found with individual-level data, although not as strong.⁴⁴⁻⁴⁶ We calculated location of residence at the Regional Health Authority level, which may have obscured important differences between those living in urban versus rural or remote areas within a Regional Health Authority. Categorization into on- or off-reserve residence was based on postal code of residence on a fixed date, and the potential for misclassification of residency exists. As our community partners suggested, First Nations people tend to be highly mobile, moving between reserve and nonreserve communities, which could result in accessing health care services in multiple locations.

Given the data available to us and the retrospective nature of the study, we were not able to adjust for all potentially confounding variables, which may have affected our results.

Ideally, we would have included measures of smoking, alcohol use, physical activity and nutrition, as these are cancer risk factors and proximal measures of more distal determinants of health. Including measures of access to health care, wait times and the cultural safety of care as confounding variables may have also been helpful, as these factors are known to affect First Nations peoples' cancer experiences.^{38,40}

Finally, this study included only Status First Nations people living in Manitoba, and the results may not be generalizable to First Nations people living in other Canadian provinces. Although Status First Nations people across Canada experience similar health status, socioeconomic status and health care services, there may be differences in the location of reserve communities or other important differences that hinder the generalizability of our results.

Conclusion

A lower proportion of Status First Nations patients living on reserve than those living off reserve were diagnosed with cancers at stage I; however, overall cancer incidence over the study years was higher in the off-reserve group. Poor access to primary and diagnostic care among Status First Nations people living on reserve may contribute to fewer early-stage diagnoses and may also result in underreporting of incidence rates. We found no significant differences in 5-year mortality between groups.

Further research is needed to better understand the reasons for differences in stage at diagnosis and overall cancer incidence, particularly in relation to access to health care. Inequities in access to primary and diagnostic care for Status First Nations people living on reserve need attention at the systems and policy levels. In addition, ensuring equitable access to oncology care and developing and implementing culturally safe models of health care for First Nations patients regardless of status and location of residence must be a priority.

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