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Cancer incidence, mortality, and stage at diagnosis in First Nations living in Manitoba

K.M. Decker PhD,*† E.V. Kliewer PhD,*†‡ A.A. Demers PhD,*† K. Fradette MSc,† N. Biswanger BSc(Math),§ G. Musto BSc,† B. Elias PhD,* and D. Turner PhD*†

ABSTRACT

Background In the present study, we examined breast (BCA) and colorectal cancer (CRC) incidence and mortality and stage at diagnosis for First Nations (FN) individuals and all other Manitobans (AOMs).

Methods Several population-based databases were linked to determine ethnicity and to calculate age-standardized incidence and mortality rates. Logistic regression was used to compare BCA and CRC stage at diagnosis.

Results From 1984–1988 to 2004–2008, the incidence of BCA increased for FN and AOM women. Breast cancer mortality increased for FN women and decreased for AOM women. First Nations women were significantly more likely than AOM women to be diagnosed at stages III–IV than at stage I [odds ratio (OR) for women ≤50 years of age: 3.11; 95% confidence limits (CL): 1.20, 8.06; OR for women 50–69 years of age: 1.72; 95% CL: 1.03, 2.88). The incidence and mortality of CRC increased for FN individuals, but decreased for AOMs. First Nations status was not significantly associated with CRC stage at diagnosis (OR for stages I–II compared with stages III–IV: 0.98; 95% CL: 0.68, 1.41; OR for stages I–III compared with stage IV: 0.91; 95% CL: 0.59, 1.40).

Conclusions Our results underscore the need for improved cancer screening participation and targeted initiatives that emphasis collaboration with FN communities to reduce barriers to screening and to promote healthy lifestyles.

Key Words Colorectal cancer, breast cancer, indigenous health

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INTRODUCTION

Many differences in health status between indigenous and nonindigenous populations in developed countries have been documented[1,2]. Historically, the incidence of chronic diseases, including cancer, has been lower in First Nations (FN) than in the rest of the population[3]. However, that difference appears to be changing because of behavioural, environmental, and social factors, and increasing life expectancy[3,4]. In Manitoba, where FN individuals constitute almost 10% of the population, health disparities in risk factors including obesity, type 2 diabetes, cardiovascular disease, periodontal disease, and renal disease between FN people and all other Manitobans (AOMs) have been reported[5–9]. The incidence of and mortality from cancer also appear to be increasing among FN people[10–12]; studies from both within and outside Canada have found poorer cancer survival among indigenous peoples[13–18].

One of the primary determinants of cancer survival is stage at diagnosis[11]. Stage describes the extent of invasion, predicts the course of the disease, and is used to help determine treatment[19]. Surveillance of stage at diagnosis helps to evaluate access to and the quality and effectiveness of screening and early detection[20–22]. Several studies have found that indigenous individuals are more likely than the nonindigenous population to be diagnosed at a later stage[13,15,17,18,23]; others have found no difference in stage distribution[14,24,25]. The primary objective of the present study was to examine trends in breast cancer (BCA) and colorectal cancer (CRC) incidence and mortality in Manitoba during 1984–2008 for FN individuals and AOMs. The secondary objectives were to compare stage at diagnosis and demographic and tumour-specific characteristics for FN individuals and AOMs.

METHODS

Study Population

All residents of Manitoba diagnosed with CRC and female BCA during 1984–2008 were included. Those two cancer

Correspondence to: Kathleen Decker, Epidemiology and Cancer Registry, CancerCare Manitoba, 825 Sherbrook Street, CC-18, Winnipeg, Manitoba R3A 1M5. E-mail: kdecker@cancercare.mb.ca ■ **DOI:** http://dx.doi.org/10.3747/co.23.2906

sites were chosen because BCA and CRC are 2 of the top 3 most commonly diagnosed cancers in Manitoba[26]. The province of Manitoba, located in central Canada, has a population of approximately 1.2 million; half the population lives in the capital city of Winnipeg. In 2011, 105,815 registered FN people were living in Manitoba, representing 8.8% of the provincial population[27]. "Registered" refers to FN individuals who, under the federal Indian Act, have treaty rights (also termed "status Indians")[28]. In Manitoba, FN groups include Ojibway, Cree, Ojibway–Cree, Dakota, and Dene. First Nations people constitute 1.9% of the total Canadian population and 45.5% of the total indigenous population, which includes FN, Inuit, and Métis people[29]. The FN people in Manitoba reside in urban and rural areas, including 63 FN communities, some of which are isolated Northern communities[27].

Data Sources

Four data sources were used for this study: the federal Indian Register, the Manitoba Population Health Research Data Repository (PHRDR), Manitoba Health's Medical Claims file, and the Manitoba Cancer Registry (MCR). The federal Indian Register is a national registry that contains a complete list of status Indians[30]. Permission was received from the (then) federal department of Aboriginal Affairs and Northern Development Canada (the data steward) to link the federal Indian Register to the PHRDR. The PHRDR includes all Manitoba residents covered by the Manitoba health insurance program (approximately 99% of the population). Through a multi-step data linkage process, registered FN individuals were identified in the PHRDR, creating a FN file[31]. The FN file was linked to the Medical Claims file, which is populated with claims filed by physicians for payment of services; it includes a billing tariff code; a service date; an International Classification of Diseases, version 9, diagnosis code; and provider identification. Linking the FN file to that database made it possible to identify individuals who had undergone a fecal occult blood test (FOBT), colonoscopy, flexible sigmoidoscopy, bilateral mammography, or screening mammography.

The MCR was used to identify all individuals diagnosed with invasive BCA or CRC during 1984–2008 and the stage at diagnosis for individuals diagnosed during 2004–2008. The MCR is a population-based central registry of all cases of cancer diagnosed in the province. It was established in the 1930s and became population based in 1956. The MCR is legally mandated under the Public Health Act to collect, classify, and maintain accurate comprehensive information on all cancer cases for the province of Manitoba. Stage at diagnosis became available beginning in 2004; the stage classification uses the American Joint Committee on Cancer collaborative staging system, which allows for the combined pathologic and clinical stages to be captured.

Variable Definitions

Using postal codes, area of residence at diagnosis was categorized as north, urban (residence in the cities of Winnipeg or Brandon), or rural (residence neither in the north nor in the two cities). Breast cancer tumour biomarkers were categorized as luminal A if either the estrogen (ER) or progesterone receptor (PR) status was positive and the HER2 (human epidermal growth factor 2) status was negative; luminal B if the ER or PR status was positive, and the HER2 status was positive; HER2 if the ER and PR statuses were negative, and the HER2 status was positive; and triple-negative ("basal-like") if the ER, PR, and HER2 statuses were negative. In BCA, the tumour hormone receptor (HR) status was categorized as positive if either the ER or the PR status was positive, and negative if the ER and PR statuses were negative. Breast cancer and CRC tumour grade (a description of the degree of cell abnormality) were classified as "well differentiated" (low grade), "moderately differentiated" (intermediate grade), "poorly differentiated" (high grade), or "undifferentiated" (high grade). Only individuals who lived in Winnipeg were included in the examination of FOBT use, because a significant proportion of FOBTs in rural and northern areas are not registered in the Medical Claims file.

Statistical Analyses

Incidence and mortality rates were calculated for FN individuals and AOMs and were age-standardized to the 1991 Canadian population. Because of the difficulty in accurately identifying and linking young FN people, rates were restricted to individuals 15 years of age and older. Trends over time and the average annual percentage change (AAPC) were calculated using the JoinPoint Regression Program (version 4.2: Statistical Methodology and Applications Branch, U.S. National Cancer Institute, Bethesda, MD, U.S.A.). JoinPoint Regression is a statistical method that describes changing trends in successive segments of time and the amount of increase or decrease within each segment. The AAPC is a summary measure of the trend over the entire period and is calculated as a weighted average of the slope coefficients of the underlying JoinPoint Regression lines, with the weights equal to the length of each segment over the interval.

Descriptive statistics are used to illustrate the characteristics of the study groups. All values less than 6 or those that could be computed as less than 6 were suppressed. The relationship between FN status and stage at diagnosis was investigated using logistic regression. For BCA, stage I was compared with stages II, III, and IV because almost half of all BCAs are diagnosed at stage I and the 5-year relative survival for BCA at stage I is close to 100%. The 5-year relative survival rate for stage II BCA is 86%; survival drops to 57% for stage III and to 20% for stage IV BCAs[32]. For CRC, stages I and II were compared with stages III and IV because CRC survival is 93% for stage I and 82% for stage II, dropping to 58% for stage III and 8% for stage IV[33]. However, because stage III CRC is potentially treatable by surgery, we also compared CRC stages I, II, and III with stage IV.

All primary invasive BCAs diagnosed in Manitoba women during 2004–2008 were included in the logistic regression models. Women whose first cancer was ductal carcinoma *in situ* were excluded, because those cancers are surgically removed to prevent progression and possible development of invasive carcinoma[34]. Because only women 50–69 years of age were eligible to participate in the provincial breast screening program during the study period, the analysis was stratified by age group (<50, 50–69, and ≥70 years). All primary invasive CRCs diagnosed in Manitobans during 2004–2008 were included in separate CRC logistic regression models.

To examine possible modifiers of the relationship between FN status and stage at diagnosis, interactions of FN status with age group at diagnosis, year of diagnosis, area of residence, tumour characteristics, and screening mammography or previous colonoscopy were investigated. All analyses were conducted in the SAS software application (version 9.2: SAS Institute, Cary, NC, U.S.A.), and p values less than 0.05 were considered significant. Ethics approvals were received from the University of Manitoba Health Research Ethics Board, Manitoba Health's Health Information Privacy Committee, the Research and Resource Impact Committee at CancerCare Manitoba, and the Health Information and Research Governance Committee of the Assembly of Manitoba Chiefs.

RESULTS

BCa

In Manitoba, the age-standardized BCa incidence rate for FN women increased to 99.6 per 100,000 in 2004–2008 from 55.8 per 100,000 in 1984–1988 (AAPC: 9.2); for AOM women, it increased to 135.0 per 100,000 in 2004–2008 from 120.2 per 100,000 in 1984–1988 [AAPC: 2.6; Figure 1(A)]. The age-standardized BCa mortality rate for FN women increased to 22.7 per 100,000 in 2004–2008 from 10.3 per 100,000 in 1984–1988 (AAPC: 15.8); for AOM women, it decreased to 30.0 per 100,000 in 2004–2008 from 41.0 per 100,000 in 1984–1988 [AAPC: –6.6; Figure 1(B)].

During 2004–2008, 131 FN and 3914 AOM women were diagnosed with invasive BCa, and 26 FN and 1019 AOM women died from BCa. Table I sets out the characteristics of women for whom complete tumour stage information was available (87.8% of all AOM and 93.1% of all FN women diagnosed with BCa). We observed a significant difference in area of residence for women diagnosed at stage I ($p < 0.0001$): More FN women lived in the north and more AOM women lived in an urban area. A significant difference in tumour biomarkers was also observed ($p = 0.0021$), most likely because no FN women had triple-negative or HER2 tumour characteristics. Among women diagnosed with stages II–IV BCa, we observed significant differences between FN and AOM women in age at diagnosis ($p < 0.0001$), residence ($p < 0.0001$), grade ($p = 0.0034$), and HR status ($p = 0.0041$). Compared with AOM women diagnosed with later-stage BCa, FN women with such a diagnosis were younger (49 years of age or less) and more often lived in the north, had poorly differentiated tumours, and had negative or missing HR status.

For the logistic regression model examining the relationship between FN status and stage at diagnosis in women less than 50 years of age, only age at BCa diagnosis was considered a potential modifier (the numbers for all other variables were too small). No significant interaction was observed between age at diagnosis and FN status. Thus, the final model included only FN status as a predictor for stage at diagnosis. Compared with their AOM counterparts, FN women less than 50 years of age were significantly more likely to be diagnosed at stages II–IV than at stage I [odds ratio (OR): 3.11; 95% confidence limits (CL): 1.20, 8.06; Table II].

Other than FN status, factors considered in the logistic regression model for women 50–69 years of age included age at diagnosis, year of diagnosis, area of residence at diagnosis, tumour grade, and screen-detected cancer. None of the variables interacted significantly with FN status. The final model included FN status as a predictor, where FN women 50–69 years of age were significantly more likely than AOM women to be diagnosed at stages II–IV (OR: 1.72; 95% CL: 1.03, 2.88) compared with stage I. To verify the 2004–2008 models, we repeated the analysis for women diagnosed with invasive BCa during 1995–2003, with similar results (OR: 1.85; 95% CL: 1.72, 3.20). For FN women 70 years of age and older, data were too sparse to perform any statistical analysis.

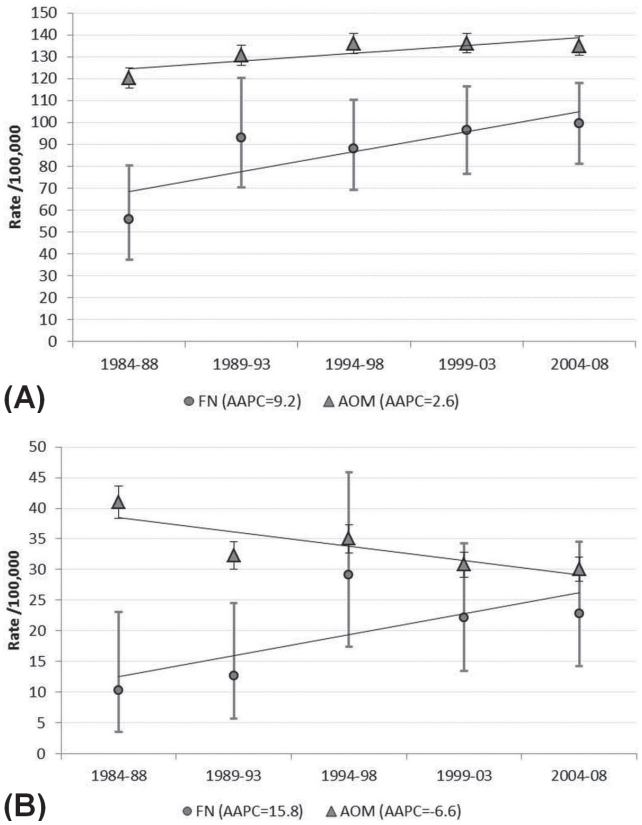

FIGURE 1 Age-standardized breast cancer (A) incidence and (B) mortality rates, with 95% confidence intervals, for First Nations (FN) and all other Manitoba (AOM) women, 1984–1988 to 2004–2008. AAPC = average annual percentage change.

CRC

In Manitoba, the age-standardized CRC incidence rate for FN individuals increased to 79.0 per 100,000 in 2004–2008 from 29.6 per 100,000 in 1984–1988 (AAPC: 23.6); for AOMs, the rate remained stable at 66.8 per 100,000 in 2004–2008 from 68.4 per 100,000 in 1984–1988 [AAPC: 0.6; Figure 2(A)]. The age-standardized mortality rate for FN individuals increased to 44.8 per 100,000 in 2004–2008 from 5.0 per 100,000 in 1984–1988 (AAPC: 33.5); for AOMs, it decreased to 25.1 per 100,000 in 2004–2008 from 31.9 per 100,000 in 1984–1988 [AAPC: –4.9; Figure 2(B)].

During 2004–2008, 155 FN individuals and 3881 AOMs were diagnosed with CRC, and 79 FN individuals and 1568

TABLE I Characteristics of First Nations (FN) women and all other Manitoban (AOM) women diagnosed with invasive breast cancer during 2004–2008, by stage at diagnosis

Characteristic	Stage I [*n* (%)]		*p* Value	Stages II–IV [*n* (%)]		*p* Value
	AOM women	FN women		AOM women	FN women	
Patients	1430	35		2008	87	
Age at diagnosis						
≤49 Years	200 (14.0)	Suppressed[a]	0.3032	450 (22.4)	35 (40.2)	<0.0001
50–69 Years	773 (54.1)	23 (65.7)		877 (43.7)	45 (51.7)	
≥70 Years	457 (32.0)	Suppressed		681 (33.9)	7 (8.0)	
Year of diagnosis						
2004	287 (20.1)	6 (17.1)	0.7871	397 (19.8)	20 (23.0)	0.1478
2005	287 (20.1)	6 (17.1)		391 (19.5)	15 (17.2)	
2006	277 (19.4)	6 (17.1)		405 (20.2)	16 (18.4)	
2007	275 (19.2)	10 (28.6)		418 (20.8)	11 (12.6)	
2008	304 (21.3)	7 (20.0)		397 (19.8)	25 (28.7)	
Residence at diagnosis						
North	19 (1.3)	12 (34.3)	<0.0001	42 (2.1)	29 (33.3)	<0.0001
Rural	431 (30.4)	13 (37.1)		654 (32.6)	34 (39.1)	
Urban	980 (68.5)	10 (28.6)		1,311 (65.3)	24 (27.6)	
Tumour biomarkers						
Triple-negative, basal-like	82 (5.7)	Suppressed	0.0021	220 (11.0)	13 (14.9)	0.6088
HER2	31 (2.2)	Suppressed		105 (5.2)	Suppressed	
Luminal A	631 (44.1)	18 (51.4)		903 (45.0)	33 (37.9)	
Luminal B	77 (5.4)	Suppressed		145 (7.2)	Suppressed	
Missing	609 (42.6)	15 (42.9)		635 (31.6)	30 (34.5)	
Grade						
Poorly differentiated (high grade)	241 (16.9)	Suppressed	0.6820	733 (36.5)	45 (51.7)	0.0034
Moderately differentiated (intermediate grade)	635 (44.4)	16 (45.7)		892 (44.4)	27 (31.0)	
Well differentiated (low grade)	458 (32.0)	14 (40.0)		238 (11.8)	9 (10.3)	
Undifferentiated	1 (0.1)	Suppressed		5 (0.3)	Suppressed	
Missing	95 (6.6)	Suppressed		140 (7.0)	Suppressed	
Hormone receptor status						
Negative	168 (11.8)	Suppressed	0.1550	421 (21.0)	26 (29.9)	0.0041
Positive	1191 (83.3)	31 (88.6)		1464 (72.9)	50 (57.5)	
Missing	71 (5.0)	Suppressed		123 (6.1)	11 (12.6)	
Screen detection (50–69 years of age)						
No	72 (9.3)	Suppressed	0.2650	218 (24.8)	14 (31.1)	0.3783
Yes	701 (90.7)	Suppressed		659 (75.1)	31 (68.9)	

[a] Fewer than 6 data points or able to be computed.

TABLE II Odds of late compared with early stage at diagnosis for First Nations (FN) patients and all other Manitoban patients, 2004–2008

Cancer type		TNM stage at diagnosis	Cases		Late stage compared with early stage (A vs. B)	
			(A) FN patients	(B) AOM patients	OR	95% CI
Breast	<50 Years	I	Suppressed[a]	200	3.11	1.20 to 8.06
		II–IV	Suppressed	450		
	50–69 Years	I	23	773	1.72	1.03 to 2.88
		II–IV	24	877		
Colorectal		I–II	67	1731	0.98	0.68 to 1.41
		III–IV	77	1760		
		I–III	102	2741	0.91	0.59 to 1.40
		IV	42	750		

[a] Fewer than 6 data points or able to be computed.
OR = odds ratio; CI = confidence interval.

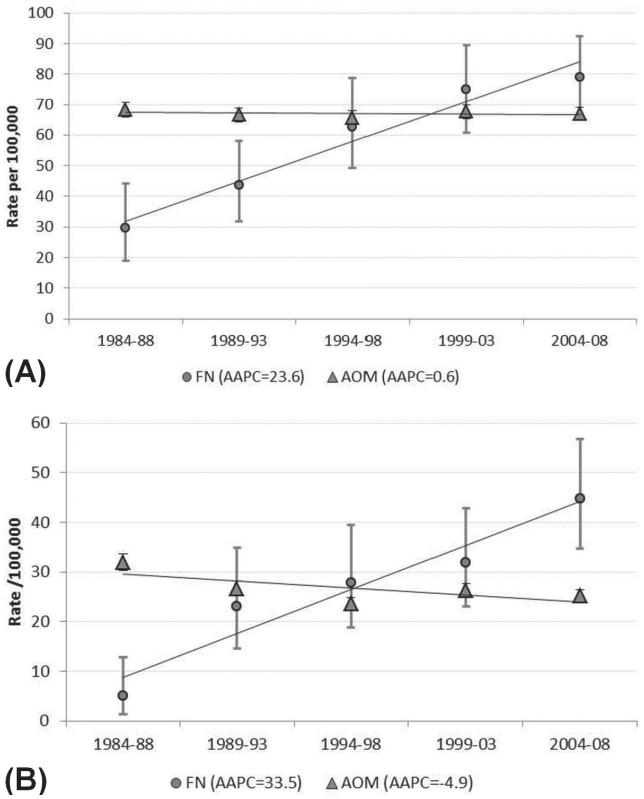

FIGURE 2 Age-standardized colorectal cancer (A) incidence and (B) mortality rates, with 95% confidence intervals, for First Nations (FN) and all other Manitoba (AOM) residents, 1984–1988 to 2004–2008. AAPC = average annual percentage change.

AOMs died from CRC. Table III sets out the characteristics of FN individuals and AOMs diagnosed with CRC for whom staging was available (89.9% for AOMs, 92.9% for FN individuals). Among patients diagnosed with stages I–II CRC, we observed a significant difference in age at diagnosis ($p < 0.0001$) and residence at diagnosis ($p < 0.0001$), with more FN individuals than AOMs being 49 years of age or younger and living in the north. Among patients living in Winnipeg, fewer FN individuals than AOMs had undergone a FOBT in the preceding 9 months ($p = 0.0150$). Among individuals diagnosed with stages III–IV CRC, we observed a significant difference between FN individuals and AOMs in age at diagnosis ($p < 0.001$) and residence ($p < 0.0001$). In addition, fewer FN individuals than AOMs diagnosed with stages III–IV CRC had received a colonoscopy in the 9 months preceding diagnosis ($p = 0.0441$).

In the CRC logistic regression models examining the relationship between FN status and stage at diagnosis, tumour grade and FOBT before diagnosis were not included because of limited data. Age at diagnosis, year of diagnosis, residence, and colonoscopy or flexible sigmoidoscopy within the 9 months preceding diagnosis were considered potential effect modifiers. None of those variables interacted significantly with FN status. When comparing stages I–II with stages III–IV, only area of residence modified the relationship between FN status and stage and was therefore included in the model. In comparing stages I–III with stage IV, area of residence, tumour grade, and previous colonoscopy or flexible sigmoidoscopy modified the relationship between FN status and stage and were therefore included in the model. Overall, after accounting for area of residence at diagnosis, FN status was not significantly associated with CRC stage at diagnosis in the comparison of stages I–II with stages III–IV (OR: 0.98; 95% CL: 0.68, 1.41; Table II). In addition, in the comparison of stages I–III with stage IV, FN status was not significantly associated with CRC stage at diagnosis with respect to area of residence, tumour grade, and previous colonoscopy or flexible sigmoidoscopy (OR: 0.91; 95% CL: 0.59, 1.40).

DISCUSSION AND CONCLUSIONS

Although the BCA incidence rate remained lower for FN compared with AOM women, the rate among FN women increased more rapidly between 1984 and 2008. Breast cancer mortality increased for FN women; it decreased for AOM women. The incidence of CRC among FN people also increased, and in 1999–2003, it surpassed the rate for AOMs. Although the CRC mortality rate for AOMs declined over time, the CRC mortality rate for FN people increased by a factor of 8. By 2004–2008, the difference in CRC mortality between FN and AOM patients was significant. Increases in the BCA and CRC incidence and mortality among indigenous peoples has been observed elsewhere, including among FN people living in northern Ontario and Quebec; Inuit living in Greenland, Alaska, and Canada; American Indian and Alaska Native peoples; and Maori living in New Zealand[10,35–41].

The increase in BCA incidence and mortality in FN woman could be attributable to biologic differences in BCA tumours that affect response to treatment and survival. Studies have found that tumour characteristics such as grade, HR status, and other unknown pathologic features vary with ethnicity, although no study has specifically included FN women[17,42–44]. Among women diagnosed at stages II–IV, we found a significant difference in grade and HR status for FN women compared with AOM women. Overall, a high-grade poorly differentiated tumour was found in 51.7% of FN women compared with 36.5% of AOM women, and negative HR status was found in 29.9% of FN women compared with 21.0% of AOM women. However, many other factors—such as changes in reproductive behaviour; lifestyle factors such as diet, alcohol use, and physical activity; differences in access to health care (delay to treatment or type of treatment received); and the presence of comorbidities—likely contribute to mortality differences[40,45].

The increase in CRC incidence could be related to the higher prevalence of CRC risk factors among FN people—for example, tobacco use, physical inactivity, obesity, alcohol intake, and a shift away from a more traditional diet[46,47]. An additional factor that likely contributes to the increasing CRC incidence and mortality among FN people is the lower rate of screening in this population[48]. In the present study, 36.2% of AOMs diagnosed with stages I–II CRC and 33.0% of those diagnosed with stages III–IV CRC had undergone a FOBT in the preceding 9 months; those percentages compare with 6.3% and 23.3% among their FN counterparts.

TABLE III Characteristics of First Nations (FN) patients and all other Manitoban patients diagnosed with colorectal cancer between 2004 and 2008, by stage at diagnosis

Characteristic	Stage I [*n* (%)]		*p* Value	Stages II–IV [*n* (%)]		*p* Value
	AOM patients	FN patients		AOM patients	FN patients	
Total	1731	67		1760	77	
Age at diagnosis						
≤49 Years	122 (7.0)	16 (23.9)	<0.0001	132 (7.5)	12 (15.6)	<0.0001
50–69 Years	586 (33.9)	27 (40.3)		705 (40.1)	46 (59.7)	
70–74 Years	242 (14.0)	11 (16.4)		235 (13.4)	7 (9.1)	
≥75 Years	781 (45.1)	13 (19.4)		688 (39.1)	12 (15.6)	
Sex						
Women	812 (46.9)	36 (53.7)	0.3185	801 (45.5)	34 (44.2)	0.9070
Men	919 (53.1)	31 (46.3)		959 (54.5)	43 (55.8)	
Year of diagnosis						
2004	331 (19.1)	14 (20.9)	0.5084	366 (20.8)	9 (11.7)	0.2980
2005	304 (17.6)	11 (16.4)		349 (19.8)	15 (19.5)	
2006	354 (20.5)	16 (23.9)		339 (19.3)	16 (20.8)	
2007	375 (21.7)	9 (13.4)		351 (19.9)	20 (26.0)	
2008	367 (21.2)	17 (25.4)		355 (20.2)	17 (22.1)	
Residence at diagnosis						
North	22 (1.3)	23 (34.3)	<0.0001	43 (2.4)	30 (39.0)	<0.0001
Rural	629 (36.3)	26 (38.8)		565 (32.1)	28 (36.4)	
Urban	1079 (62.3)	18 (26.9)		1152 (65.5)	19 (24.7)	
Missing	1 (0.1)	0 (0.0)				
Tumour grade						
Poorly differentiated (high grade)	146 (8.4)	Suppressed[a]	0.2709	299 (17.0)	14 (18.2)	0.1869
Moderately differentiated (intermediate grade)	1194 (69.0)	51 (76.1)		1049 (59.6)	38 (49.4)	
Well differentiated (low grade)	153 (8.8)	6 (9.0)		66 (3.8)	Suppressed	
Undifferentiated (high grade)	7 (0.4)	Suppressed		14 (0.8)	Suppressed	
Missing	231 (13.3)	9 (13.4)		332 (18.9)	23 (29.9)	
Colonoscopy or flexible sigmoidoscopy within 9 months						
No	238 (13.8)	9 (13.4)	1.0000	434 (24.7)	27 (35.1)	0.0441
Yes	1493 (86.3)	58 (86.6)		1326 (75.3)	50 (64.9)	
FOBT within 9 months (residents of Winnipeg)						
No	629 (63.7)	Suppressed	0.0150	728 (67.0)	Suppressed	0.6030
Yes	358 (36.2)	Suppressed		358 (33.0)	Suppressed	

[a] Fewer than 6 data points or able to be computed.
FOBT = fecal occult blood test.

Regardless of age, FN women were significantly more likely than their AOM counterparts to be diagnosed with a later-stage breast cancer; however, FN status was not associated with CRC stage at diagnosis. A more advanced stage at diagnosis for FN women diagnosed with BCA has been observed in other studies[23]. The only significant difference in survival for FN women was for stage I BCA; 86% of FN women compared with 94% of AOM women survived 5 years after a stage I diagnosis. Kelly *et al.*[47] found that fewer CRCS diagnosed in Alaska Native people were localized (30% vs. 38% in white U.S. patients), which could be related to lower screening rates; however, the percentages of individuals diagnosed with regional or distant-stage CRC were more similar. In contrast, Gibberd *et al.*[49] found no significant difference in stage at diagnosis for Australian Aboriginal people compared with non-Aboriginal people diagnosed with BCA or CRC.

An important strength of the present study is the linkage of the federal Indian Register to the PHRDR to accurately identify FN individuals. To our knowledge, ours is also the first Canadian study to examine differences in CRC stage at diagnosis for FN people. However, our findings should be considered in the context of several study limitations. We did not include nonregistered FN individuals, nor did we distinguish between several distinct FN cultural groups. However, such information constitutes part of the collaboration with FN communities and the planning of local strategies to improve cancer screening in the population. Reporting by tribe should therefore be considered in the design of future research. We did not include measures of socioeconomic status in the study; future studies could examine the relationship between FN status, socioeconomic status, and stage at diagnosis. Finally, the number of BCAS

diagnosed in women 70 years of age and older was too small to perform any statistical analysis.

Our study found that the incidence of and mortality from BCA among FN women in Manitoba increased to 2004–2008 from 1984–1988 and that FN women were significantly more likely to be diagnosed at an advanced stage than were AOM women. We also found a dramatic increase in CRC incidence and mortality in FN people, but no difference in CRC stage at diagnosis for FN individuals compared with AOMs. Further research is required to understand the differences in BCA tumours diagnosed in FN women and to assess the effects of recent initiatives on BCA mortality and stage at diagnosis for FN women. Our results also underscore the need for improved utilization of screening and targeted initiatives that use a culturally relevant, inclusive, and validated framework to reduce barriers to CRC screening and to address behavioural risk factors for cancer.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology*'s policy on disclosing conflicts of interest, and we declare that we have none.

AUTHOR AFFILIATIONS

*Department of Community Health Sciences, University of Manitoba, and †Epidemiology and Cancer Registry, CancerCare Manitoba, Winnipeg, MB; ‡Cancer Control Research, BC Cancer Agency, Vancouver, BC; §Screening Programs, CancerCare Manitoba, Winnipeg, MB.

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