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Research

Sociodemographic characteristics of women with invasive cervical cancer in British Columbia, 2004–2013: a descriptive study

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Abstract

Background: Although cancer screening has led to reductions in the incidence of invasive cervical cancer (ICC) across Canada, benefits of prevention efforts are not equitably distributed. This study investigated the sociodemographic characteristics of women with ICC in British Columbia compared with the general female population in the province.

Methods: In this descriptive study, data of individuals 18 years and older diagnosed with ICC between 2004 and 2013 were obtained from the BC Cancer Registry. Self-reported sociodemographic characteristics were derived from standardized health assessment forms (HAFs) completed upon admission in the BC Cancer Registry. Standardized ratios (SRs) were derived by dividing observed and age-adjusted expected counts by ethnicity or race, language, and marital, smoking and urban–rural status. Differences between observed and expected counts were tested using χ^2 goodness-of-fit tests. General population data were derived from the 2006 Census, 2011 National Household Survey and 2011/12 Canadian Community Health Survey.

Results: Of 1705 total cases of ICC, 1315 were referred to BC Cancer (77.1%). Of those who were referred, 1215 (92.4%) completed HAFs. Among Indigenous women, more cases were observed (n = 85) than expected (n = 39; SR 2.16, 95% confidence interval [CI] 2.15–2.18). Among visible minorities, observed cases (n = 320) were higher than expected (n = 253; 95% CI 1.26–1.26). Elevated SRs were observed among women who self-identified as Korean (SR 1.78, 95% CI 1.76–1.80), Japanese (SR 1.77, 95% CI 1.74–1.79) and Filipino (SR 1.60, 95% CI 1.58–1.62); lower SRs were observed among South Asian women (SR 0.63, 95% CI 0.62–0.63). Elevated SRs were observed among current smokers (SR 1.34, 95% CI 1.33–1.34) and women living in rural-hub (SR 1.29, 95% CI 1.28–1.31) and rural or remote (SR 2.62, 95% CI 2.61–2.64) areas; the SR was lower among married women (SR 0.90, 95% CI 0.90–0.90).

Interpretation: Women who self-identified as visible minorities, Indigenous, current smokers, nonmarried and from rural areas were overrepresented among women with ICC. Efforts are needed to address inequities to ensure all women benefit from cervical cancer prevention.

Substantial reductions in incidence and mortality of invasive cervical cancer (ICC) have been observed across Canada, largely because of access to cytology-based cervical cancer screening.[1,2] With the addition of new technologies and practices in cervical cancer prevention, such as human papillomavirus (HPV) vaccination and HPV-based testing, the World Health Organization (WHO) issued an international call to accelerate efforts toward the elimination of cervical cancer globally.[3–5] However, despite reductions in ICC rates overall in Canada, benefits of prevention efforts are not equally distributed among all women.

Programmatic cervical cancer screening using cytology is offered across Canadian jurisdictions to detect and treat precancerous lesions and has been successful in reducing cervical cancer incidence and mortality.[2] Screening is publicly funded and available in all Canadian provinces and territories.[2,6] However, the proportion of women who are up to date with screening (at least 1 Papanicolaou [Pap] test in the past 3 years) is below the national target (≥ 80%) in all jurisdictions.[7]

Sociodemographic characteristics are associated with disparities in access to and use of cervical cancer screening and incidence across Canada. Factors associated with lower access to screening services include lower educational attainment, lower socioeconomic status, not having a regular primary care provider, immigration history and identifying as Indigenous.[8–18] Disparities in cervical cancer incidence were reported among First Nations women in

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British Columbia and Manitoba compared with non–First Nations women.[15,19]

With recent calls for the acceleration of cervical cancer elimination in Canada, it is critical that strategies ensure equitable benefit from cervical cancer prevention and control efforts for all women and trans and nonbinary people with a cervix. Although disparities in cervical cancer screening and incidence exist across Canada,[8–15] information is incomplete in BC. The purpose of this study was to investigate sociodemographic characteristics of women with ICC in BC and compare these characteristics with those of the general population of women in the province. Evaluating ICC by sociodemographic characteristics provides important information on potential disparities in screening and incidence in BC.

Methods

Study setting

There are nearly 2.4 million women and trans and nonbinary people of all ages with a cervix (hereafter referred to as women) in BC.[20] Overall, 722 975 women (31.1%) identify as a visible minority and 140 320 as Indigenous (6.0%).[20] There are 3 distinct Indigenous groups in Canada: First Nations, Métis and Inuit. Canada's first organized cervical cancer screening program was established in BC in 1960 and is operated by BC Cancer.[6] Routine cervical cancer screening with conventional cytology is publicly funded for women aged 25–69 years, reflecting national recommendations.[2,6]

Data sources and analytic sample

In this descriptive study, data were retrospectively obtained from population-based administrative databases and national survey data (Table 1). Personal, tumour and geographic information on all ICC cases diagnosed among BC residents 18 years and older between Jan. 1, 2004, and Dec. 31, 2013, were obtained from the BC Cancer Registry (BCCR) (n = 1705). This included codes C53.0–9 as defined by the *International Classification of Diseases for Oncology, Third Revision*.[30]

Self-reported responses to sociodemographic information were derived from standardized health assessment forms (HAFs) completed upon BC Cancer admission. BC Cancer is the provincial agency responsible for cancer control, including the operation of 6 regional cancer centres. BC Cancer accepts patients who have a diagnosis of cancer and are referred by a physician. Sociodemographic information was available only for women seen in consultation at a BC Cancer centre. Hard copy HAFs were located in patients' charts and 4 research assistants reviewed the charts to collect the patients' verbatim responses from HAFs. HAF data were linked to BCCR deterministically by a common patient identification number.

Information for the female general population 18 years and older ("the general population" hereafter) in BC was obtained from Statistics Canada public use microdata files for the 2006 Census,[23] 2011 National Household Survey,[26] Canadian Community Health Survey Cycle 2011/12[27] and BC Stats[28] (Table 1).

Sociodemographic and health characteristics

Variables included age (5-yr bands), ethnicity or race, language most often spoken at home, marital status (single and never married; divorced or separated or widowed; married), and smoking status (current; former; never). Categories of ethnicity or race and language were categorized according to Census categories.[31]

For ethnicity or race, 3 subanalyses were conducted. First, women were categorized based on identifying as either "not a visible minority" (White or Indigenous) or a "visible minority." Second, groups within "not a visible minority" were evaluated (White or Indigenous). Lastly, groups within a "visible minority" were evaluated (any population group other than White or Indigenous). Marital and smoking status were categorized by Canadian Community Health Survey 2011/12 categories.[27]

Geographic classification

Level of urbanization was classified by Community Health Service Area (CHSA) urban–rural classifications (metropolitan, large-urban, medium-urban, small-urban, rural-hub or rural or remote). Health services in BC are delivered within 5 administrative health boundaries, made up of 89 local health areas. Nested within local health areas are 218 CHSAs.[32] The patient's postal code in the BCCR at diagnosis was linked to the Postal Code Conversion File[33] to obtain longitude and latitude. Point locations were mapped on the BC CHSA boundary map[32] to identify CHSA urban–rural classifications. For the general population, the smallest geography with available population estimates was the local health area.[28] Urban–rural classification of the local health areas corresponded to the highest level of urban–rural classification among nested CHSAs.

Statistical analysis

The direct method was used to calculate annual provincial age-standardized incidence rates.[34] The 2011 Canadian age structure with 19 5-year age groups was used.[1] Annual provincial population denominators were available from Statistics Canada.[35]

A frequency analysis was conducted for all variables. For the general population, weighted counts of the 2006 Census and 2011 National Household Survey were summed to reflect the distribution over the analytic period. Sociodemographic data for nonsurvey years were not available, and intercensal years were not estimated. Age-specific proportions were derived by dividing age-specific weighted counts by the total of weighted counts among ages 18 years and older.

Observed counts of sociodemographic and health characteristics were compared with age-adjusted expected counts, relative to corresponding distributions among the general population. To derive expected counts, the general population distribution for a given characteristic was directly age-standardized to the corresponding BCCR ICC age-structure and the age-standardized proportions were multiplied by the size of the BCCR ICC cohort (excluding unknowns). Estimates derived from Statistics Canada survey data sets were weighted to account for nonprobability sampling. The

Table 1: Data sources accessed for the study

Population	Database	Description	Years of data used	Variables used in analysis
BC ICC cases	BC Cancer Registry	A population-based registry of all cases of cancer diagnosed in BC residents since 1970. Data includes personal, geographic and tumour diagnosis information. Sociodemographic information is available only for cases seen in consultation at a BC Cancer clinic.	2004–2013	Age, geography
	BC HAFs	Health assessment forms are completed upon first admission to a BC Cancer centre. HAFs capture sociodemographic characteristics via a standardized questionnaire.	HAF: 2004–2010 PRISM: 2011–2013	Self-reported ethnicity or race, language, smoking status, marital status
General population of women in BC	Canadian Census PUMF (individuals file)	The Canadian Census of Population is a primary source of sociodemographic data in Canada and vital for government, community and planning services.[21] The 2006 Census national response rate was 96.5%.[22] The public use microdata file contains 844 476 records, representing 2.7% of the Canadian population. The file does not include people living in institutions.[23]	2006	Self-reported age, ethnicity or race, language
	National Household Survey PUMF (individuals file)	In 2011, the mandatory long-form census was replaced with a voluntary survey called the National Household Survey (NHS). The NHS collected similar information as gathered from the Census. The national response rate in 2011 was 77.2%.[24] Statistics Canada implemented various methods to account for error and biases related to the voluntary nature of the survey.[25] The 2011 NHS PUMF on individuals represents a 2.7% sample of the Canadian population. It contains social, demographic and economic data.[26]	2011	Self-reported age, ethnicity or race, language
	CCHS PUMF	The CCHS is a national cross-sectional survey that collects health information and is conducted every 2 years by Statistics Canada. The survey uses multistage cluster sampling and collects data on "health and social characteristics of the population." The CCHS PUMF provides data on a 2-year period. The response rate was 68.4%. Data are based on in-person and telephone interviews administered to participants, with about 130 000 respondents aged 12 years or older, residing in households in all provinces and territories. Data are not collected on members of the Canadian Armed Forces and those residing on First Nations reserves, in institutions and in some remote regions. Exclusions represent less than 3% of the Canadian population.[27]	2011/12 cycle	Self-reported smoking status, marital status
	BC Stats[28]	Population statistics by BC geographical classifications. BC Stats provides population estimates by various levels of geography. Population estimates are based on the Census of Population with adjustments that consider net under-enumeration in the Census.[29]	2006, 2011	Geography

Note: BCCR = BC Cancer Registry, CCHS = Canadian Community Health Survey, HAF = health assessment form, ICC = invasive cervical cancer, PRISM = Patient-Reported Information and Symptom Measurement, PUMF = public use microdata file.

BCCR standard included 5 age groups (18–29, 30–44, 45–59, 60–74 and ≥ 75 yr). Standardized ratios (SRs) were calculated by dividing observed over age-adjusted expected counts. A χ^2 goodness-of-fit test tested the null of no differences between observed and expected values.

A sensitivity analysis was performed to evaluate time trends in the observed versus age-adjusted expected counts of sociodemographic and health characteristics. Data were stratified into two 5-year periods: 2004–2008 and 2009–2013. For the more recent period (2009–2013), data from the 2011 National Household Survey were used for population denominators. For the earlier period (2004–2008), data from the 2006 Census were used for population denominators. All analyses were conducted using R Version 4.0.3.

Ethics approval

Ethics approval was obtained from the University of British Columbia BC Cancer Research Ethics Board (H15-01605).

Results

Incidence

Incidence rates remained stable with slight fluctuations around the cumulative provincial rate (7.5 per 100 000 people; Figure 1). On average, there were 170 cases annually and a total of 1705 cases between 2004 and 2013; 1315 of the total cases were referred to BC Cancer (77.1%). Completed HAFs were available for 1215 women (92.4%); those seen in consultation at BC Cancer with completed HAFs represented, on average, 71.5% of ICC cases annually.

Age distribution

The age distribution of ICC cases was compared with the general population (Table 2). Nearly 40% of women were between 35 and 49 years at ICC diagnosis (the most common age range). The median age of referred ICC cases with complete HAFs was 49.0 (interquartile range 40.0–61.5) years. Nearly 85% of cancers were diagnosed among ages eligible for screening under current guideline recommendations (25-69).

Ethnicity or race and language

Nonresponses to ethnicity (*n* = 98, 8.1%) and language (*n* = 134, 11.0%) were excluded. Adjusted for age, observed counts of women with ICC identifying as "not a visible minority" or "visible minority" were significantly different than expected, relative to the general population (p < 0.001) (Table 3). Observed cases among visible minorities (*n* = 320) were higher than expected (*n* = 253, SR 1.26). Within "not a visible minority" categories, observed counts differed significantly from expected (p < 0.001) (Table 3). Although a small proportion in the general population identify as Indigenous, the ratio of observed (*n* = 85) to expected cases (*n* = 39; SR 2.16) was the largest among all groups. Within visible minorities, observed counts differed significantly from expected (p < 0.001) (Table 3). The largest SRs were observed among women with the following ethnicities: Korean (SR 1.78), Japanese (SR 1.77) and Filipino (SR 1.60). Observed cases among South Asian women was lower than expected (SR 0.63).

Observed counts by official and nonofficial languages did not differ significantly than expected (p = 0.3). Within the set

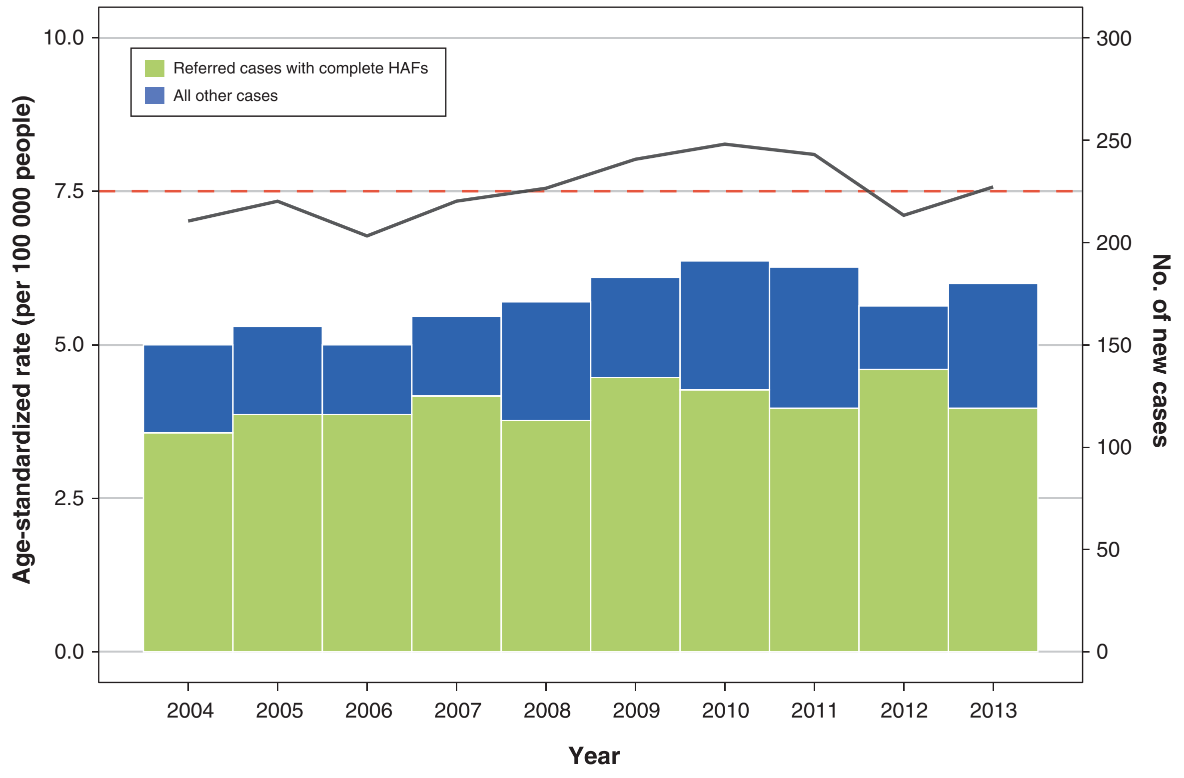

Figure 1: Age-standardized incidence rates of cervical cancer and number of new cases by year, 2004–2013. The dashed line shows the provincial cumulative age-standardized incidence rate, 2004–2013, the solid line shows the age-standardized incidence rate and the bars show counts of invasive cervical cancer cases. Note: HAF = health assessment form.

Table 2: Age distribution of invasive cervical cancer cases and general female population in British Columbia, 2004–2013

Age group, yr	BC Cancer ICC cases* (all cases in BC) No. (%) n = 1705	BC Cancer ICC cases* (referred with complete HAFs) No. (%) n = 1215	BC female population 18 yr and older† %
18–24	13 (0.8)	5 (0.4)	11.8
25–29	87 (5.1)	40 (3.3)	8.0
30–34	165 (9.7)	92 (7.6)	7.8
35–39	209 (12.3)	154 (12.7)	8.4
40–44	269 (15.8)	188 (15.5)	9.4
45–49	195 (11.4)	145 (11.9)	10.2
50–54	166 (9.7)	123 (10.1)	9.9
55–59	164 (9.6)	124 (10.2)	9.2
60–64	118 (6.9)	94 (7.7)	7.7
65–69	89 (5.2)	78 (6.4)	5.6
70–74	64 (3.8)	47 (3.9)	4.4
75–79	62 (3.6)	50 (4.1)	3.6
80–84	65 (3.8)	48 (4.0)	2.4
≥ 85	39 (2.3)	27 (2.3)	1.5

Note: HAF = health assessment form, ICC = invasive cervical cancer.
*Only ICC cases aged 18 years and older were considered.
†Data for the BC female population aged 18 years and older were derived by adding weighted counts for each age group from the 2006 Census[23] and 2011 NHS.[26] To derive proportions, the weighted counts were divided by the total of weighted counts among ages 18 years and older.

of nonofficial languages, there were significant differences between observed and expected counts ($p < 0.01$) (Table 3).

Smoking and marital status

Nonresponses to smoking (n = 24, 2.0%) and marital status (n = 12, 1.0%) were excluded. Adjusted for age, observed and expected counts by smoking status were significantly different ($p < 0.001$) (Table 4). Observed cases among current smokers were greater than expected (SR 1.34).

Observed and expected cases differed significantly by marital status ($p < 0.001$) (Table 4). Observed cases among "widowed, separated or divorced" (SR 1.23) and single women (SR 1.18) were elevated.

Level of urbanization

BCCR records without a postal code were excluded (n = 22, 1.3%). Adjusted for age, observed and expected counts by urban–rural classification were significantly different ($p <$ 0.001) (Table 4). Although a small proportion of the general population reside in rural areas, observed cases among rural-hub (87 cases) and rural or remote areas (n = 216) were elevated compared with expected cases in rural-hub (n = 67; SR 1.29) and rural or remote areas (n = 82; SR 2.62). Among metro and urban areas, SRs were less than 1.0.

Sensitivity analysis

When cases were stratified by time period, trends in SRs were similar to those reported for the overall period (Appendix 1, Supplementary Tables 1 and 2, available at www.cmajopen.ca/content/9/2/E424/suppl/DC1). Observed cases among visible minorities and Indigenous women were higher than expected in both periods. Within visible minorities, trends in SRs were generally similar to those reported in Table 3, with the exception of women who identified as Chinese (Appendix 1, Supplementary Table 1). Adjusted for age, observed cases among current smokers were greater than expected in 2009–2013 (SR 1.22) and 2004–2008 (SR 1.46) (Appendix 1, Supplementary Table 2). Observed cases among "widowed, separated or divorced" and single women were also elevated in both periods (Appendix 1, Supplementary Table 2). Adjusted for age, observed cases among rural-hub and rural or remote areas were elevated compared with expected cases in both periods. Among metro and urban areas, SRs were equal to or less than 1.0 in both periods (Appendix 1, Supplementary Table 2).

Interpretation

This study found significant differences in the number of observed cases of ICC by ethnicity or race compared with the expected cases based on the ethnicity or race distribution of the general population. Specifically, we found a greater number of observed cases than expected in women who self-identified as a visible minority (Filipino, Korean or Japanese) or Indigenous. Observed cases among White and South Asian women were lower than expected. Significant differences were also detected among smoking and marital status, and level of urbanization.

Table 3: Observed invasive cervical cancer cases by self-identified ethnicity or race and language most often spoken at home compared with expected cases relative to the general female population in British Columbia

Category	Observed cases (crude proportion, %)	Census age-standardized weighted proportion, % (95% CI)	Expected cases	Standardized ratio (95% CI)*	Test statistics, χ^2†
Ethnicity or race					
Overall, *n* = 1117					22.8¶
Not a visible minority	797 (71.3)	77.3 (77.2–77.4)	864	0.92 (0.92–0.92)	
Visible minority	320 (28.6)	22.7 (22.6–22.7)	253	1.26 (1.26–1.26)	
Within not a visible minority, *n* = 797					55.9¶
White	712 (89.3)	95.1 (94.9–95.2)	758	0.94 (0.94–0.94)	
Indigenous	85 (10.7)	4.9 (4.9–5.0)	39	2.16 (2.15–2.18)	
Within visible minority, *n* = 320					38.8¶
Chinese	118 (36.9)	35.4 (35.2–35.6)	113	1.04 (1.04–1.05)	
South Asian	72 (22.5)	35.9 (35.8–36.1)	115	0.63 (0.62–0.63)	
Filipino	38 (11.9)	7.4 (7.4–7.5)	24	1.60 (1.58–1.62)	
Korean	21 (6.6)	3.7 (3.6–3.7)	12	1.78 (1.76–1.80)	
Japanese	17 (5.3)	3.0 (3.0–3.1)	10	1.77 (1.74–1.79)	
All other‡	54 (16.9)	14.5 (14.4–14.6)	47	1.16 (1.15–1.17)	
Language					
Overall, *n* = 1081					1.2
Official languages§	901 (83.3)	82.1 (82.0–82.2)	887	1.02 (1.01–1.02)	
Nonofficial languages	180 (16.7)	17.9 (17.9–18.0)	194	0.93 (0.93–0.93)	
Within nonofficial languages, *n* = 180					12.6**
Chinese languages	80 (44.4)	41.7 (41.5–41.9)	75	1.07 (1.06–1.07)	
Punjabi	45 (25.0)	18.4 (18.3–18.6)	33	1.36 (1.35–1.37)	
Other Indo-Iranian languages	16 (8.9)	6.9 (6.8–7.0)	12	1.29 (1.28–1.31)	
All other languages	39 (21.7)	33.0 (32.8–33.2)	59	0.66 (0.65–0.66)	

Note: CI = confidence interval, ICC = invasive cervical cancer.
*The standardized ratio was derived by dividing the observed and age-adjusted expected counts.
†Goodness-of-fit testing the null of no differences between observed and expected values.
‡The population group "All other" includes various population groups that individually had less than 5 counts.
§The official languages include French and English.
¶$p < 0.001$.
**$p < 0.01$.

We found a greater number of observed cases than expected among women who reported being a current smoker, not currently married or from rural-hub or rural or remote areas.

Generally, immigration history, visible minority status and being foreign-born are associated with lower participation rates of cervical cancer screening.[9,10,16,17,36,37] Canadian and US ICC incidence trends are closely tied to patterns of screening participation.[1,38] Risk factors for cervical cancer include smoking history and number of lifetime sexual partners. HPV is associated with nearly all cervical cancers.[39]

In Ontario, cervical cancer screening rates were significantly lower among urban immigrant women (53.1%)[10] compared with long-term residents (64.6%).[18] Rates were lowest among immigrant women from South Asia and lower among immigrant women older than 50 years, in the lowest income quintile and without access to a primary care provider.[18] Similar findings were reported among urban Chinese immigrant women in BC.[40] Visible minority women in Canada were more than twice as likely never to have had a Pap test compared with White women.[11]

Few studies have evaluated ICC incidence and ethnicity or race in Canada. One study showed substantial variations of ICC stage distribution by birth region.[17] Immigrant women from East Asia, Western Europe and America had higher early-stage incidence whereas South Asian women had higher late-stage incidence. This study emphasizes that taking into account immigration history and birth region can identify important differences between population groups.

ICC incidence rates were reported to be 1.92 times greater among First Nations than among non-First Nations women in BC.[19] In Manitoba, ICC incidence was 2 times greater among First Nations compared with non-First Nations

Table 4: Observed invasive cervical cancer cases by smoking status, marital status and community health service area urban–rural classification compared with expected cases relative to the general female population in British Columbia

Category	Observed cases (crude proportion, %)	Census age-standardized weighted proportion, % (95% CI)	Expected cases	Standardized ratio* (95% CI)	Test statistics, χ^2†
Smoking status, *n* = 1191					22.8‡
Current smoker	229 (19.2)	14.4 (14.3–14.5)	172	1.34 (1.33–1.34)	
Former smoker	429 (36.0)	39.0 (38.9–39.1)	464	0.92 (0.92–0.93)	
Never smoker	533 (44.8)	46.6 (46.5–46.7)	555	0.96 (0.96–0.96)	
Marital status, *n* = 1203					26.2‡
Married	725 (60.3)	67.2 (67.0–67.3)	808	0.90 (0.90–0.90)	
Widowed, separated or divorced	289 (24.0)	19.5 (19.4–19.6)	235	1.23 (1.23–1.24)	
Single	189 (15.7)	13.3 (13.3–13.4)	160	1.18 (1.17–1.18)	
CHSA classifications, *n* = 1683					239.2‡
Metro	766 (45.5)	50.5 (50.4–50.6)	850	0.90 (0.90–0.90)	
Large urban	244 (14.5)	15.1 (15.1–15.2)	255	0.96 (0.95–0.96)	
Medium urban	240 (14.3)	16.5 (16.5–16.6)	278	0.86 (0.86–0.87)	
Small urban	130 (7.7)	8.9 (8.9–9.0)	150	0.86 (0.86–0.87)	
Rural-hub	87 (5.2)	4.0 (4.0–4.0)	67	1.29 (1.28–1.30)	
Rural or remote	216 (12.8)	4.9 (4.9–4.9)	82	2.62 (2.61–2.64)	

Note: CHSA = community health service area, CI = confidence interval, ICC = invasive cervical cancer.
*The standardized ratio was derived by dividing the observed and age-adjusted expected counts.
†Goodness-of-fit testing the null of no differences between observed and expected values.
‡*p* <0.001.

women.[15] Similar incidence trends were reported among Indigenous people in Australia, New Zealand and the US.[41] These findings are consistent with the present study's observation that, after adjusting for age, the number of observed ICC cases among self-identified Indigenous women was more than 2 times greater than expected. Increased risk for ICC may be related to higher prevalence of HPV and decreased access and uptake of screening.[15,42] Health disparities experienced by Indigenous people in Canada are rooted in the legacy of colonialism, the residential school system, racism and the intergenerational trauma that continues.[43,44] The resulting mistrust may lead to disparities in screening and diagnosis.

Canadian studies report little variation in cervical cancer screening participation by levels of urbanization.[16,17,45] One study suggested rural residence was associated with lower screening rates.[11] Urban–rural variations may indicate differences in access to screening and diagnostic services, but also HPV prevalence, and sociodemographic and health characteristics.

In prior research, marital status was associated with cancer screening uptake,[11,37,46] stage at diagnosis, mortality and survival.[47–49] Canadian women who self-reported as never married, separated or divorced were 2.3 times as likely as married women to never have had a Pap test.[11,37] Marriage and common-law status may be protective for screening, early detection and survival through positive influences of health-seeking behaviours.[46,48,50]

The proportion of current smokers was similar to national prevalence among female cancer patients (18.7%).[51] Tobacco smoking is a causal factor for ICC, and the risk may increase with smoking intensity and duration.[52] The association appears to be specific to squamous cell carcinoma (which accounts for most ICC).[52] There is an increased risk of cervical cancer for smokers among HPV-positive women, and smoking may increase the risk of progression after HPV is acquired.[53] There is no clear association among former smokers.[52,53]

Limitations

Although data collection was verified for accuracy, sociodemographic information collected on HAFs was available only for patients with ICC seen in consultation at a cancer centre. BC Cancer accepts patients who have a diagnosis of cancer and are referred by a physician. However, some cancer services are provided outside of BC Cancer, including surgery. Some early-stage cervical cancers can be treated by surgery alone at a regional hospital, and patients may not be seen in consultation at BC Cancer. Although the BCCR aims to capture all tumours among BC residents, case ascertainment for all cancers in BC over the study period was estimated at 91.2%.[54]

Among patients with ICC seen in consultation at a cancer centre, missing information for individual questions ranged between 1.0% and 11.0%. Information on factors related to screening, primary care, immigration history, country of birth, socioeconomic status, HIV status and BMI were not available in HAFs. Self-reported data are subject to survey and response biases.

Information for the general population was derived from multiple data sources and periods, affecting internal validity. Data sources used for the general population contain potential sampling error and nonresponse biases. HAF questions differed in wording and response categories to Statistics Canada surveys, which may affect internal validity. Numerator–denominator bias may be present for Indigenous people and people of colour where barriers to enumeration exist in Canada.[55] However, self-identification was used to determine ethnicity or race in HAF and Census data.

Historically, access to cancer services in northern BC were challenging throughout the study period because of a variety of reasons, including the lack of a regional cancer centre. This changed when the BC Cancer Centre for the North opened in 2012, which would have affected referral patterns. Before 2012, referral patterns likely were lower for the people of northern BC, where the proportion of Indigenous people is larger. Given that information on ethnicity or race was not available for patients who were not seen at a cancer centre, this group may be overrepresented in the northern and Indigenous populations. This likely underestimates the number of Indigenous ICC cases and SR estimate.

Conclusion

The present study provides evidence of important differences in ICC incidence in BC by ethnicity or race, level of urbanization and marital and smoking status. The present study suggests that social and sociocultural determinants of health are closely linked to cervical cancer incidence, even in the context of universal health care access. Information on indicators of cervical cancer screening by ethnicity or race have not been available in BC, and this void is a barrier to informing equitable cancer control and prevention strategies. Efforts are needed to reverse this information gap to better understand and address inequities, and inform culturally relevant and population-based strategies to ensure elimination of cervical cancer for women and trans and nonbinary people at risk of this preventable malignancy.

References

1. Canadian Cancer Statistics Advisory Committee. *Canadian Cancer Statistics 2019*. Toronto: Canada Cancer Society; 2019. Available: cancer.ca/Canadian-Cancer-Statistics-2019-EN (accessed 2019 Oct. 1).
2. Dickinson J, Tsakonas E, Gorber SC, et al.; Canadian Task Force on Preventive Health Care. Recommendations on screening for cervical cancer. *CMAJ* 2013;185:35-45.
3. Blake J. The elimination of cervical cancer in our lifetime. *J Obstet Gynaecol Can* 2018;40:1555-7.
4. Simms KT, Steinberg J, Caruana M, et al. Impact of scaled up human papillomavirus vaccination and cervical screening and the potential for global elimination of cervical cancer in 181 countries, 2020–99: a modelling study. *Lancet Oncol* 2019;20:394-407.
5. WHO Director-General calls for all countries to take action to help end the suffering caused by cervical cancer. Geneva: World Health Organization; 2018. Available: www.who.int/reproductivehealth/call-to-action-elimination-cervical-cancer/en/ (accessed 2019 Feb. 25).
6. Cervical cancer screening in Canada: environmental scan (2018). Toronto: Canadian Partnership Against Cancer; 2018. Available: www.partnershipagainstcancer.ca/topics/cervical-cancer-screening-environmental-scan-2018/ (accessed 2020 Feb. 27).
7. Cervical cancer screening: charts and tables. Toronto: Canadian Partnership Against Cancer. Available: www.systemperformance.ca/cancer-control-domain/screening/cervical-cancer-screening/ (accessed 2019 July 15).
8. Drolet M, Boily M-C, Greenaway C, et al. Sociodemographic inequalities in sexual activity and cervical cancer screening: implications for the success of human papillomavirus vaccination. *Cancer Epidemiol Biomarkers Prev* 2013;22:641-52.
9. Lofters A, Glazier RH, Agha MM, et al. Inadequacy of cervical cancer screening among urban recent immigrants: a population-based study of physician and laboratory claims in Toronto, Canada. *Prev Med* 2007;44:536-42.
10. Lofters AK, Moineddin R, Hwang SW, et al. Predictors of low cervical cancer screening among immigrant women in Ontario, Canada. *BMC Womens Health* 2011;11:20.
11. Amankwah E, Ngwakongnwi E, Quan H. Why many visible minority women in Canada do not participate in cervical cancer screening. *Ethn Health* 2009;14:337-49.
12. Borkhoff CM, Saskin R, Rabeneck L, et al. Disparities in receipt of screening tests for cancer, diabetes and high cholesterol in Ontario, Canada: a population-based study using area-based methods. *Can J Public Health* 2013;104:e284-90.
13. Elit L, Saskin R, Raut R, et al. Sociodemographic factors associated with cervical cancer screening coverage and follow-up of high grade abnormal results in a population-based cohort. *Gynecol Oncol* 2013;128:95-100.
14. Young TK, Kliewer E, Blanchard J, et al. Monitoring disease burden and preventive behavior with data linkage: cervical cancer among aboriginal people in Manitoba, Canada. *Am J Public Health* 2000;90:1466-8.
15. Decker KM, Demers AA, Kliewer EV, et al. Pap test use and cervical cancer incidence in First Nations women living in Manitoba. *Cancer Prev Res (Phila)* 2015;8:49-55.
16. Kerner J, Liu J, Wang K, et al. Canadian cancer screening disparities: a recent historical perspective. *Curr Oncol* 2015;22:156-63.
17. Voruganti T, Moineddin R, Jembere N, et al. Comparing stage of diagnosis of cervical cancer at presentation in immigrant women and long-term residents of Ontario: a retrospective cohort study. *CMAJ Open* 2016;4:E424-30.
18. Lofters AK, Hwang SW, Moineddin R, et al. Cervical cancer screening among urban immigrants by region of origin: a population-based cohort study. *Prev Med* 2010;51:509-16.
19. McGahan CE, Linn K, Guno P, et al. Cancer in First Nations people living in British Columbia, Canada: an analysis of incidence and survival from 1993 to 2010. *Cancer Causes Control* 2017;28:1105-16.
20. Census Profile, 2016 Census: British Columbia [Province] and Canada [Country]. Ottawa: Statistics Canada; modified 2019 Aug. 9. Available: www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=59&Geo2=&Code2=&SearchText=British Columbia&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=59&type=0 (accessed 2019 July 15).
21. Guide to the Census of Population, 2016: Chapter 1 — Introduction. Ottawa: Statistics Canada; modified 2019 Jan. 3. Available: www12.statcan.gc.ca/census-recensement/2016/ref/98-304/chap1-eng.cfm (accessed 2019 Jan. 27).
22. 2007 October Report of the Auditor General of Canada: Chapter 6 — Management of the 2006 Census — Statistics Canada. Ottawa: Office of the Auditor General of Canada; 2007. Available: www.oag-bvg.gc.ca/internet/English/parl_oag_200710_06_e_23830.html (accessed 2020 Sept. 11).
23. Individuals file, 2006 Census (Public Use Microdata Files). Public use microdata 95M0028X. Ottawa: Statistics Canada; 2010. Available: www150.statcan.gc.ca/n1/en/catalogue/95M0028X (accessed 2020 Feb. 27).

24. National Household Survey: final response rates. Ottawa: Statistics Canada; modified 2015 Dec. 31. Available: www12.statcan.gc.ca/nhs-enm/2011/ref/about-apropos/nhs-enm_r012.cfm?Lang=E (accessed 2019 Nov. 13).
25. Smith WR. The 2011 National Household Survey: the complete statistical story. Ottawa: Statistics Canada; 2015. Available: www.statcan.gc.ca/eng/blog-blogue/cs-sc/2011NHSstory (accessed 2020 Sept. 5).
26. Public Use Microdata Files (PUMFs), National Household Survey, 2011. Ottawa: Statistics Canada; modified 2016 Apr. 13. Availablewww12.statcan.gc.ca/nhs-enm/2011/dp-pd/pumf-fmgd/index-eng.cfm (accessed 2020 Feb. 27).
27. Canadian Community Health Survey: Public Use Microdata File. Public use microdata 82M0013X. Ottawa: Statistics Canada. Available: www150.statcan.gc.ca/n1/en/catalogue/82M0013X (accessed 2020 Feb. 27).
28. British Columbia: population estimates — How to use the population estimates application. Government of British Columbia. Available: https://bcstats.shinyapps.io/popApp/ (accessed 2020 Feb. 27).
29. About population estimates. Government of British Columbia. Available: www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-estimates/about-population-estimates (accessed 2020 Feb. 11).
30. *International Classification of Diseases for Oncology (ICD-O), third edition, first revision*. Geneva: World Health Organization; 2013.
31. Surveys and statistical programs; Census of Population — variables for 2016. Ottawa: Statistics Canada; modified 2017 Feb. 7. Available: www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvVariableList&Id=152274&db=IMDB (accessed 2020 Feb. 27).
32. Data catalogue: Community Health Service Areas — CHSA. Government of British Columbia. Available: https://catalogue.data.gov.bc.ca/dataset/community-health-service-areas-chsa (accessed 2020 Jan. 3).
33. Postal Code$^{\mathrm{OM}}$ Conversion File Plus (PCCF+). Geographic files and documentation 82F0086X. Ottawa: Statistics Canada; updated 2017 Mar. 6. Available: www150.statcan.gc.ca/n1/en/catalogue/82F0086X (accessed 2019 Jan. 1).
34. Boyle P, Parkin DM. Statistical methods for registries. *IARC Sci Publ* 1991;(95):126-58.
35. Table 051-0001: Population estimates on July 1st, by age and sex. Ottawa: Statistics Canada. Available: www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501 (accessed 2019 Oct. 1)
36. Lofters AK, McBride ML, Li D, et al. Disparities in breast cancer diagnosis for immigrant women in Ontario and BC: results from the CanIMPACT study. *BMC Cancer* 2019;19:42.
37. Blackwell DL, Martinez ME, Gentleman JF. Women's compliance with public health guidelines for mammograms and pap tests in Canada and the United States: an analysis of data from the Joint Canada/United States Survey Of Health. *Womens Health Issues* 2008;18:85-99.
38. Adegoke O, Kulasingam S, Virnig B. Cervical cancer trends in the United States: a 35-year population-based analysis. *J Womens Health (Larchmt)* 2012;21:1031-7.
39. *IARC monographs on the evaluation of carcinogenic risks to humans*. Volume 90: Human Papillomaviruses. Lyon (France): World Health Organization, International Agency for Research on Cancer; 2007.
40. Hislop TG, Teh C, Lai A, et al. Pap screening and knowledge of risk factors for cervical cancer in Chinese women in British Columbia, Canada. *Ethn Health* 2004;9:267-81.
41. Moore SP, Antoni S, Colquhoun A, et al. Cancer incidence in indigenous people in Australia, New Zealand, Canada, and the USA: a comparative population-based study. *Lancet Oncol* 2015;16:1483-92.
42. Jiang Y, Brassard P, Severini A, et al. The prevalence of human papillomavirus and its impact on cervical dysplasia in Northern Canada. *Infect Agent Cancer* 2013;8:25.
43. *First Nations Cancer Control in Canada Baseline Report*. Toronto: Canadian Partnership Against Cancer; 2013. Available: www.partnershipagainstcancer.ca/topics/disparities-in-cancer-control/# (accessed 2019 Oct. 1).
44. *Canada's residential schools: the legacy*. The final report of the Truth and Reconciliation Commission of Canada Volume 5. Winnipeg: Truth and Reconciliation Commission of Canada; 2015. Available: www.trc.ca/assets/pdf/Volume_5_Legacy_English_Web.pdf (accessed 2019 Oct. 1).
45. Examining disparities in cancer control: a system performance report. Toronto: Canadian Partnership Against Cancer; 2014. Available: www.partnershipagainstcancer.ca/topics/disparities-in-cancer-control/# (accessed 2019 Oct. 1).
46. Hanske J, Meyer CP, Sammon JD, et al. The influence of marital status on the use of breast, cervical, and colorectal cancer screening. *Prev Med* 2016;89:140-5.
47. Martínez ME, Anderson K, Murphy JD, et al. Differences in marital status and mortality by race/ethnicity and nativity among California cancer patients. *Cancer* 2016;122:1570-8.
48. Aizer AA, Chen M-H, McCarthy EP, et al. Marital status and survival in patients with cancer. *J Clin Oncol* 2013;31:3869-76.
49. Inverso G, Mahal BA, Aizer AA, et al. Marital status and head and neck cancer outcomes. *Cancer* 2015;121:1273-8.
50. Meyler D, Stimpson JP, Peek MK. Health concordance within couples: a systematic review. *Soc Sci Med* 2007;64:2297-310.
51. Liu J, Chadder J, Fung S, et al. Smoking behaviours of current cancer patients in Canada. *Curr Oncol* 2016;23:201-3.
52. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Personal habits and indoor combustions. Volume 100 E. A review of human carcinogens. *IARC Monogr Eval Carcinog Risks Hum* 2012;100:1-538.
53. Plummer M, Herrero R, Franceschi S, et al.; IARC Multi-centre Cervical Cancer Study Group. Smoking and cervical cancer: pooled analysis of the IARC multi-centric case — control study. *Cancer Causes Control* 2003;14:805-14.
54. BC cancer registry certification results from North American Association of Central Cancer Registries NAACCR. Vancouver: Cancer BC. Available: www.bccancer.bc.ca/statistics-and-reports-site/Documents/naaccr-certification-results.pdf (accessed 2020 Sept. 7).
55. Sarfati D, Garvey G, Robson B, et al. Measuring cancer in indigenous populations. *Ann Epidemiol* 2018;28:335-42.

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