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Investigating epidemiologic trends and the geographic distribution of patients with anal squamous cell carcinoma throughout Canada

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ABSTRACT

Background Anal cancer is a rare disease, constituting 0.5% of new cancer cases in the United States. The most common subtype is squamous cell carcinoma (SCC). Studies in several developed nations have reported on an increasing incidence of anal cancer in recent decades, and various risk factors pertaining to the pathogenesis of the disease have been identified, including infection with the human papillomavirus, tobacco use, and immunosuppression. The epidemiology and distribution of anal SCC throughout Canada remain poorly understood, however.

Methods Using 3 population-based cancer registries, a retrospective analysis of demographic data across Canada for 1992–2010 was performed. The incidence and mortality for anal SCC was examined at the levels of provinces, cities, and the forward sortation area (FSA) component (first 3 characters) of postal codes.

Results During 1992–2010, 3720 individuals were diagnosed with anal SCC in Canada; 64% were women. The overall national incidence rate was 6.3 cases per million population per year, with an average age at diagnosis of 60.4 years. The incidence increased over time, with significantly higher incidence rates documented in British Columbia and Nova Scotia (9.3 cases per million population each). Closer examination revealed clustering of cases in various urban centres and self-identified LGBTQ communities in Toronto, Montreal, and Vancouver.

Discussion This study provides, for the first time, a comprehensive analysis of the burden of anal SCC in Canada, identifying susceptible populations and shedding light onto novel avenues of research to lower the incidence of anal cancer throughout the country.

Key Words Anal cancer, anorectal cancer, anorectal adenocarcinoma, anal squamous cell carcinoma, geographic clustering, epidemiology, incidence in Canada

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INTRODUCTION

Anal cancer is one of the least common malignancies worldwide, representing only 2.4% of all gastrointestinal cancers[1]. Cancers of the anal canal can be divided into several subtypes, the most common being squamous cell carcinoma (SCC), which accounts for 85% of reported cases[2,3]. The precursor lesion to anal SCC is an anal intraepithelial neoplasia[4], which can be further classified as either a low-grade or a high-grade squamous intraepithelial neoplasm[4]. The most common symptom at presentation of anal cancer is anorectal bleeding[5]. Treatment of anal cancer depends heavily on the grade and stage of the neoplasm; a multimodal approach is frequently required[6].

Various risk factors are implicated in the pathogenesis of this malignancy, including infection with the human papillomavirus (HPV), tobacco use, advanced age, and immunosuppression (such as in the case of HIV/AIDS or receipt

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of a solid organ transplant)[7,8]. In addition, risk factors related to sexual practices such as anal receptive intercourse and having multiple sexual partners have been linked to a higher incidence of anal SCC[3]. A history of dysplasia or malignancy of the cervix, vagina, or vulva has also been found to increase the risk[3]. Current data demonstrate that, in approximately 90% of all cases of anal SCC, positivity for HPV infection is seen, with most of those infections (approximately 79%) being attributed to HPV strains 16 and 18[3,9].

Previous epidemiologic analyses of data from the U.S. Surveillance, Epidemiology, and End Results program[10] found that anal cancer constitutes only 0.5% of new cancer cases in the United States[10]. The median age of diagnosis is reported to be approximately 60 years[5]. However, although this cancer is relatively uncommon, several epidemiologic studies have reported an increasing incidence in recent decades, particularly in developed countries such as Australia[11], Scotland[12], France[13], Denmark[14], and the United States[2,15]. In Canada, limited studies have reported rising rates of anal SCC in Quebec and Alberta in recent years[16,17]. Because of a low anal cancer incidence rate, the epidemiology of this malignancy is generally poorly documented, and studies describing its epidemiologic characteristics are sparse. For the present study, we conducted an extensive epidemiologic analysis of the burden of anal SCC across all provinces and territories in Canada between 1992 and 2010. The geographic distribution of patients in Canada was analyzed with the aim of better understanding the risk factors related to the pathogenesis of this neoplasm and of identifying communities at high risk for anal SCC.

METHODS

Our study was conducted in accordance with the CISSRDC-668035 and 13-SSH-MCG-3749-S001 protocols approved by, respectively, the Social Sciences and Humanities Research Council of Canada and the Québec Inter-University Center for Social Statistics. In accordance with institutional policy, the study also received an exemption from review by the McGill University Research Ethics Board. The data for anal SCC incidence was examined using two distinct population-based cancer databases: the Canadian Cancer Registry and the Registre québécois du cancer for 1992–2010. Codes set out in the *International Classification of Diseases for Oncology,* 3rd edition, were used for 2 subtypes of anal SCC as reported in previous studies by the authors[18–41]. To assess causes of mortality, we used the Canadian Vital Statistics database, applying topographic codes from the *International Statistical Classification of Diseases and Related Health Problems,* 9th revision (ICD-9) for deaths occurring during 1992–1999 and 10th revision (ICD-10) for deaths occurring during 2000–2010. Because of space limitations, detailed methods are presented in supplementary Appendix 1.

RESULTS

Demographic and Epidemiologic Characteristics of Patients with Anal SCC in Canada

The subtypes of anal SCC examined using information gathered from the Canadian Cancer Registry and the Registre québécois du cancer included SCC and verrucous carcinoma. Given that approximately 98% of cases in the database corresponded to the SCC histology, a further breakdown of demographic data by subtype was not performed.

Table I presents a general overview of epidemiologic characteristics of anal SCC in Canada for the selected time period. Of 3720 total patients diagnosed with anal SCC, most (64%) were women, for a female:male incidence ratio of 1.8:1. The average age at diagnosis was 60.4 ± 1.6 years, with 74% of the patients being more than 50 years of age. Overall, the annual incidence of anal SCC showed a steady upward trend [Figure 1(A)]. In 1992, the incidence rate was 3.7 cases per million population per year; in 2010, it had risen to approximately 9.0 cases, representing an increase of 142% over 18 years. A notable increase in the incidence rate in 2007 corresponded to a rate of 9.7 cases per million population per year. When examining the annual incidence by sex, a general upward trend over the years was noted [Figure 1(B)], with the highest incidence consistently being seen for women.

A relationship between anal SCC incidence rates and socioeconomic status (SES) was evident. The incidence rates were significantly lower in the highest SES quintile compared with the lowest SES quintile (incidence rate ratio for SES Q5 vs. Q1: 0.20; 95% confidence interval: 0.11 to 0.37). With respect to ethnicity, incidence rates were higher in $Q5_{white}$ (highest-SES white individuals) than in $Q1_{white}$ (lower-SES white individuals), with an incidence rate ratio of 1.16. However, that increase was not statistically significant (95% confidence interval: 0.99 to 1.36).

Geographic Distribution of Anal SCC Cases in Canada

The average national incidence rate for anal SCC during 1992–2010 was 6.3 cases per million population per year (Table I). Figure 2 presents a geographic analysis of trends in anal SCC throughout the country. On the provincial level, Nova Scotia and British Columbia had incidence rates significantly higher than the national average, at 9.31 cases per million population each. In contrast, Manitoba, Saskatchewan, and Newfoundland and Labrador had significantly lower incidence rates of 5.0, 4.4, and 3.9 cases per million respectively. Prince Edward Island, New Brunswick, Quebec, Ontario, and Alberta had incidence rates that matched the national average. Although the frequencies of anal SCC in the 3 Canadian territories were examined, those frequencies were not within a reportable range.

Incidence rates for Canadian cities (Table II) corroborated the foregoing trends. In total, 120 cities with a reportable frequency of anal SCC between 1992 and 2010 were identified. Of those cities, only 10 had incidence rates significantly higher than the national average. Strikingly, 7 of them (70%) were located in British Columbia, 2 (20%) in Ontario, and 1 (10%) in Nova Scotia. Conversely, of the 12 significantly low-incidence cities identified in Canada during the period of interest, 9 (75%) were located in Ontario; the remaining 3 (25%) were in Quebec.

The distribution within cities or rural areas of patients with anal SCC was then analyzed by the forward sortation area (FSA) component (first 3 characters) of postal codes (Table III, Figures 3–5). Of the 56 high-incidence FSAs identified,

TABLE I Epidemiologic characteristics of anal squamous cell carcinoma, Canada, 1992–2010

Characteristic	Incidence	Mortality
Total patients *(n)*	3720	1110
Sex [*n* (%)]		
Men	1325 (36)	475 (43)
Women	2395 (64)	635 (57)
Age group *(n)*		
<10 Years	0	0
10–19 Years	20	0
20–29 Years	10	0
30–39 Years	205	30
40–49 Years	720	110
50–59 Years	950	210
60–69 Years	785	250
70–79 Years	660	255
80–89 Years	345	195
≥90 Years	30	45
Average age (years)	60.42±1.58	67.37±3.21
Annual cases (*n* pmp)		
Average	6.27	1.84
95% CI	6.07 to 6.48	1.74 to 1.96

pmp = per million population; CI = confidence interval.

21 (37.5%) were identified in Ontario; 17 (30.4%) in British Columbia; 10 (17.9%) in Quebec; 2 each (3.6%) in Nova Scotia, New Brunswick, and Alberta; and 1 each (1.7%) in Manitoba and Saskatchewan.

A notably high incidence was found for the M4Y FSA, representing the borough of Church and Wellesley in downtown Toronto, Ontario, with a rate of 46.4 cases per million population per year (95% confidence interval: 28.4 to 71.7), an incidence approximately 7.5 times the national average. A cluster of high-incidence FSAs surrounds Church and Wellesley in Toronto [Figure 3(A)], encompassing High Park/The Junction (M6P), Harbourfront/Regent Park (M5A), St. James Town (M4X), East York (M4J), and North York (M3C). Similarly, a cluster of high-incidence FSAs was identified in the city of Montreal [Figure 3(B)], encompassing Montréal-Nord (H1H), Hochelaga (H1W), Saint-Michel (H2A), Centre-Sud (H2K, H2L), Côte-des-Neiges (H3W), Southern Westmount (H3Z), and Verdun (H4G).

Several notable clusters of anal SCC cases were found in the province of British Columbia. The first (Figure 4) covers a significant part of south Vancouver Island (V0R), Duncan (V9L), and Victoria (V9B, V9A, V8T, V8V). The second (Figure 5) encompasses areas of downtown Vancouver such as West Vancouver (V7V), West End and Stanley Park (V6G), Davie Village (V6E), and the Downtown Eastside (V6A).

Table III identifies 3 statistically significant zero-incidence FSAs in Fredericton, New Brunswick (E3G), Stoneham-et-Tewkesbury, Quebec (G3C), and Sturgeon Country, Alberta (T8T). Of the 56 high-incidence FSAs identified, only 10 (18%) were located in rural areas across the country (Table IV).

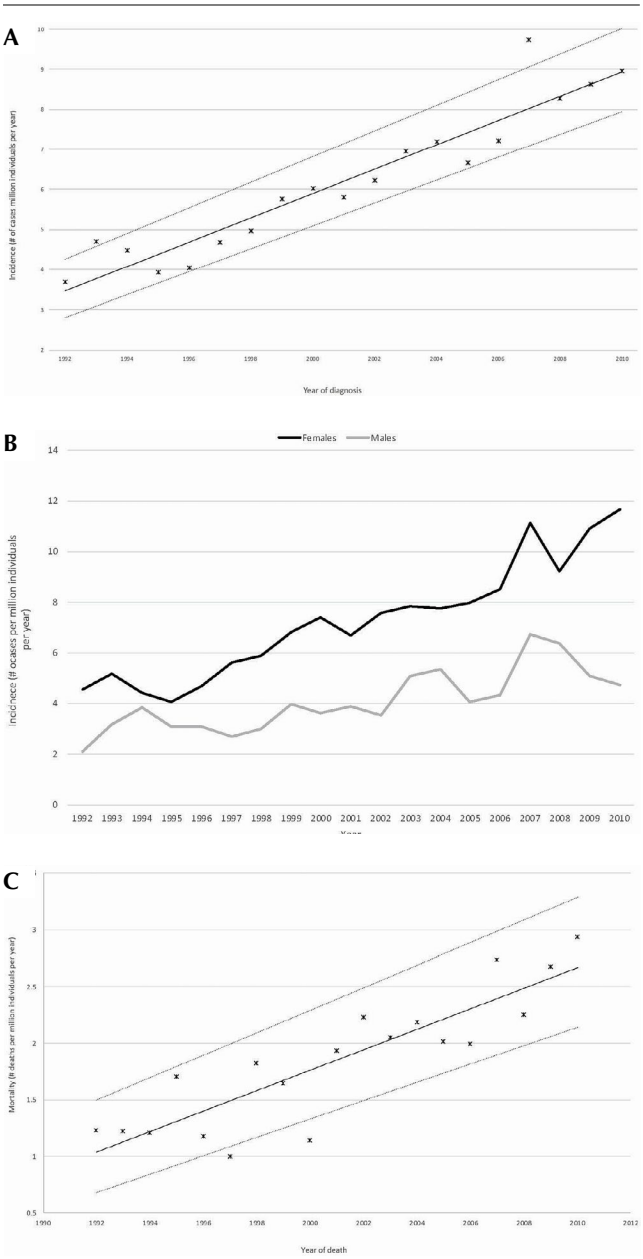

FIGURE 1 Incidence and mortality rates for anal squamous cell carcinoma over time (cases per million population per year), Canada, 1992–2010. (A) Changing incidence rates. Linear regression analysis: $R^2 = 0.90$; $p = 0.002$. The slope of the line was 0.30 cases per million population per year. Dotted lines indicate the 95% confidence interval. (B) Change in incidence by sex. (C) Change in mortality. Linear regression analysis: $R^2 = 0.77$; $p = 0.002$. The slope of the line was 0.091 cases per million population per year. Dotted lines indicate the 95% confidence interval.

Analysis of Mortality from Anal Canal Cancer Across Canada

Table I presents a general overview of the epidemiologic characteristics of anal cancer mortality. Overall, 1110 patients died of anal cancer between 1992 and 2010 in Canada. Most were women (57% vs. 43% men), with a female:male incidence ratio of 1.3:1. The average age at death was 67.4 ± 3.2 years.

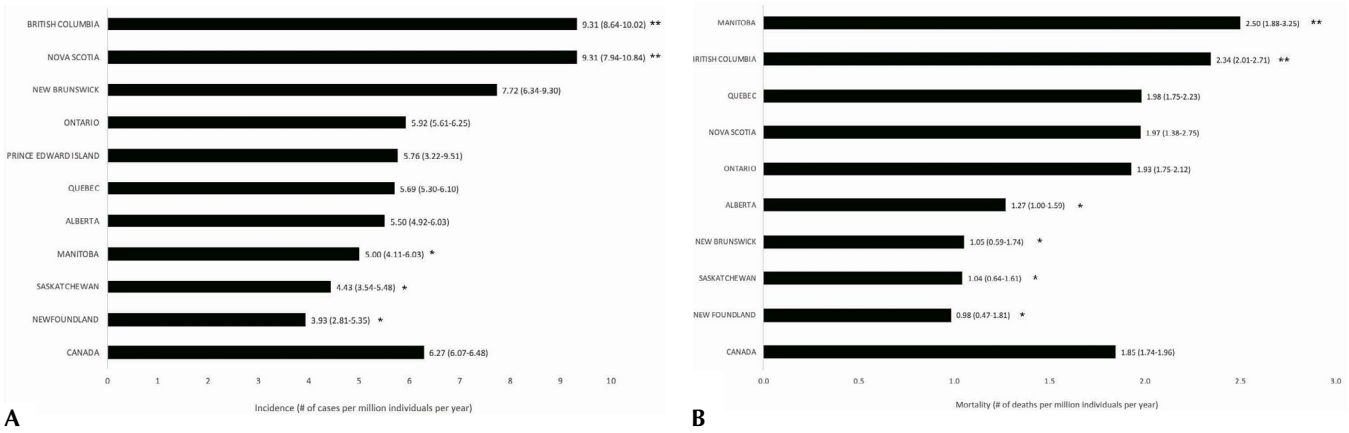

FIGURE 2 Incidence and mortality of anal squamous cell carcinoma by province and for Canada (cases per million population per year), 1992–2010. (A) Incidence rates. *Statistically significant lower incidence rate ($p < 0.05$) compared with Canada. **Statistically significant higher incidence rate ($p < 0.05$) compared with Canada. (B) Mortality rates. *Statistically significant lower mortality rate ($p < 0.05$) compared with Canada. **Statistically significant higher mortality rate ($p < 0.05$) compared with Canada.

TABLE II Incidence of anal squamous cell carcinoma relative to incidence for Canada, Canadian cities, 1992–2010

City	Province	Frequency[a]	Population[b]	Annual incidence (pmp)	95% CL	
					Lower	Upper
Canada overall				6.27	6.07	6.48
High-incidence cities						
Vancouver	BC	105	560,000	9.86	8.07	11.94
Langley	BC	20	91,000	11.54	7.04	17.82
Saanich	BC	25	106,000	12.44	8.05	18.37
Penticton	BC	10	32,000	16.61	7.95	30.55
New Westminster	BC	20	57,000	18.43	11.25	28.46
North Cowichan	BC	10	27,000	19.53	9.35	35.92
Georgina	ON	15	40,000	19.75	11.04	32.57
East Hants	NS	10	21,000	25.04	11.99	46.05
Victoria	BC	40	76,000	27.54	19.68	37.51
Carleton Place	ON	5	9,000	28.57	9.21	66.68
Low-incidence cities						
Vaughan	ON	5	210,000	1.25	0.40	2.92
Scarborough	ON	15	559,000	1.41	0.79	2.33
North York	ON	20	590,000	1.78	1.09	2.76
Richmond Hill	ON	5	146,000	1.81	0.58	4.22
Lévis	QC	5	134,000	1.96	0.63	4.57
Etobicoke	ON	15	365,000	2.16	1.21	3.57
Markham	ON	10	236,000	2.23	1.07	4.10
Mississauga	ON	30	635,000	2.49	1.68	3.55
Quebec City	QC	25	504,000	2.61	1.69	3.85
Brampton	ON	20	388,000	2.71	1.66	4.19
Gatineau	QC	15	254,000	3.11	1.74	5.13
Greater Sudbury	ON	10	160,000	3.30	1.58	6.06

[a] Rounded to the nearest 5.
[b] Rounded to the nearest thousand.
pmp = per million population; CL = confidence limits.

TABLE III Populous forward sortation areas (FSAs) with a high or zero incidence of anal squamous cell carcinoma, Canada, 1992–2010

FSA	Province	Frequency	Population[a]	Annual incidence (pmp)	95% CL	
					Lower	Upper
High-incidence FSAs						
B0K	NS	10	38,390	13.71	6.56	25.21
B3A	NS	10	20,440	25.75	12.33	47.36
E1C	NB	10	29,160	18.05	8.64	33.20
E7M	NB	5	9,700	27.13	8.74	63.31
H1H	QC	10	34,700	15.17	7.26	27.90
H1W	QC	10	28,140	18.70	8.95	34.40
H2A	QC	10	18,510	28.43	13.61	52.29
H2K	QC	15	27,080	29.15	16.30	48.09
H2L	QC	10	22,250	23.65	11.32	43.50
H3W	QC	10	31,110	16.92	8.10	31.11
H3Z	QC	5	11,680	22.53	7.26	52.58
H4G	QC	10	28,700	18.34	8.78	33.73
J2G	QC	10	36,570	14.39	6.89	26.47
J4K	QC	10	25,480	20.66	9.89	37.99
K0G	ON (Eastern)	10	33,410	15.75	7.54	28.97
K0L	ON (Eastern)	15	68,320	11.56	6.46	19.06
K1L	ON (Eastern)	10	17,310	30.41	14.56	55.92
K8P	ON (Eastern)	10	20,490	25.69	12.30	47.24
L0M	ON (Central)	10	31,170	16.89	8.08	31.05
L1G	ON (Central)	10	41,740	12.61	6.04	23.19
L2R	ON (Central)	10	24,670	21.33	10.21	39.24
L4P	ON (Central)	10	24,330	21.63	10.36	39.79
L6K	ON (Central)	5	12,650	20.80	6.70	48.55
L8K	ON (Central)	10	32,510	16.19	7.75	29.77
L8L	ON (Central)	10	33,520	15.70	7.52	28.88
M3C	ON (Toronto)	10	35,780	14.71	7.04	27.05
M4J	ON (Toronto)	10	35,710	14.74	7.06	27.11
M4K	ON (Toronto)	10	32,250	16.32	7.81	30.01
M4X	ON (Toronto)	10	20,740	25.38	12.15	46.67
M4Y	ON (Toronto)	20	22,660	46.45	28.36	71.75
M5A	ON (Toronto)	10	32,840	16.03	7.67	29.48
M6P	ON (Toronto)	10	37,400	14.07	6.74	25.88
N6C	ON (Southern)	10	32,200	16.35	7.83	30.06
N9C	ON (Southern)	5	12,810	20.54	6.62	47.94
P0K	ON (Northern)	5	12,270	21.45	6.91	50.05
R3B	MB	5	11,580	22.73	7.32	53.03
S7K	SK	10	39,180	13.43	6.43	24.71
T0E	AB	10	40,240	13.08	6.26	24.06
T3B	AB	10	34,780	15.13	7.24	27.83
V0B	BC	10	32,860	16.02	7.67	29.46
V0H	BC	15	50,980	15.49	8.66	25.54
V0R	BC	15	64,150	12.31	6.88	20.30
V0X	BC	10	19,960	26.37	12.62	48.50
V1R	BC	5	9,950	26.45	8.52	61.72
V2A	BC	10	35,040	15.02	7.19	27.63

TABLE III Continued

FSA	Province	Frequency	Population[a]	Annual incidence (pmp)	95% CL	
					Lower	Upper
High-incidence FSAs, continued						
V3M	BC	10	34,410	15.30	7.32	28.13
V4A	BC	10	34,870	15.09	7.23	27.76
V6A	BC	10	16,530	31.84	15.24	58.56
V6E	BC	15	22,550	35.01	19.58	57.75
V6G	BC	20	24,280	43.35	26.47	66.96
V7V	BC	10	15,000	35.09	16.80	64.53
V8T	BC	10	18,150	29.00	13.88	53.33
V8V	BC	20	23,770	44.28	27.04	68.40
V9A	BC	15	34,760	22.71	12.70	37.46
V9B	BC	10	32,330	16.28	7.79	29.94
V9L	BC	10	31,560	16.68	7.98	30.67
Zero-incidence FSAs						
T8T	AB	0	5,360	0	0	36.02
G3C	QC	0	7,660	0	0	25.20
E3G	NB	0	8,120	0	0	23.78

[a] Rounded to the nearest 10.
pmp = per million population; CL = confidence limits.

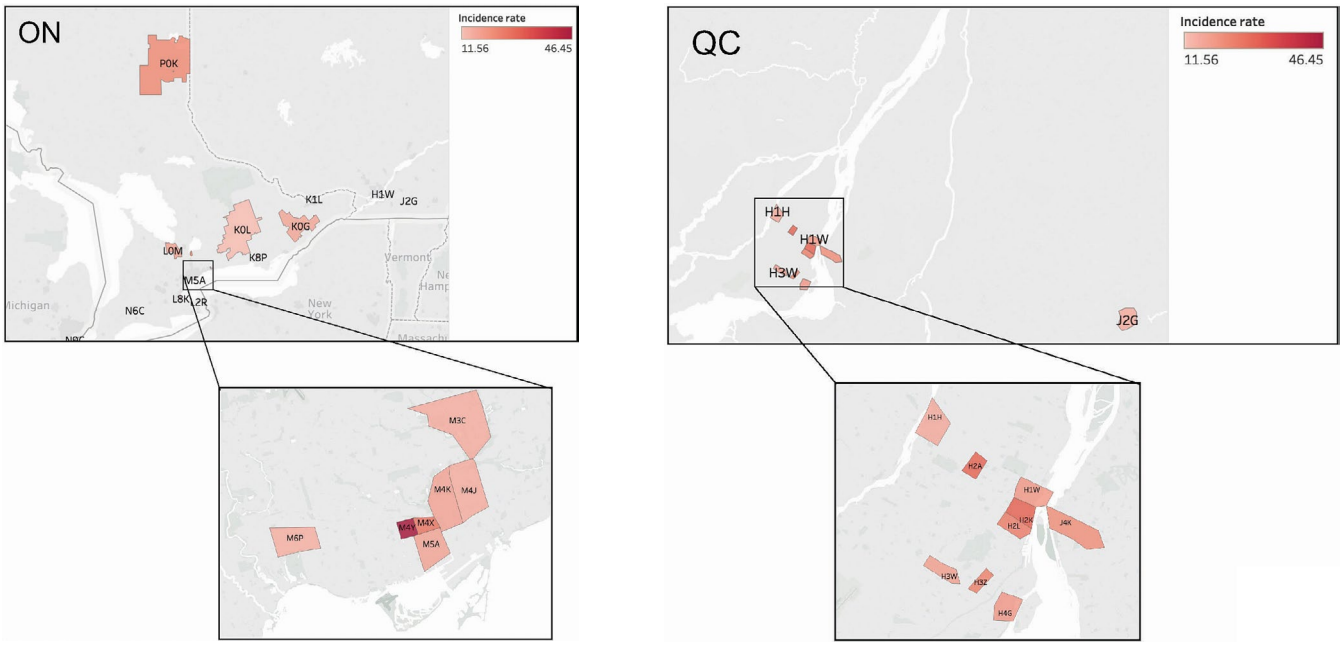

FIGURE 3 Incidence rate trends relative to the national average for anal squamous cell carcinoma (cases per million population per year) by forward sortation area [FSA (first 3 characters of a postal code)]. Based on the Canadian Cancer Registry and the Registre québécois du cancer databases. (A) Ontario: high-incidence FSAs in the Greater Toronto Area, including the highest incidence FSA, M4Y, representing the borough of Church and Wellesley in downtown Toronto. (B) Quebec: high-incidence FSAs in the Greater Montreal Area.

The annual mortality from anal cancer showed an overall upward trend [Figure 1(C)]. In 1992, the mortality rate was 1.2 cases per million population per year; in 2010, that rate had risen to 2.9 cases, representing an increase of 138% over 18 years. The average national mortality rate for anal cancer between 1992 and 2010 was 1.8 cases per million population per year. Tables V and VI and Figure 6 present a geographic analysis of anal cancer mortality

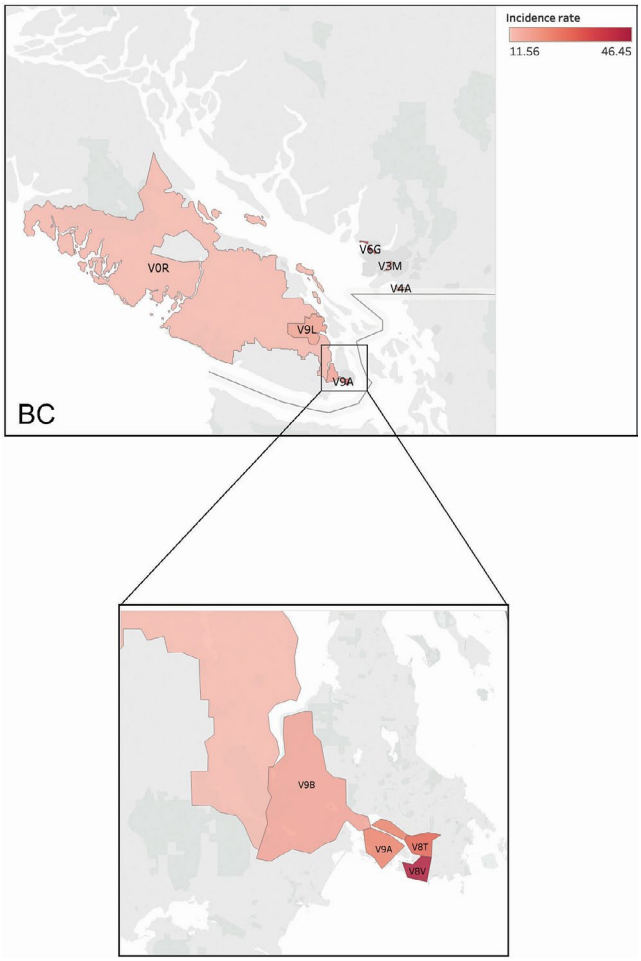

FIGURE 4 Incidence rate trends relative to the national average for anal squamous cell carcinoma (cases per million population per year) by forward sortation area [FSA (first 3 characters of a postal code)] in British Columbia. High-incidence FSAs on Vancouver Island and in Duncan and Victoria are highlighted. Based on the Canadian Cancer Registry database.

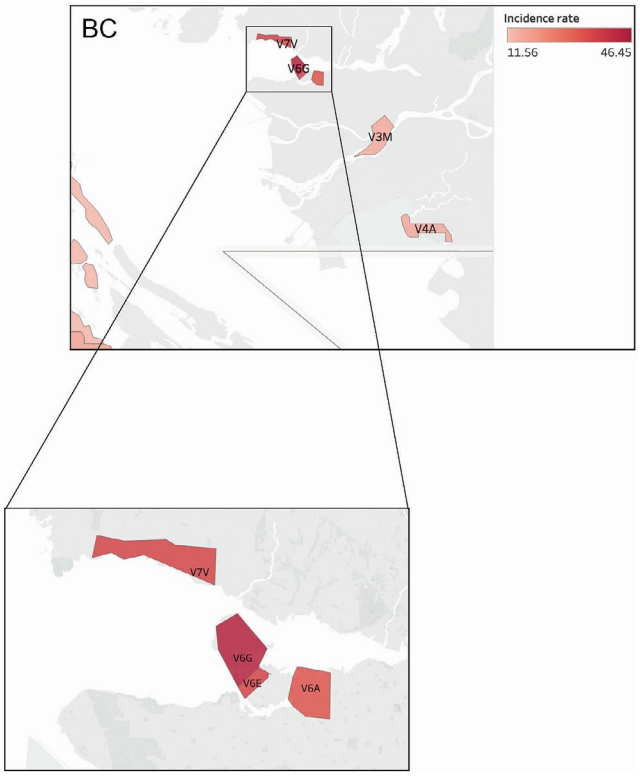

FIGURE 5 Incidence rate trends relative to the national average for anal squamous cell carcinoma (cases per million population per year) by forward sortation area [FSA (first 3 characters of a postal code)] in British Columbia. High-incidence FSAs in downtown Vancouver, Surrey, and New Westminster are highlighted. Based on the Canadian Cancer Registry database.

trends throughout the country. Further analysis of those results can be found in supplementary Appendix 2.1.

DISCUSSION

In this report, we present extensive data on the epidemiology of anal SCC throughout Canada during 1992–2010 at the provincial, municipal, and FSA levels. To the best of our knowledge, no previous study has assessed the distribution of anal SCC across the entire country and to this level of detail. At the national level, we report a steadily increasing burden of anal SCC, with a female predominance and an average incidence rate of 6.3 cases per million individuals per year. Similar trends have been observed in several studies conducted in Europe, Australia, and the United States[11,13,15,43,44]. The results of those studies are further detailed in supplementary Appendix 3.1. Geographic analysis of anal SCC trends throughout the country demonstrated clustering of cases in the 3 largest cities in Canada, located in the provinces of Ontario [Figure 3(A)], Quebec [Figure 3(B)], and British Columbia (Figures 4 and 5). The highest incidence of anal SCC nationwide was located in the borough of Church and Wellesley, an area known as "The Village," a historic neighborhood for LGBTQ communities[45,46]. Similarly, significant clusters were found in Montreal's Gay Village and Vancouver's Davie Village[47,48]. The others corresponded to the boroughs predominantly inhabited by low-income or immigrant populations[49–53]. Those findings are corroborated by our analysis of median income by FSA, which demonstrated a statistically significant relationship between low SES and a high incidence rate of anal SCC. Further details concerning those FSA clusters are provided in supplementary Appendix 3.2.

We report a significantly higher incidence of anal SCC in urban areas, with only 18% of cases found in rural FSAs. The same trend has been noted in Norway and the United States[44,54]. This predilection of anal SCC for urban centres might reflect an increased concentration of individuals exposed to predisposing risk factors for the disease—namely, changes in sexual practices leading to increased HPV transmission, tobacco use, and HIV infection. Changes in sexual practices throughout the world, such as lower age at first intercourse, higher number of sexual partners, and increased practice of anal receptive intercourse, might be contributing to the increasing incidence of anal SCC[55–57]. The increased incidence of this disease was observed in

TABLE IV Populous urban and rural forward sortation areas (FSAs) with a high incidence of anal squamous cell carcinoma, Canada, 1992–2010

FSA	Province	Frequency	Population[a]	Annual incidence (pmp)	95% CL	
					Lower	Upper
Urban						
B3A	NS	10	20,440	25.75	12.33	47.36
E1C	NB	10	29,160	18.05	8.64	33.20
E7M	NB	5	9,700	27.13	8.74	63.31
H1H	QC	10	34,700	15.17	7.26	27.90
H1W	QC	10	28,140	18.70	8.95	34.40
H2A	QC	10	18,510	28.43	13.61	52.29
H2K	QC	15	27,080	29.15	16.30	48.09
H2L	QC	10	22,250	23.65	11.32	43.50
H3W	QC	10	31,110	16.92	8.10	31.11
H3Z	QC	5	11,680	22.53	7.26	52.58
H4G	QC	10	28,700	18.34	8.78	33.73
J2G	QC	10	36,570	14.39	6.89	26.47
J4K	QC	10	25,480	20.66	9.89	37.99
K1L	ON (Eastern)	10	17,310	30.41	14.56	55.92
K8P	ON (Eastern)	10	20,490	25.69	12.30	47.24
L1G	ON (Central)	10	41,740	12.61	6.04	23.19
L2R	ON (Central)	10	24,670	21.33	10.21	39.24
L4P	ON (Central)	10	24,330	21.63	10.36	39.79
L6K	ON (Central)	5	12,650	20.80	6.70	48.55
L8K	ON (Central)	10	32,510	16.19	7.75	29.77
L8L	ON (Central)	10	33,520	15.70	7.52	28.88
M3C	ON (Toronto)	10	35,780	14.71	7.04	27.05
M4J	ON (Toronto)	10	35,710	14.74	7.06	27.11
M4K	ON (Toronto)	10	32,250	16.32	7.81	30.01
M4X	ON (Toronto)	10	20,740	25.38	12.15	46.67
M4Y	ON (Toronto)	20	22,660	46.45	28.36	71.75
M5A	ON (Toronto)	10	32,840	16.03	7.67	29.48
M6P	ON (Toronto)	10	37,400	14.07	6.74	25.88
N6C	ON (Southern)	10	32,200	16.35	7.83	30.06
N9C	ON (Southern)	5	12,810	20.54	6.62	47.94
R3B	MB	5	11,580	22.73	7.32	53.03
S7K	SK	10	39,180	13.43	6.43	24.71
T3B	AB	10	34,780	15.13	7.24	27.83
V1R	BC	5	9,950	26.45	8.52	61.72
V2A	BC	10	35,040	15.02	7.19	27.63
V3M	BC	10	34,410	15.30	7.32	28.13
V4A	BC	10	34,870	15.09	7.23	27.76
V6A	BC	10	16,530	31.84	15.24	58.56
V6E	BC	15	22,550	35.01	19.58	57.75
V6G	BC	20	24,280	43.35	26.47	66.96
V7V	BC	10	15,000	35.09	16.80	64.53
V8T	BC	10	18,150	29.00	13.88	53.33
V8V	BC	20	23,770	44.28	27.04	68.40
V9A	BC	15	34,760	22.71	12.70	37.46
V9B	BC	10	32,330	16.28	7.79	29.94
V9L	BC	10	31,560	16.68	7.98	30.67

TABLE IV Continued

FSA	Province	Frequency	Population[a]	Annual incidence (pmp)	95% CL	
					Lower	Upper
Rural						
B0K	NS	10	38,390	13.71	6.56	25.21
K0G	ON (Eastern)	10	33,410	15.75	7.54	28.97
K0L	ON (Eastern)	15	68,320	11.56	6.46	19.06
L0M	ON (Central)	10	31,170	16.89	8.08	31.05
P0K	ON (Northern)	5	12,270	21.45	6.91	50.05
T0E	AB	10	40,240	13.08	6.26	24.06
V0B	BC	10	32,860	16.02	7.67	29.46
V0H	BC	15	50,980	15.49	8.66	25.54
V0R	BC	15	64,150	12.31	6.88	20.30
V0X	BC	10	19,960	26.37	12.62	48.50

[a] Rounded to the nearest 10.
pmp = per million population; CL = confidence limits.

TABLE V Mortality from anal cancer in high-mortality and low-mortality cities compared with the average mortality rate from anal cancer, Canada, 1992–2010

City	Province	Frequency[a]	Population[b]	Annual incidence (pmp)	95% CL	
					Lower	Upper
Canada overall				1.84	1.74	1.96
High-mortality cities						
Winnipeg	MB	35	649,000	2.84	1.98	3.95
Montreal	QC	100	1,635,000	3.22	2.62	3.92
Vancouver	BC	40	591,000	3.56	2.54	4.85
London	ON	25	359,000	3.67	2.37	5.41
Langley	BC	10	99,000	5.32	2.55	9.78
Cornwall	ON	5	46,340	5.68	1.84	13.25
Victoria	BC	15	79,000	9.99	5.59	16.48
Greenfield Park	QC	5	17,160	15.34	4.98	35.79
Low-mortality cities						
Mississauga	ON	5	691,000	0.38	0.12	0.89
North York	ON	5	590,000	0.45	0.14	1.04
Scarborough	ON	5	559,000	0.47	0.15	1.10
Surrey	BC	5	432,000	0.61	0.20	1.42
Laval	QC	5	385,000	0.68	0.22	1.60

[a] Rounded to the nearest 5.
[b] Rounded to the nearest 1000.
pmp = per million population; CL = confidence limits.

TABLE VI Populous forward sortation areas (FSAs) with high anal cancer mortality, Canada, 1992–2010

FSA	Province	Frequency	Population[a]	Annual incidence (pmp)	95% CL	
					Lower	Upper
V6E	BC	5	22,550	11.67	3.79	27.23
H4L	QC	5	32,940	7.99	2.59	18.64
V0N	BC	5	77,040	3.42	1.11	7.97
J0K	QC	5	132,200	1.99	0.65	4.65

[a] Rounded to the nearest 1000.

Western countries[58,59]. Tobacco use has been cited as a risk factor for anal SCC[60]; however, the rate of tobacco use throughout Canada has been steadily decreasing[61], and therefore might not be one of the most contributory risk factors in this population. Infection with HIV has also been cited as an important risk factor for the pathogenesis of anal SCC[62], and its prevalence throughout Canada has been increasing, particularly in men having sex with men (MSM), representing 47% of national cases in 2011[40]. Clustering of HIV cases in MSM has been noted in Ontario, Quebec, and British Columbia[40], and in fact, we report clustering of anal SCC cases in the FSAs that encompass the 3 largest self-identified LGBTQ communities in the country, which are also located in those 3 provinces. Similar trends have been observed worldwide and have been attributed to higher proportions of MSM, leading to an increased prevalence of anal receptive intercourse[63]. Data for the prevalence of LGBTQ-identifying individuals by FSA were not available for our study. However, in parts of the world where that information has been available, similar trends have been observed; they are detailed in supplementary Appendix 3.3.

The incidence of HPV-related cancers is increasing internationally[64]; however, it appears that the frequency of anal SCC is increasing the most dramatically of all—in both sexes and most ethnic groups[64]. Despite those observations, no national anal SCC screening guidelines are in place[54]. Since 2010, widespread HPV vaccination programs have been instituted across Canada, leading to significant declines in the prevalences of HPV, anogenital warts, and cervical cancer in every province[65–67]. Cervical cancer and anal SCC have both been strongly linked to the same particular strain, HPV 16[68,69]. Cost–benefit analyses of anal cancer screening in women with cervical cancer[70] and in MSM with and without concomitant HIV infection[71–74] have shown that vaccine campaigns against HPV 16, regular digital rectal examination, and anal Pap smear screening could be beneficial in reducing morbidity and mortality from the disease. Given the increasing rate of anal SCC and lack of knowledge about this disease in high-risk groups[72,75,76], it might be useful to consider instituting screening or vaccination programs for susceptible populations in the Canadian urban centres with higher incidences.

It is often believed that routine screening for anal cancer could cause physical and psychological discomfort to patients, but a study performed in 2011 in Toronto found that only 15%–32% of 104 regularly screened patients reported negative psychological consequences associated with the screening process[77]. In fact, the largest barrier to care for these high-risk patient groups, both male and female, is the lack of knowledge and awareness about the disease, its risk factors, and the available prevention and screening resources[78–80]. Through this study, our group has provided data that can be used to target populations within each province affected by a high burden of anal SCC, consequently providing increased opportunities and needs for intervention and outreach. The information we have compiled might help to guide community health ambassadors in developing targeted and culturally appropriate education and promotion campaigns to raise awareness of the risk factors for anal cancer, of screening methods, and of HPV vaccination. Primary health care workers within affected communities can be encouraged to incorporate screening questionnaires, relevant physical exams, and HPV vaccination more readily into their practice, and they in turn can encourage their patients to perform self-directed anal visual inspection regularly at home[81]. Our results could be further correlated with demographic information (such as education level, income, employment status, location and accessibility of medical specialists in the region) from other Canadian studies, to contribute to health care policy development and resource allocation.

Our study is not without limitations; large retrospective studies that use databases such as those used here present a risk of data omission or misclassification. When conducting our search, different sets of ICD codes had to be used, depending on the year of interest. Data for the Canadian territories were generally sparse, and therefore not sufficiently statistically significant to comment on. Data concerning the prevalence of various sexual orientations and sexual practices by region were not available for our study, but might have strengthened the clustering trends observed. Finally, because of federal confidentiality regulations and the associated mandatory rounding and suppression of data at too-low frequencies, the data obtained could not be presented in their entirety.

CONCLUSIONS

This epidemiology study highlights areas of clustering of anal SCC throughout Canada, localizing it to the 3 main urban centres: Toronto, Montreal, and Vancouver. We provide an overview of risk factors to consider, particularly in susceptible populations in the inner cities and in LGBTQ-predominant communities. Future analyses might confirm the existence of those risk factors in those communities. Our report also provides the basis for highlighting areas of Canada that could benefit from more efforts in education, primary prevention, and screening for the disease, and more focused distribution of health care resources to lower the incidence, morbidity, and mortality relating to anal cancer throughout the country.

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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.

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