Rates of Cancer Incidence Across Terciles of the Foreign-born Population in Canada From 2001-2006

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ABSTRACT

OBJECTIVES: To address the issue of comparative risk of cancer in Canada's immigrant population, an area-based methodology was applied to examine whether or not estimated cancer incidence rates among individuals living in given areas vary systematically according to the concentration of foreign-born individuals living in the same area. This method provides an alternative, accessible surveillance method in the absence of linked individual-level information to extend the work of others by providing both national and subnational standardized, hence comparable, results to address this issue.

METHODS: Canadian Cancer Registry data (2001 to 2006) and 2006 Census data provided dissemination area information regarding the concentration of the foreign-born population and population estimates for rate denominators. Cancer (all cause and cause-specific) incidence rate ratios (age-standardized and by age/sex) were calculated by foreign-born concentration areas at both national and regional levels.

RESULTS: An inverse gradient was identified between cancer incidence rates and area concentration of foreign-born, with the all-sites cancer rate ranging from a low of 388 per 100,000 among individuals living in areas with a high concentration of foreign-born to a high of 493 per 100,000 among individuals living in areas with a low concentration of foreign-born. This pattern occurred nationally for lung, colorectal, prostate and female breast cancers. However, for liver, nasopharynx, and thyroid cancers, higher cancer rates were observed in areas with a higher versus lower concentration of foreign-born populations.

CONCLUSION: The study findings provide suggestive evidence of decreased cancer risk among foreign-born populations for most cancers except nasopharynx, liver and thyroid for which risks were higher. The results of this study demonstrate the value of ecological-based methods for disease surveillance in the absence of individual-level information on immigrant status in the national cancer registry.

KEY WORDS: Immigrants; cancer incidence; vital statistics

La traduction du résumé se trouve à la fin de l'article.

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Understanding the potential impact of immigration trends on Canada's public health program needs is increasingly important. In 2006, an estimated 6.2 million immigrants comprised 19.8% of Canada's population,[1] and it is estimated that by 2031, 28% of Canada's population will be foreign-born.[2] Current evidence on cancer screening indicates lower rates of uptake among immigrant populations, potentially leading to delayed detection and increase in the risk of cancer-related deaths.[3-7] These risks may translate into increases in cancer[8] and cancer-related health service utilization.[9] Therefore, anticipating the relative cancer risks for this growing subpopulation is important. However, there are data challenges hindering our ability to fully understand the pattern of cancer risk among Canada's immigrant population.

Evidence to date suggests that, overall in Canada, immigrants and refugees experience lower risk for cancer generally[10,11] and lower risk of death caused by cancer.[12,13] However, these reduced risks may not extend to all cancers. Cohort-based research showed that, nationally, immigrants experience a higher risk for liver, nasopharynx and cervical cancers.[10] Furthermore, both cancer incidence and mortality risk can differ according to country of birth[10-19] and time since immigration so that, depending upon the cancer site and relative risk within country of origin, cancer risk may increase to approach risk similar to that of the host country,[19-23] or alternatively, decrease for some cancer sites in comparison to that within the host country.[22,23]

As the composition of Canada continues to change,[1] challenges to providing comparable information regarding patterns of cancer risk among immigrants at both the national and subnational level persist. Currently, information needed to track cancer incidence by foreign-born status is not available at the national level. The Canadian Cancer Registry does not consistently report place of birth for all provinces and territories. Studies have used record linkage to conduct cancer surveillance.[10,11] However, data are not routinely available to conduct national and comparable regional cancer surveillance by a person's foreign-born status in order to track incidence in this subpopulation. The objective of this study is to apply a standardized area-based measure to examine whether or not estimated cancer incidence rates among individuals living in given areas vary systematically according to the concentration of foreign-born individuals living in the same given areas. The presented results are relevant since this standardized measure extends previous work, and enables reporting of comparable subnational cancer incidence rates according to concentration of foreign-born population, in addition to the reported national rates. Furthermore, as the population com-

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Conflict of Interest: None to declare.

position changes over time, results obtained using this method remain relevant to future research that may continue to apply this publically accessible methodology to report changes over time to incident cancer according to a standardized measure of area concentration of foreign-born population.

METHODS

Data sources

Cancer incidence was calculated using 2001 to 2006 data from the national Canadian Cancer Registry (CCR), a dynamic, person-oriented, population-based database maintained by Statistics Canada. A file containing records of incident invasive cancer cases was created using the multiple primary coding rules of the International Agency for Research on Cancer (IARC).[24] Cancers were classified based on the *International Classification of Diseases for Oncology, Third Edition*[25] and grouped using Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions (coding available upon request to author).[26] Non-melanoma skin cancers (basal and squamous) were not included.[27] Incident cancer counts were compiled using CCR postal codes that represented patients' usual place of residence at the time of tumour diagnosis. Incidence patterns for eighteen types of cancer were initially investigated; seven specific cancers were chosen for this report given their population incidence (lung, female breast, prostate, colorectal), and because distinctly reversed incidence patterns were noted for nasopharynx, liver, and thyroid compared to those found for other cancers.

In total, 895,838 records were extracted from the CCR from 2001 to 2006. Of those, 27,020 records were excluded (3%) due to missing or invalid postal code information, or because the postal code indicated an institutional address (e.g., hospitals) that was considered out-of-scope for the study population.

Canadian population estimates and area-based estimates of the foreign-born population, including non-permanent residents, were taken from the 2006 Census (20% sample) weighted to represent the Canadian population. This socio-demographic information is aggregated and made available at the dissemination area (DA) level, representing the smallest areas for which census population characteristics data are disseminated.[28] Population counts by percentage foreign-born terciles are provided by region in the Appendix table.

Definition of Foreign-born

"Foreign-born" refers to those who either 1) ever held the legal status of immigrant to Canada, or 2) were a non-permanent resident (NPR). NPRs are people from another country who, at the time of the Census, held a work or study permit or were refugee claimants, or who had applied for landed immigrant status but had not yet been accepted, in addition to family members living with them in Canada. From a health perspective,

Table 1. Standardized Cancer Incidence Rates (ASIR)* and Incidence Rate Ratios (IRR) for Site-specific Cancers, by Area Tercile for Percentage Foreign-born Population From 2001 to 2006, Canada Overall, and by Region

		Low % Foreign-born (tercile 1)†			Medium % Foreign-born (tercile 2)					High % Foreign-born (tercile 3)				
Cancer Site	**Area**	**# Cases**	**ASIR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**
All sites	Canada	653,990	493	492-494	145,346	447	444-449	0.91‡	0.90-0.91	69,481	388	385-391	0.79‡	0.78-0.79
	Atlantic	71,929	516	512-520	309	531	471-592	1.03	0.92-1.15	–	–	–	–	–
	Quebec	191,388	510	508-512	26,885	476	471-482	0.93‡	0.92-0.95	7742	433	423-442	0.85‡	0.83-0.87
	Ontario	203,895	493	491-496	73,176	446	443-449	0.90‡	0.90-0.91	47,739	389	385-392	0.79‡	0.78-0.80
	Prairies	118,753	479	476-482	16,302	427	420-433	0.89‡	0.88-0.91	954	364	341-388	0.76‡	0.71-0.81
	British Columbia	66,560	464	461-468	28,674	435	430-440	0.94‡	0.93-0.95	13,046	361	355-367	0.78‡	0.76-0.79
Lung	Canada	98,382	74	74-75	18,164	57	56-57	0.76‡	0.75-0.77	7935	46	45-47	0.62‡	0.60-0.63
	Atlantic	10,812	77	76-79	44	77	59-100	1.00	0.74-1.35	–	–	–	–	–
	Quebec	34,471	92	91-93	4051	72	69-74	0.78‡	0.75-0.80	1076	61	57-65	0.66‡	0.62-0.71
	Ontario	27,735	67	66-68	8509	53	52-54	0.79‡	0.77-0.81	5086	43	42-45	0.65‡	0.63-0.67
	Prairies	15,618	64	63-65	2049	57	54-59	0.89‡	0.85-0.93	127	53	44-62	0.83‡	0.69-0.99
	British Columbia	9486	66	64-67	3511	53	52-55	0.81‡	0.78-0.85	1646	46	44-48	0.70‡	0.67-0.74
Female Breast§	Canada	85,001	122	121-123	20,285	115	113-117	0.94‡	0.93-0.96	9643	97	95-99	0.80‡	0.78-0.81
Colorectal	Canada	84,812	64	64-64	18,001	56	55-57	0.87‡	0.86-0.89	8469	48	47-50	0.76‡	0.74-0.77
	Atlantic	10,292	74	72-75	39	68	51-90	0.93	0.68-1.28	–	–	–	–	–
	Quebec	25,145	67	66-68	3531	62	60-64	0.92‡	0.89-0.96	999	56	52-59	0.83‡	0.78-0.89
	Ontario	26,280	63	63-64	8953	55	54-56	0.87‡	0.85-0.89	5680	48	47-49	0.75‡	0.73-0.78
	Prairies	14,688	59	58-60	1928	52	50-55	0.88‡	0.84-0.92	96	37	30-45	0.63‡	0.51-0.77
	British Columbia	8156	57	55-58	3550	54	52-55	0.95‡	0.91-0.99	1694	47	45-50	0.84‡	0.80-0.88
Prostate‖	Canada	91,357	150	150-151	20,242	141	139-143	0.94‡	0.92-0.95	9323	121	118-123	0.80‡	0.79-0.82
Nasopharynx‖	Canada	614	5	4-5	283	8	7-9	1.83‡	1.59-2.11	378	19	17-21	4.20‡	3.69-4.78
Liver‖	Canada	4434	33	32-34	1626	51	48-53	1.51‡	1.43-1.60	1187	67	63-71	2.00‡	1.88-2.14
Thyroid‖	Canada	11,346	86	84-87	4181	122	118-125	1.42‡	1.37-1.47	3089	155	149-160	1.81‡	1.74-1.88

* Age-standardized to the total 2006 population within the low % foreign-born areas. Rates are expressed per 100,000 population, except for nasopharynx, liver, thyroid that are reported per million population. Both sexes were combined except for female breast and prostate. National figures include northern territories, Nunavut.
† Reference category.
‡ Significantly different compared to reference category.
§ Sex-specific population denominators were used. For breast cancer, figures are only shown for national level. Figures for regions are shown in Table 3.
‖ For prostate cancer, figures are only shown for national level. Figures for regions are shown in Table 2.
– Not applicable, no high % foreign-born population dissemination areas existed for this jurisdiction.
Sources: 2006 Census (20% sample), the Canadian Cancer Registry, Statistics Canada.

Table 2. Standardized Cancer Incidence Rates (ASIR)* and Incidence Rate Ratios (IRR) for Site-specific Cancers for Males, by Area Tercile for Percentage Foreign-born Population From 2001 to 2006, Canada Overall and by Region

		Low % Foreign-born (tercile 1)†			Medium % Foreign-born (tercile 2)					High % Foreign-born (tercile 3)				
Cancer Site	**Area**	**# Cases**	**ASIR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**
All sites	Canada	345,065	571	569-573	73,805	510	507-514	0.89‡	0.89-0.90	34,604	439	434-444	0.77‡	0.76-0.78
	Atlantic	38,933	615	609-621	153	623	523-723	1.01	0.86-1.19	–	–	–	–	–
	Quebec	99,180	594	590-598	13,345	540	531-549	0.91‡	0.89-0.93	3787	495	479-511	0.83‡	0.81-0.86
	Ontario	107,370	566	562-569	37,190	509	504-514	0.90‡	0.89-0.91	23,706	439	433-445	0.78‡	0.77-0.79
	Prairies	63,057	558	553-562	8254	495	484-506	0.89‡	0.87-0.91	496	419	381-457	0.75‡	0.69-0.82
	British Columbia	35,773	530	524-535	14,863	499	491-507	0.94‡	0.92-0.96	6615	409	399-419	0.77‡	0.75-0.79
Lung	Canada	55,452	93	92-93	9886	70	68-71	0.75‡	0.74-0.77	4589	60	58-62	0.65‡	0.63-0.67
	Atlantic	6360	101	99-104	23	95	64-135	0.93	0.62-1.41	–	–	–	–	–
	Quebec	20,492	124	122-125	2326	94	90-98	0.76‡	0.73-0.79	650	85	78-92	0.69‡	0.64-0.74
	Ontario	15,129	80	79-82	4612	65	63-66	0.81‡	0.78-0.83	2960	57	55-59	0.71‡	0.68-0.74
	Prairies	8351	75	74-77	1099	70	66-74	0.93‡	0.87-0.99	74	68	52-83	0.90	0.71-1.13
	British Columbia	4973	74	72-76	1826	62	59-65	0.84‡	0.80-0.89	905	57	53-61	0.78‡	0.72-0.83
Prostate	Canada	91,357	150	150-151	20,242	141	139-143	0.94‡	0.92-0.95	9323	121	118-123	0.80‡	0.79-0.82
	Atlantic	10,517	164	160-167	47	195	151-250	1.19	0.89-1.59	–	–	–	–	–
	Quebec	20,321	121	119-123	2652	108	104-112	0.89‡	0.85-0.93	697	93	86-100	0.77‡	0.71-0.83
	Ontario	31,574	165	164-167	10,893	151	148-153	0.91‡	0.89-0.93	6789	128	125-132	0.78‡	0.76-0.80
	Prairies	18,767	168	165-170	2300	142	136-148	0.85‡	0.81-0.89	109	93	75-111	0.56‡	0.46-0.67
	British Columbia	10,045	147	144-150	4350	147	142-151	1.00	0.96-1.03	1728	109	104-114	0.74‡	0.70-0.78
Colorectal	Canada	45,962	77	76-77	9628	67	66-69	0.88‡	0.86-0.90	4462	57	56-59	0.75‡	0.73-0.77
	Atlantic	5520	88	86-91	24	99	68-141	1.12	0.75-1.68	–	–	–	–	–
	Quebec	13,512	81	80-83	1862	75	72-79	0.92‡	0.88-0.97	517	69	63-74	0.84‡	0.77-0.92
	Ontario	14,171	75	74-77	4833	67	65-69	0.89‡	0.86-0.92	2999	57	54-59	0.75‡	0.72-0.78
	Prairies	8101	72	71-74	1044	64	60-68	0.88‡	0.82-0.94	49	42	32-54	0.58‡	0.43-0.77
	British Columbia	4513	67	65-69	1865	63	60-66	0.94‡	0.89-0.99	897	56	52-60	0.83‡	0.78-0.90
Nasopharynx§	Canada	407	6	6-7	201	13	11-14	1.98‡	1.67-2.34	267	28	25-32	4.47‡	3.80-5.20
Liver§	Canada	3330	55	53-56	1199	80	76-85	1.47‡	1.38-1.57	883	107	100-115	1.97‡	1.83-2.12
Thyroid§	Canada	2641	41	39-43	905	56	52-59	1.36‡	1.26-1.46	577	62	57-67	1.52‡	1.38-1.66

* Age-standardized to the total 2006 population within the low % foreign-born area. Rates are expressed per 100,000 population except for nasopharynx, liver, thyroid that are reported per million population. Canada figures include the two northern territories and Nunavut.
† Reference category.
‡ Significantly different compared to reference category.
§ Sex-specific population denominators were used.
– Not applicable, no high % foreign-born population dissemination areas existed for this jurisdiction.
Sources: 2006 Census (20% sample), the Canadian Cancer Registry, Statistics Canada.

NPRs more closely resemble immigrants than Canadian-born, so they were included in the foreign-born category. Everyone else was considered to be non-foreign-born.

The concentration of foreign-born was calculated using the 2006 Census (20% sample) data at the DA level (n=50,214). The foreign-born percentage value was used to classify each DA into one of the following terciles: low foreign-born (tercile 1: ≤27.0% foreign-born); medium foreign-born (tercile 2: >27.0% to ≤51.8% foreign-born); and high foreign-born (tercile 3: >51.8% foreign-born). The rationale and methods used to establish the cut-off percentage values to define the terciles are described in detail elsewhere.[29] Note that there were no DAs with a high concentration of foreign-born in the Atlantic region.

Each cancer record was assigned a 2006 DA code based on postal code of patients' residence at time of diagnosis by using Statistics Canada's Postal Code Conversion File application (PCCF+) version 5F.[30] The DA code on the cancer record was then used to assign the foreign-born tercile information. This process allowed each incident cancer event to be classified as having occurred in an area with either a low, medium or high concentration of foreign-born (Appendix Table).

Analysis

Counts of incident cancers, pooled within 2001-2006, represented cancer incidence rate numerators. The 2006 Census dissemination area population estimates (including institutional residents) by age and sex were multiplied by six to estimate person-years at risk (the incidence rate denominator). Rates were calculated per 100,000 population, with the exceptions of nasopharynx, liver and thyroid cancers which were calculated per million population. Rates were standardized using the direct method to the age and sex structure of the 2006 national population within all low foreign-born category areas (tercile 1). The following four categories of age-specific rates were used to produce age-standardized results: <60 years, 60-69, 70-79 and ≥80. Standard errors used to compute 95% confidence intervals for age-standardized incidence rates (ASIR) were derived using methods published by the International Agency for Research on Cancer (IARC).[31] Confidence intervals for small counts (<50) used methods from Fay and Feuer.[32] Incidence Rate Ratios (IRR) represent comparisons of cancer rates of terciles 2 and 3 to that for the reference rate, tercile 1. Comparisons were conducted across terciles nationally, and within each of the five regions.

In the computation of IRR, denominators were the rates of the reference group (tercile 1), numerators were those of terciles 2 or 3; corresponding standard errors were used to calculate confidence intervals to these ratios.

RESULTS

National cancer incidence patterns

At the national level (Table 1), the standardized incidence rates for all cancer sites combined were significantly lower among individuals living in areas with medium or high concentration of foreign-born population (ASIR = 447 and 388 per 100,000 population, respectively) compared to areas that had a low concentration of foreign-born population (ASIR = 493). Systematic variation in incidence according to concentration for foreign-born areas is apparent from resulting incident rate ratios (IRR = 0.91, IRR = 0.79 for medium and high concentration foreign-born areas, respectively). Lung, female breast, prostate and colorectal cancer incidence rates followed a similar pattern of variation, as did the sex-specific rates for lung and colorectal cancer (Table 2 for males, Table 3 for females).

However, not all cancers followed this pattern. The ASIRs and IRRs for cancers of the nasopharynx, liver and thyroid show an inverse association in which incidence rates were significantly elevated within high (tercile 3) and medium (tercile 2) concentration foreign-born populated areas compared to areas with low concentration foreign-born. The IRRs for these cancers within tercile 3 were 4.20, 2.00 and 1.81, respectively, and for tercile 2, 1.83 (nasopharynx), 1.51 (liver), and 1.42 (thyroid). These significantly different, inverse patterns for these cancers persisted for both males and females.

Regional cancer incidence patterns

At the regional level (Table 1), significantly lower colorectal cancer incidence rates occurred within tercile 3 compared to tercile 1 (Prairies IRR = 0.63, Ontario IRR = 0.75, Quebec IRR = 0.83, British Columbia IRR = 0.84). For female breast cancer (Table 3), significantly lower incidence rates occurred within tercile 3 areas compared to tercile 1 for the Prairie regions (IRR = 0.71), Ontario and British Columbia (IRR = 0.79), and Quebec (IRR = 0.82). Significantly lower incidence for prostate cancer (Table 2) occurred within tercile 3 areas for the Prairie regions (IRR = 0.56), British Columbia (IRR = 0.74), Quebec (IRR = 0.77) and Ontario (IRR = 0.78). Lower lung cancer rates occurred within tercile 3 (Ontario IRR = 0.65, Quebec IRR = 0.66, British Columbia IRR = 0.70, Prairies IRR =

Table 3. Standardized Cancer Incidence Rates (ASIR)* and Incidence Rate Ratios (IRR) for Site-specific Cancers for Females, by Area Tercile for Percentage Foreign-born Population From 2001 to 2006, Canada Overall and by Region

		Low % Foreign-born (tercile 1)†			Medium % Foreign-born (tercile 2)					High % Foreign-born (tercile 3)				
Cancer Site	**Area**	**# Cases**	**ASIR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**	**# Cases**	**ASIR**	**95% CI**	**IRR**	**95% CI**
All sites	Canada	308,925	436	434-438	71,541	400	397-403	0.92‡	0.91-0.92	34,877	352	349-356	0.81‡	0.80-0.82
	Atlantic	32,996	440	435-445	156	456	384-529	1.04	0.88-1.22	–	–	–	–	–
	Quebec	92,208	451	448-454	13,540	432	425-440	0.96‡	0.94-0.98	3955	390	377-402	0.86‡	0.84-0.89
	Ontario	96,525	439	436-442	35,986	400	396-404	0.91‡	0.90-0.92	24,033	353	349-358	0.80‡	0.79-0.82
	Prairies	55,696	421	418-425	8048	376	367-384	0.89‡	0.87-0.91	458	320	290-350	0.76‡	0.69-0.84
	British Columbia	30,787	416	412-421	13,811	387	381-394	0.93‡	0.91-0.95	6431	328	320-336	0.79‡	0.77-0.81
Lung	Canada	42,930	61	60-61	8278	46	45-47	0.77‡	0.75-0.79	3346	34	33-36	0.57‡	0.55-0.59
	Atlantic	4452	59	57-61	21	64	43-94	1.09	0.70-1.68	–	–	–	–	–
	Quebec	13,979	68	67-69	1725	54	52-57	0.80‡	0.76-0.84	426	41	37-45	0.61‡	0.55-0.67
	Ontario	12,606	57	56-58	3897	44	42-45	0.76‡	0.74-0.79	2126	32	31-34	0.57‡	0.54-0.59
	Prairies	7267	56	55-57	950	47	44-50	0.84‡	0.78-0.90	53	40	29-51	0.72‡	0.55-0.95
	British Columbia	4513	60	59-62	1685	47	45-49	0.78‡	0.74-0.82	741	38	35-41	0.63‡	0.59-0.68
Female breast§	Canada	85,001	122	121-123	20,285	115	113-117	0.94‡	0.93-0.96	9643	97	95-99	0.80‡	0.78-0.81
	Atlantic	8903	121	119-124	41	122	92-159	1.01	0.74-1.37	–	–	–	–	–
	Quebec	25,293	127	125-128	3643	121	117-125	0.95‡	0.92-0.99	1007	104	97-110	0.82‡	0.77-0.87
	Ontario	26,620	124	122-125	10,331	116	114-118	0.93‡	0.92-0.96	6701	98	95-100	0.79‡	0.77-0.81
	Prairies	15,372	118	116-119	2305	106	102-110	0.90‡	0.86-0.94	120	83	68-98	0.71‡	0.59-0.85
	British Columbia	8599	119	116-121	3965	114	111-118	0.96	0.93-1.00	1815	94	90-98	0.79‡	0.75-0.83
Colorectal	Canada	38,850	53	53-54	8373	46	45-47	0.86‡	0.84-0.88	4007	41	40-42	0.77‡	0.74-0.79
	Atlantic	4772	61	59-63	15	39	24-62	0.64	0.38-1.08	–	–	–	–	–
	Quebec	11,633	55	54-56	1669	50	48-53	0.91‡	0.86-0.96	482	46	41-50	0.83‡	0.75-0.91
	Ontario	12,109	53	52-54	4120	45	44-46	0.85‡	0.82-0.88	2681	40	39-42	0.76‡	0.73-0.79
	Prairies	6587	49	48-50	884	43	40-45	0.87‡	0.81-0.94	47	33	25-42	0.68‡	0.50-0.91
	British Columbia	3643	48	46-49	1685	46	43-48	0.95	0.90-1.01	797	40	37-43	0.85‡	0.78-0.91
Nasopharynx§	Canada	207	3	3-3	82	5	4-6	1.55‡	1.20-2.01	111	11	9-13	3.61‡	2.87-4.56
Liver§	Canada	1104	15	14-16	427	24	21-26	1.56‡	1.39-1.74	304	31	28-35	2.05‡	1.80-2.33
Thyroid§	Canada	8705	129	127-132	3276	187	180-193	1.44‡	1.39-1.50	2512	246	236-255	1.90‡	1.82-1.99

* Age-standardized to the total 2006 population within the low % foreign-born area. Rates are expressed per 100,000 population, except for nasopharynx, liver, thyroid that are reported per million population. Canada figures include the two northern territories and Nunavut.
† Reference category.
‡ Significantly different compared to reference category.
§ Sex-specific population denominators were used.
– Not applicable, no high % foreign-born population dissemination areas existed for this jurisdiction.
Sources: 2006 Census (20% sample), the Canadian Cancer Registry, Statistics Canada.

Table 4. Area Population Characteristics by Tercile of the Foreign-born Population, by Province or Region, Canada 2006

% Foreign-born Tercile	Canada	Atlantic	Quebec	Ontario	Prairies	British Columbia
			%			
High foreign-born (tercile 3)						
Foreign-born	63.8	–	62.5	64.3	59.0	63.0
Recent immigrant/non-permanent resident	17.1	–	22.3	16.8	23.2	15.3
Place of birth was Asia	37.7	–	24.4	36.5	40.2	48.4
Place of birth was Europe	11.6	–	14.5	12.7	4.1	6.7
Place of birth was Africa	3.5	–	9.2	3.3	4.4	1.4
Low income after taxes	19.9	–	32.3	18.0	18.4	21.9
Completed university degree	28.4	–	28.6	28.3	28.7	28.7
Medium foreign-born (tercile 2)						
Foreign-born	37.6	35.3	37.7	38.1	34.7	38.5
Recent immigrant/non-permanent resident	7.9	18.6	9.3	6.9	9.8	7.9
Place of birth was Asia	14.8	12.9	10.0	13.0	18.6	20.6
Place of birth was Europe	12.9	5.4	12.3	15.5	7.8	10.3
Place of birth was Africa	2.4	1.2	5.4	1.9	2.5	1.3
Low income after taxes	12.6	22.0	17.9	10.8	12.1	13.8
Completed university degree	28.3	45.1	28.5	29.0	24.7	28.4
Low foreign-born (tercile 1)						
Foreign-born	9.8	3.9	5.8	13.3	10.5	14.9
Recent immigrant/non-permanent resident	1.5	0.8	1.4	1.4	2.0	1.7
Place of birth was Asia	1.9	0.7	1.1	2.1	2.7	3.1
Place of birth was Europe	5.2	1.7	2.4	8.2	4.7	8.3
Place of birth was Africa	0.5	0.2	0.7	0.4	0.5	0.4
Low income after taxes	7.4	8.1	8.8	6.0	7.3	8.1
Completed university degree	17.2	15.1	16.4	18.7	17.5	16.6

– Not applicable, no high % foreign-born population dissemination areas existed within this jurisdiction.
Sources: 2006 Census (20% sample), Statistics Canada.

0.83). For discussion purposes, characteristics of overall populations who resided within geographical areas classified as % foreign-born terciles are presented in Table 4.

DISCUSSION

Cancer surveillance using an area-based approach can be used to report cancer rates among individuals living in areas with varying concentration of foreign-born populations according to a standard, hence comparable, concentration measure of this subpopulation. Lower incidence occurred generally for areas with a high versus low concentration of foreign-born population. These findings extend the work of others[10] by providing subnational analyses and are consistent with individual-level based analyses which also found lower rates of most cancers among immigrant groups.[10-12] Exceptions to the reported pattern were found for liver, thyroid and nasopharynx cancers where more elevated incidence occurred within these same high concentration foreign-born areas. These national findings are similar to what had been reported for liver cancer using area-based information for Ontario.[33]

Lower cancer rates among areas with a high concentration of foreign-born may be partially explained by the composition of immigrants residing in these areas. There is great heterogeneity among Canadian immigrants within these areas, and health determinant behaviours likewise may vary greatly among immigrants according to place of birth.[16] Yet findings suggest that many of the source countries of immigrants to Canada, such as China, India, and the Philippines,[1] have lower incidence rates of cancer in general[15] by comparison to Canadian individuals. Furthermore, immigrants may carry reduced risk that may continue for several years following immigration. While the concentration of foreign-born from Asia for example, varies greatly across terciles, and across different regions (Table 4), higher concentrations of Asian foreign-born individuals who may carry reduced cancer risk[15] tended to be located primarily within tercile 3. For example, 37.7% of the population in tercile 3 reported an Asian birthplace, compared to 1.9% in tercile 1. This may explain, in part, why reported ASIRs for all cancers, and by type, are generally lowest within the high concentration foreign-born tercile. According to international data, cancer incidence (all sites excluding non-melanoma skin cancer) among Asia's population was lower at 153.6 (per 100,000, age-standardized) compared to that for Canada (296.6).[15] Conversely, liver cancer incidence is reportedly four times higher in Asian males (21.4 per 100,000) compared to Canadian males (5.2 per 100,000).[15] Differential cancer risk exposure in the birth country may explain, in part, the elevated ASIRs for liver cancer observed in areas with high compared to low concentrations of foreign-born individuals. Higher rates of liver cancer among Asian immigrant populations have been reported to be potentially associated with a greater prevalence of known liver cancer risk factors.[34,35] The presented trends may also suggest explanations for regional differences of cancer incidence observed in Canada. In particular, the results suggest an explanation for lower cancer rates generally among high foreign-born terciles in British Columbia and the Prairies. The more concentrated foreign-born populated areas for these regions are comprised of greater proportions of immigrants from Asia than were found in the concentrated foreign-born areas in Quebec, for example (Table 4). As stated, immigrants from Asia may carry comparatively less risk for cancer incidence in general.[15]

Differences in cancer rates derived using this area-based approach may partially be explained by variation in other population characteristics that are spatially distributed in similar ways. Since immigrants for the most part settle within urban areas,[1,36] rural populations are exclusively represented within low or medium foreign-born areas. It is possible, therefore, that differences in cancer rates among individuals living in areas with high versus low concentration foreign-born partially reflect health differences between rural and urban populations. Rural populations experience increased prevalence for smoking behaviours,[37,38] overweight or obese,[38] which are recognized risk factors for some cancers.[39] Population research has shown that Canada's immigrants are generally less likely to

Appendix A. Population in 2006* by tercile of the foreign-born population, by sex, by province or region, Canada

	Total	Low Foreign-born (tercile 1)			Medium Foreign-born (tercile 2)			High Foreign-born (tercile 3)		
	All	All	Males	Females	All	Males	Females	All	Males	Females
Population in 2006										
Canada	31,169,185	22,097,060	10,841,655	11,255,405	5,734,465	2,786,780	2,947,685	3,337,660	1,619,380	1,718,280
Atlantic	2,274,315	2,263,740	1,097,640	1,166,100	10,575	5060	5515	–	–	–
Quebec	7,480,310	6,269,040	3,070,670	3,198,370	906,290	435,645	470,645	304,980	147,800	157,180
Ontario	12,077,010	6,814,775	3,334,985	3,479,790	2,918,810	1,415,475	1,503,335	2,343,425	1,136,265	1,207,160
Prairies	5,227,955	4,375,040	2,169,425	2,205,615	798,685	395,585	403,100	54,230	27,295	26,935
British Columbia	4,009,085	2,273,955	1,117,665	1,156,290	1,100,105	535,015	565,090	635,025	308,020	327,005

* Counts include all ages. National figures include the two northern territories and Nunavut.
– Not applicable, no high % foreign-born population dissemination areas existed for this jurisdiction.
Source: 2006 Census (20% sample), Statistics Canada.

smoke.[40] If foreign-born persons are less likely to access primary care, or to participate in cancer screening, as mentioned, then this may have partly contributed to decreased detection of cancer incidence in these areas. Finally, education levels also vary by foreign-born terciles with higher prevalence of post-secondary education among individuals living in areas having high and medium concentration of foreign-born (Table 4). Potential relationships between cancer incidence, education and concentration foreign-born population require further investigation. As well, in future, since national and provincial person-level information is not readily available to address the issue of comparative cancer risk among Canada's immigrant population, this area-based method provides a standardized surveillance tool that could be used to report changes to cancer incidence according to area foreign-born concentration over time.

This study has several limitations. This area-based analysis does not provide cancer incidence information about foreign-born persons per se, but instead, describes cancer events occurring within geographies populated by differing concentrations of foreign-born as determined by the 2006 Census. Rate denominators used 2006 population estimates and did not adjust for population growth over the reference period. Nor did denominators account for institutional population as rate numerators did, the likely impact of which may have been conservative estimation of incidence rates. Length of residence and age at immigration were not controlled for in this area-based analysis. Despite evidence to suggest foreign-born carry reduced incident cancer risk upon arrival,[15] risk may increase over time to the degree that risk among foreign-born individuals resembles that of the Canadian-born population,[19,22,23] possibly in particular with regard to risks for lung and colorectal cancers. Risk convergence for these cancers to host country has been observed for second-generation persons, and those who migrated at young ages.[41] If effects of reduced cancer risk are conferred by factors related to having been foreign-born, then had information been available to directly measure this at the individual level, the magnitude of variation in area cancer incidence according to concentration foreign-born could possibly be greater than these results suggest. Our results may demonstrate conservative differences since, even within high-concentration foreign-born areas, Canadian-born persons comprised 36% of the population, therefore reported ASIRs reflect composite cancer risks for both foreign- and non-foreign-born population groups. Any effects of reduced cancer risk among the foreign-born may have been attenuated accordingly. Area-based concentration of additional population characteristics known to be relevant to health, including percentage area low income and educational attainment, varied greatly across foreign-born terciles but were not adjusted for. These other unadjusted factors may operate as confounders. For example, prevalence for low income was greater for tercile 3 areas, therefore if low income was associated with increased cancer risk, this could confound any protective effects associated with increased concentration of foreign-born population. Information regarding cancer risk health behaviours, such as smoking status, was not available. The descriptive associations described are not interpreted as causal; an experimental methodology was not applied.

Population estimates adjusted for net undercount on the Census were not available for dissemination areas. The 2006 Census collected no information on the place of birth or foreign-born status of residents of institutional collective dwellings (such as nursing homes), therefore calculations to produce foreign-born percentages used to classify areas did not include the institutional population. Finally, interpretation of regional differences needs to consider that variations to registry reporting practices across the 13 provinces and territories may have contributed to a small extent to noted regional variation to cancer incidence.[42]

CONCLUSIONS

Application of an area-based method creates the opportunity for regular population cancer incidence surveillance to produce standardized cancer incidence estimates at national and regional levels among the foreign-born population. Results from this area-based analysis resemble incidence patterns previously produced using individual-level records and are interpreted as suggestive evidence of associations between the characteristic of living in an area with a high concentration of foreign-born and decreased cancer risk generally, with the reverse being the case for at least three specific cancers. This area-based method provides a surveillance tool that uses a standardized measure of foreign-born population concentration that could be used to report changes to cancer incidence according to area foreign-born concentration over time. The tool could also inform health services planning such as the development of public education planning regarding cancer screening as the Canadian population becomes increasingly diverse.

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RÉSUMÉ

OBJECTIFS : Pour aborder la question du risque comparatif de cancer dans la population immigrante du Canada, nous avons appliqué une méthode régionale pour déterminer si les taux d'incidence estimatifs du cancer chez les résidents de certaines régions varient systématiquement selon la concentration de personnes nées à l'étranger vivant dans la même région. En l'absence de données individuelles maillées, une telle méthode offre une solution de surveillance accessible pour compléter le travail d'autres chercheurs; elle offre des résultats à la fois nationaux et sous-nationaux standardisés, et donc comparables, pour aborder la question.

MÉTHODE : Les données du Registre canadien du cancer (2001 à 2006) et celles du Recensement de 2006 ont fourni de l'information par aire de diffusion sur la concentration de personnes nées à l'étranger et des estimations démographiques pour les dénominateurs des taux. Les ratios des taux d'incidence (standardisés pour l'âge et pour l'âge/le sexe) du cancer (toutes causes confondues et par cause) ont été calculés pour chaque zone de concentration de personnes nées à l'étranger à l'échelle nationale et régionale.

RÉSULTATS : Nous avons observé un gradient inversé entre les taux d'incidence du cancer et la concentration régionale de personnes nées à l'étranger : les taux de cancer tous sites confondus variaient de 388 p. 100 000 (chez les résidents des régions à forte concentration de personnes nées à l'étranger) à 493 p. 100 000 (chez les résidents des régions à faible concentration de personnes nées à l'étranger). Cette tendance se manifestait à l'échelle nationale pour les cancers du poumon, colorectal et de la prostate et pour le cancer du sein féminin. Toutefois, pour les cancers du foie, du nasopharynx et de la thyroïde, nous avons observé des taux de cancer supérieurs dans les régions à forte plutôt qu'à faible concentration de personnes nées à l'étranger.

CONCLUSION : Les constatations de l'étude donnent à penser que le risque de cancer est réduit au sein des populations nées à l'étranger pour la plupart des cancers sauf ceux du nasopharynx, du foie et de la thyroïde, pour lesquels les risques sont supérieurs. Ces résultats démontrent la valeur des méthodes écologiques pour la surveillance des maladies en l'absence de données individuelles sur le statut d'immigrant dans le registre national du cancer.

MOTS CLÉS : immigrants; incidence du cancer; statistiques de l'état civil