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Original quantitative research

Noticing of cannabis health warning labels in Canada and the US

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Abstract

Introduction: Product labelling and health warnings are important components of regulatory frameworks for consumer products such as tobacco, alcohol and food. However, evidence in the cannabis domain is limited. This study aimed to examine the reach of mandated health warnings on cannabis products using a natural experimental design.

Methods: Data are from the online International Cannabis Policy Study 2018 and 2019 surveys. Respondents were men and women aged 16 to 65 years in Canada and US states with illegal and legal nonmedical cannabis ("illegal" and "legal" states, respectively) (n = 72 549). Regression models tested differences in noticing health warnings on cannabis packages pre- and post-legalization in Canada, with comparisons to US states, adjusting for cannabis use, cannabis source and sociodemographics.

Results: Respondents in Canada showed a greater increase in noticing warnings (+8.9%) in 2019 (14.7%) versus 2018 (5.8%) than respondents in US "illegal" states (+2.8%) and "legal" states (+3.2%). In 2019, consumers residing in jurisdictions with legal recreational cannabis who purchased from legal retail sources were more likely to report noticing warnings than consumers who obtained cannabis from illegal/unstated sources (Canada: 40.4% vs. 15.3%; US "legal" states: 35.3% vs. 17.0%). Regular cannabis consumers were more likely to notice warnings than less frequent consumers.

Conclusion: Mandating warning labels on cannabis products may increase exposure to messages communicating the health risks of cannabis, especially among frequent consumers and those who access the legal market.

Keywords: health warnings, cannabis, North America

Highlights

- The aim of this study was to examine noticing of mandated health warnings on cannabis products.
- Compared to respondents in US states, respondents in Canada noticed more health warnings after nonmedical cannabis legalization in 2019 versus pre-legalization in 2018.
- Purchasing cannabis from legal sources was associated with increased noticing of health warnings.
- Regular cannabis consumers were more likely to notice warnings than less frequent consumers.
- Mandating warning labels on cannabis products may increase exposure to messages communicating the health risks of cannabis, especially among frequent consumers and those who access the legal market.

Introduction

Product labelling and health warnings are important components of regulatory frameworks for consumer products such as tobacco, alcohol and food. Health warnings on packages are particularly important due to both the frequency and timing of the consumer's exposure; the latter typically occurs at the point of purchase and immediately preceding use.[1,2] However, the influence of health warnings depends largely upon their design. Small, obscure warnings have relatively little influence compared with larger, more comprehensive warnings.[1] Several factors can enhance the effectiveness of labels, including increased size, the use of pictorial images, and distinctive design factors that enhance legibility and salience.[1,3]

Regulations for mandated warnings on cannabis products are at an early stage due to the recency of legal cannabis markets. In Canada, nonmedical cannabis was legalized on 17 October 2018, along with regulations that required health warnings on all cannabis packages.[4,5] Warnings must be displayed on the principal display area, written in black type on a yellow background, using a font size equal to or larger than the brand name and larger than that of the product information, and must feature a black border[4] (Figure 1). Different warning messages are rotated across products, each of which describes a different health effect. While formatting requirements remain the same, the warning label messages were revised one year post-legalization, with nine revised warnings implemented on 17 October 2019, near the end of the 2019 study period, which ended October 31, 2019.[5] In both the original and revised versions, the warnings related to

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WARNING: Do not use if pregnant or breastfeeding.

Substances found in cannabis are also found in the breast milk of mothers who use cannabis.
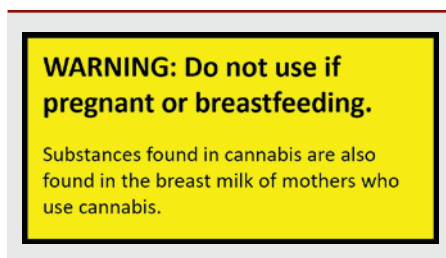
cannabis smoke, pregnancy or breastfeeding, driving or operating machinery, mental health, risk among adolescents and young adults, high THC content and—in 2019 onward—delayed effects of edibles.

In the US, although recreational cannabis remains a Schedule I Controlled Substance at the federal level, adult use has been legalized in an increasing number of states since 2012. As of September 2019, retail cannabis sales were legal in seven states, all of which required at least one mandatory health warning label on their products at the time of writing. Unlike the mandatory warnings in Canada, none of the states requires rotating warning content. Most US warnings are printed in black type on a white background, and may appear as a block of text that summarizes several health risks in one paragraph. In addition, several states, including those that have prohibited nonmedical cannabis, require health warnings on medical cannabis, with varying requirements across states.[6]

There are relatively few studies on cannabis health warnings, given their relative novelty. Experimental, or "pre-implementation," research indicates high levels of public support for mandatory warnings.[7] Large, comprehensive warnings also have the potential to reduce the appeal of cannabis products, including among young people.[7-9] A survey conducted with cannabis consumers in Canada and the US in the year following nonmedical cannabis legalization in Canada showed survey respondents six text-based warnings.[10] One-third of cannabis consumers indicated they would be "happy" to see health warning messages on cannabis products, and each of the warning messages was rated as believable by between half and three-quarters of consumers. Compared to consumers in the US, those in Canada

reported higher levels of support and believability, and perceived the health information as less novel.

As an increasing number of jurisdictions consider legalizing nonmedical cannabis, there is a need to examine the effectiveness of health warnings in population-based studies that evaluate the naturalistic "real-world" effect of warnings. As a first step, there is a need to examine the extent to which mandated warnings are salient among consumers. The concept of "noticing" is a fundamental and necessary first step within conceptual frameworks for health warnings. Put simply, health warnings must be noticed before they can improve health knowledge and influence consumer behaviour.[1,2,11] Noticing has been assessed in conceptual models examining how health warnings can influence consumer behaviour, and is a function of the size, position and visual salience of warnings, as well as frequency of exposure.[1,11,12] Indeed, research suggests that pack-a-day smokers are exposed to packages—and thus health warnings where mandated— about 7300 times per year.[13] For product domains such as cannabis, which have very high levels of illicit sales even within legalized markets, the extent to which consumers purchase from regulated retail sources may be an important determinant of exposure to mandated health warnings.

The aim of this study was to examine whether residing in Canada would be associated with increased self-reported noticing of health warning labels pre- versus post-legalization, compared to residing in US states that had or had not legalized recreational cannabis ("legal" and "illegal" states, respectively). It was hypothesized that a greater increase in noticing health warnings would be observed in Canada after the legalization of cannabis, compared to US "legal" states. It was further hypothesized that rates of noticing would be relatively stable in US "illegal" states (comparison group), where recreational cannabis is not available for legal purchase.

Methods

Data are cross-sectional findings from Waves 1 and 2 of the International Cannabis Policy Study (ICPS)[14] conducted in Canada and the US. Data were collected via self-completed web-based surveys conducted in fall 2018, immediately before cannabis legalization in Canada, and fall 2019 with respondents aged 16 to 65 years.

Respondents were recruited through the Nielsen Consumer Insights Global Panel and their partners' panels using nonprobability methods. Email invitations (with a unique link) were sent to a random sample of panellists after targeting for age and country criteria. Panellists known to be ineligible were not invited.

Surveys were conducted in English in the US and English or French in Canada. Median survey times were 20 and 25 minutes in 2018 and 2019, respectively. Respondents provided consent before completing the survey. Respondents received remuneration in keeping with their panel's usual incentive structure (e.g. points-based or monetary rewards, chances to win prizes). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#31330). The survey underwent pilot testing, and a full description of the study methods can be found in the ICPS Technical Reports and methodology paper.[14-18]

Measures

Full question wording is available in the ICPS surveys (http://cannabisproject.ca/methods/).

Sociodemographic factors
Sociodemographic factors included sex, age, ethnicity, highest education level and perceived income adequacy (all categorical variables). Suspected device type used to complete the survey was collected by Nielsen. See Table 1 for response options.

Noticing of cannabis health warning labels
Noticing of cannabis health warning labels was assessed using the question "In the past 12 months, have you seen health warnings on marijuana products or packages?" (Yes; No; Not applicable – I have not seen any marijuana products or packages; Don't know; Refuse to answer).

Cannabis use status
Cannabis use status was assessed by asking about most recent and current cannabis use (coded into the following exclusive categories: Not in past 12 months; In past 12 months but not more recently; Monthly use; Weekly use; Daily/almost daily use; Don't know; Refuse to answer).

Cannabis source
Cannabis source was assessed by asking past 12-month cannabis consumers,

	Canada				US "illegal" states[a]				US "legal" states[b]			
	2018 (pre-legalization) (n = 10 018)		2019 (post-legalization) (n = 15 151)		2018 (n = 9692)		2019 (n = 10 231)		2018 (n = 7358)		2019 (n = 20 099)	
	%	n	%	n	%	n	%	n	%	n	%	n
Sex												
Female	50.0	5 006	49.8	7 547	50.4	4 883	50.3	5 150	49.8	3 665	49.8	10 019
Male	50.0	5 012	50.2	7 604	49.6	4 808	49.7	5 081	50.3	3 693	50.2	10 081
Age (years)												
16–25	18.9	1 894	18.6	2 824	19.9	1 933	19.9	2 034	19.4	1 429	19.7	3 957
26–35	20.6	2 066	20.8	3 157	21.4	2 069	21.5	2 198	22.9	1 685	22.6	4 551
36–45	19.6	1 963	19.8	3 002	18.9	1 835	19.1	1 950	17.4	1 279	19.3	3 886
46–55	20.8	2 088	20.0	3 025	20.2	1 954	19.8	2 027	21.8	1 605	19.5	3 912
56–65	20.0	2 008	20.7	3144	19.6	1 900	19.8	2 022	18.5	1 360	18.9	3 794
Ethnicity												
White	77.4	7 758	73.4	11 116	76.4	7 407	76.1	7 787	76.4	5 622	76.3	15 329
Other/mixed/unstated	22.6	2 261	26.6	4 035	23.6	2 284	23.9	2 444	23.6	1 736	23.7	4 771
Highest education level												
Unstated	0.7	73	1.0	150	0.3	27	0.4	36	0.4	32	0.4	79
Less than high school	15.5	1 549	15.4	2 333	15.2	1 474	12.1	1 237	11.8	865	5.1	1 015
High school diploma	26.6	2 666	26.5	4 017	19.4	1 880	22.5	2 304	15.8	1 164	20.2	4 067
Some college/technical training	32.4	3 242	32.4	4 911	38.4	3 717	36.4	3 725	42.0	3 090	41.7	8 385
Bachelor's degree or higher	24.8	2 488	24.7	3 740	26.8	2 593	28.6	2 928	30.0	2 207	32.6	6 553
Income adequacy (difficulty making ends meet)												
Unstated	3.4	346	3.8	576	2.0	199	2.5	259	2.9	216	3.1	615
Very difficult	8.2	822	9.7	1 463	9.3	901	10.6	1 088	8.9	655	10.0	2 018

TABLE 1 (continued)
Sample characteristics, International Cannabis Policy Study 2018 and 2019, weighted (n = 72 549)

	Canada				US "illegal" states[a]				US "legal" states[b]			
	2018 (pre-legalization) (n = 10 018)		2019 (post-legalization) (n = 15 151)		2018 (n = 9692)		2019 (n = 10 231)		2018 (n = 7358)		2019 (n = 20 099)	
	%	n	%	n	%	n	%	n	%	n	%	n
Difficult	20.0	2 002	22.2	3 368	22.2	2 156	23.2	2 378	19.5	1 438	22.6	4 550
Neither easy nor difficult	35.9	3 601	35.0	5 308	31.5	3 053	33.0	3 381	32.2	2 370	33.2	6 673
Easy	21.2	2 122	19.7	2 984	22.0	2 132	19.0	1 946	22.9	1 682	19.9	4 009
Very easy	11.2	1 125	9.6	1 452	12.9	1 251	11.5	1 180	13.5	996	11.1	2 234
Cannabis use status[c]												
Not in past 12 months	72.6	7 275	64.9	9 836	76.3	7 394	69.5	7 109	66.0	4 856	61.1	12 287
Past 12-month user	8.6	862	11.3	1 717	6.9	672	8.1	831	9.3	685	10.1	2 022
Monthly user	4.8	485	6.9	1 053	5.2	507	6.1	624	6.8	499	6.3	1 272
Weekly user	5.1	507	5.6	850	4.1	397	4.7	482	6.6	485	6.2	1 252
Daily/almost daily user	8.9	889	11.2	1 696	7.4	721	11.6	1 185	11.3	833	16.3	3 266
Cannabis source												
Legal source	2.2	220	18.2	2 760	1.4	136	2.0	208	19.1	1 407	23.6	4 739
Illegal/unstated source	25.2	2 523	16.9	2 555	22.3	2 161	28.5	2 914	14.9	1 094	15.3	3 073
Not used in past 12 months	72.6	7 275	64.9	9 836	76.3	7 394	69.5	7 109	66.0	4 856	61.1	12 287
Suspected survey device type												
Smartphone[d]	0.0	0	42.7	6 475	0.0	0	51.9	5 306	0.0	0	52.7	10 598
Tablet	10.8	1 081	9.5	1 442	7.5	730	6.2	638	10.9	801	5.9	1 183
Computer	89.2	8 937	47.7	7 234	92.5	8 961	41.9	4 287	89.1	6 557	41.4	8 318

Note: Percentages may not total to 100 due to rounding.

[a] US states in which nonmedical cannabis is illegal.

[b] US states in which nonmedical cannabis is legal.

[c] Mutually exclusive categories. A "past 12-month user" is a respondent who indicated use in past 12 months, but not more recently.

[d] Use of smartphones to complete survey was prohibited in the 2018 (Wave 1) survey.

"In the past 12 months, have you gotten any type of marijuana from the following sources?" Response options were Made or grew my own; Family member or friend; Dealer; Internet delivery or mail order; Store, co-op or dispensary (Select all that apply), with follow-up questions to indicate authorized/legal versus unauthorized/illegal website or store if either of the latter two options were selected. Cannabis source was recoded to a binary variable (1 = legal source; 0 = illegal/unstated source). Coding of legal versus illegal sources is available upon request.

Data analysis

The final 2018 and 2019 cross-sectional samples comprised 27 169 and 45 735 respondents, respectively, for a combined total of 72 904 respondents. A subsample of 72 549 were included in the analysis after excluding respondents who refused to answer the question on noticing of health warning labels on cannabis products. Post-stratification sample weights were constructed based on Canadian and US census estimates and a raking algorithm applied; see the ICPS Technical Reports for details.[15,16] Weights were rescaled to the sample size for Canada and US "legal" states and "illegal" states. Estimates are weighted unless otherwise specified.

Binary logistic regression was used to test for differences in prevalence of noticing health warning labels (1 = Noticed cannabis health warning labels; 0 = Did not notice health warning labels/Not applicable/Don't know) between the three jurisdictions over time: fall 2018 (immediately before legalization in Canada) versus fall 2019, one year after legalization. Interactions between survey wave and jurisdiction were tested in subsequent model steps. Models were adjusted for time, age, sex, education, ethnicity, income adequacy, frequency of cannabis use and survey device type; 95% confidence intervals (95% CIs) and adjusted odds ratios (AORs) are reported. A threshold of $p < 0.05$ was used for significance. A subsequent model was conducted among cannabis users only, adjusting for the same covariates plus cannabis source. Analyses were conducted using survey procedures in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Sample characteristics are shown in Table 1. Within each jurisdiction, respondents were about equally distributed in terms of sex and age group. Mean respondent age (SD) was 40.3 (14.7) years. Most respondents identified as White and had at least a high school diploma.

Effect of time, jurisdiction and cannabis use on noticing health warnings

The prevalence of noticing health warnings by sociodemographic characteristics and other tested covariates among all respondents is shown in Table 2. The overall prevalence of noticing health warnings over time by jurisdiction is shown in Figure 2. Overall, respondents in Canada showed a greater increase in noticing warnings (+8.9%) in 2019 versus 2018 than respondents in US "illegal" states (+2.8%) and "legal" states (+3.2%).

Results of the regression model indicated a significant interaction between survey year and jurisdiction ($F(2,72649) = 41.37$, $p < 0.001$), such that the increase in noticing health warnings in 2019 (post-legalization) versus 2018 (pre-legalization) was greater in Canada compared to US "illegal" states (AOR = 2.02, 95% CI = 1.65–2.49, $p < 0.001$) and US "legal" states (2.34, 1.93–2.83, $p < 0.001$). There was no effect of survey year in US "illegal" versus "legal" states ($p = 0.150$).

The main effects model also showed a significant effect of cannabis use status ($F(4,72,647) = 386.18$, $p < 0.001$). Compared to those who had not consumed cannabis in the past 12 months, past 12-month (AOR = 1.88, 95% CI = 1.70–2.08, $p < 0.001$), monthly (3.12, 2.78–3.49, $p < 0.001$), weekly (3.59, 3.20–4.03, $p < 0.001$), and daily/almost daily (4.76, 4.38–5.19, $p < 0.001$) cannabis consumers were more likely to report noticing health warning labels.

Effect of cannabis source on noticing health warnings

The prevalence of noticing warnings by cannabis source among past 12-month cannabis consumers is shown in Figure 3. In 2019, consumers residing in jurisdictions with legal recreational cannabis who purchased from legal retail sources were also more likely to report noticing warnings than consumers who obtained cannabis from illegal/unstated sources (Canada: 40.4% vs. 15.3%; US "legal" states: 35.3% vs. 17.0%).

Results of the regression model show that the main effects of time and jurisdiction, as well as the interaction between time and jurisdiction, remained significant in this model ($p < 0.001$ for all), with the same pattern of results observed above (data not shown). Consumers who obtained their cannabis from a legal source were more likely to have noticed warnings than those who obtained it from an illegal/unstated source (37.1% vs. 12.7%, $p < 0.001$). There was also a significant interaction between jurisdiction and cannabis source ($F(2,22469) = 12.69$, $p < 0.001$), such that the positive effect of obtaining cannabis from a legal source was more pronounced in Canada compared to US "illegal" states (AOR = 21.71, 95% CI = 15.29–30.84, $p < 0.001$) and "legal" states (9.40, 7.50–11.77, $p < 0.001$), as well as in US "illegal" versus "legal" states (16.53, 11.75–23.28, $p < 0.001$). There was no three-way interaction between time, jurisdiction and cannabis source ($p = 0.731$).

The following groups were more likely to report noticing warnings: males versus females (AOR = 1.34, 95% CI = 1.22–1.46, $p < 0.001$); Other/mixed/unstated ethnic groups versus White respondents (1.12, 1.00–1.25, $p = 0.044$); those with college or technical training (1.49, 1.23–1.80, $p < 0.001$) or a bachelor's degree (1.69, 1.38–2.06, $p < 0.001$) versus less than high school; and those who said it was "very easy" to make ends meet versus those who said it was "neither easy nor difficult" (1.24, 1.05–1.45, $p = 0.009$) or who had unstated income adequacy (2.43, 1.54–3.83, $p < 0.001$). Respondents aged 16 to 25 (3.24, 2.77–3.80, $p < 0.001$), 26 to 35 (2.34, 2.03–2.70, $p < 0.001$), 36 to 45 (1.74, 1.49–2.03, $p < 0.001$) and 46 to 55 (1.42, 1.21–1.66, $p < 0.001$) were also more likely to notice warnings than older adults aged 56 to 65 years.

Similar to the pattern of results among all respondents, monthly (AOR = 1.45, 95% CI = 1.26–1.67, $p < 0.001$), weekly (1.51, 1.31–1.75, $p < 0.001$) and daily/almost daily consumers (1.97, 1.74–2.22, $p < 0.001$) were more likely to notice warning labels compared to those who consumed cannabis in the past 12 months (but not more recently). There was no effect of survey device type ($p = 0.492$).

Discussion

The results of this study suggest an increase in noticing health warnings on

TABLE 2
Percentage of respondents noticing health warning labels by tested covariates, International Cannabis Policy Study 2018 and 2019
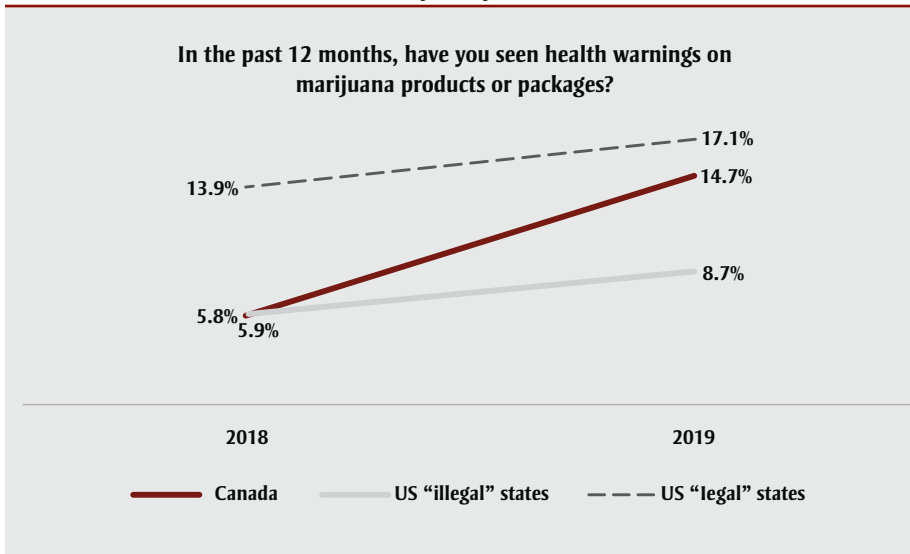
	Canada		US "illegal" states[a]		US "legal" states[b]	
	2018 (pre-legalization) (n = 10 018) %	2019 (post-legalization) (n = 15 151) %	2018 (n = 9692) %	2019 (n = 10 231) %	2018 (n = 7358) %	2019 (n = 20 099) %
Sex						
Female	4.6	11.8	3.8	6.8	11.5	14.1
Male	7.1	17.7	8.1	10.6	16.3	20.2
Age (years)						
16–25	7.5	19.4	5.1	10.7	14.1	23.9
26–35	7.8	23.2	10.2	13.6	22.6	23.6
36–45	6.6	15.3	8.5	10.3	18.0	16.6
46–55	4.2	9.6	4.5	5.4	7.6	11.8
56–65	3.2	6.3	1.1	3.0	6.3	8.4
Ethnicity						
White	5.1	13.1	5.6	7.4	14.8	16.6
Other/mixed/unstated	8.1	19.2	7.1	12.7	11.0	18.9
Highest education level						
Unstated	13.1	6.9	14.2	1.5	0.0	3.3
Less than high school	6.5	13.2	3.2	4.5	9.5	17.5
High school diploma	5.4	15.3	4.3	8.9	12.5	17.9
Some college/technical training	5.6	15.2	4.8	7.7	13.3	16.8
Bachelor's degree or higher	5.9	14.6	10.3	11.5	17.4	17.2
Income adequacy (difficulty making ends meet)						
Unstated	5.7	7.4	4.9	4.0	6.4	7.3
Very difficult	6.6	17.4	5.0	9.8	11.7	20.1
Difficult	5.3	15.2	4.0	6.6	12.1	16.5
Neither easy nor difficult	5.1	14.1	5.3	7.0	12.7	15.9
Easy	6.8	14.3	6.3	9.7	16.7	17.5
Very easy	6.7	16.7	10.9	16.0	17.4	21.4
Cannabis use status[c]						
Not in past 12 months	4.1	7.3	4.3	6.7	7.1	10.1
Past 12-month user	5.8	18.6	8.2	8.0	15.6	17.1
Monthly user	11.2	28.3	14.2	12.2	28.5	26.0
Weekly user	10.0	30.7	12.6	15.4	29.2	30.0
Daily/almost daily user	14.5	37.0	11.3	16.4	34.6	35.1
Cannabis source						
Legal source	27.3	40.4	47.6	41.4	36.6	35.3
Illegal/unstated source	8.9	15.3	9.0	11.2	15.0	17.0
Not used in past 12 months	4.1	7.3	4.3	6.7	7.1	10.1

[a] US states in which nonmedical cannabis is illegal.

[b] US states in which nonmedical cannabis is legal.

[c] Mutually exclusive categories (e.g. a past 12-month user is a respondent who indicated using cannabis in the past 12 months, but not more recently).

FIGURE 2
Percentage of respondents noticing cannabis health warning labels, International Cannabis Policy Study, 2018 and 2019 (n = 72 549)

In the past 12 months, have you seen health warnings on marijuana products or packages?

- Canada: 5.9% (2018) → 14.7% (2019)
- US "illegal" states: 5.8% (2018) → 8.7% (2019)
- US "legal" states: 13.9% (2018) → 17.1% (2019)

Legend: ── Canada ── US "illegal" states – – – US "legal" states
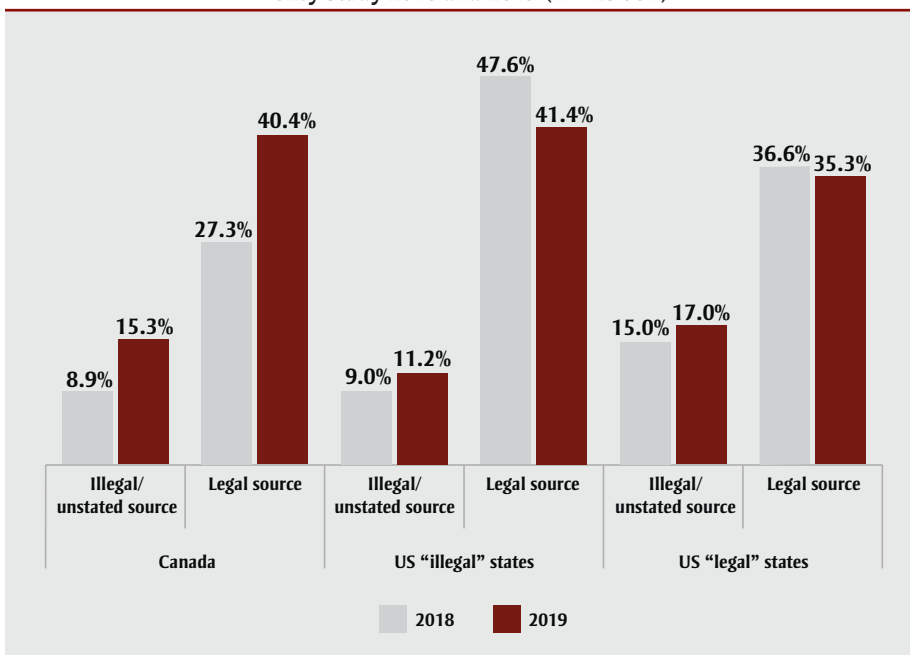
Note: "Legal" and "illegal" US states are states in which nonmedical cannabis is legal and illegal, respectively.

cannabis products after they were mandated as part of legalization of recreational cannabis in Canada. This is consistent with our hypotheses and with a recent national monitoring survey in Canada that found an increase in noticing health warnings on cannabis packages at one compared to two years post-legalization.[19] Indeed, consumers living in jurisdictions that had legalized cannabis were more likely to report noticing health warnings on packages than consumers in US "illegal" states (i.e. states where nonmedical cannabis remained illegal). Noticing warnings in 2019 was also greater among consumers who reported obtaining cannabis from legal sources. Although some products sourced through unregulated channels carry warnings—particularly if they have been diverted from legal

FIGURE 3
Percentage of respondents noticing cannabis health warning labels by cannabis source, among past 12-month consumers, International Cannabis Policy Study 2018 and 2019 (n = 23 792)

Canada:
- Illegal/unstated source: 8.9% (2018), 15.3% (2019)
- Legal source: 27.3% (2018), 40.4% (2019)

US "illegal" states:
- Illegal/unstated source: 9.0% (2018), 11.2% (2019)
- Legal source: 47.6% (2018), 41.4% (2019)

US "legal" states:
- Illegal/unstated source: 15.0% (2018), 17.0% (2019)
- Legal source: 36.6% (2018), 35.3% (2019)

Legend: 2018 2019

Note: "Legal" and "illegal" US states are states in which nonmedical cannabis is legal and illegal, respectively.

markets—labelling of unregulated products is highly variable and unreliable.

The analysis did not examine whether the greater size and prominence of the Canadian labels improved levels of noticing relative to the mandated warnings in US states, which are generally less distinctive and prominent. However, the higher rate of noticing among those who obtained cannabis from legal sources was more pronounced in Canada than in US "legal" or "illegal" states. In addition to the more distinctive warning labels in Canada, legal cannabis products in Canada also must follow packaging requirements similar to those for "plain" or "standardized" packaging for tobacco products—including the limitation to one background colour and restrictions on brand imagery[4]—which have been shown to reduce product appeal among young people and increase perceptions of risk.[20] Future longitudinal research is required to adequately examine the effectiveness of the Canadian warnings, given the recency of the legal market in Canada, and the fact that only a minority of consumers had transitioned to the legal market at the time of the study.

There was also a higher rate of noticing warnings among those who obtained cannabis from legal sources in US "illegal" versus "legal" states. Although "illegal" states were originally included as a comparison group that did not have legal recreational cannabis, this finding may reflect approved medical cannabis users purchasing from medical retail stores—the only type of "legal" retail store available in these states. Medical cannabis users are likely to be more selective consumers who are particularly motivated to seek health information and engage with product warnings.

More frequent cannabis consumers were also more likely to notice warnings, which is consistent with greater exposure to cannabis packaging in general. This higher level of exposure may be particularly important given that those who use cannabis more frequently are at a greater risk of health consequences from regular use.[21]

Other sociodemographic differences were also observed, although these differences were relatively modest in magnitude and may have been driven by jurisdictional differences. For example, the few differences observed in education level were

largely driven by differences among the states in which recreational cannabis remained illegal. In contrast, in legal jurisdictions with mandated warnings, levels of noticing warnings tended to be more similar across education levels (Table 2). These findings are broadly consistent with findings on tobacco warnings, which demonstrate that more prominent labels are associated with fewer differences across socioeconomic levels, particularly if warnings include pictures than do not require literacy to understand.[1] Early research of warnings on cannabis products suggests that pictorial health warnings are perceived as more effective and believable than text-based warnings.[7]

Finally, it is important to note that in Canada, only about one in five past 12-month consumers who obtained cannabis legally reported noticing health warnings. There are several possible reasons for this.

First, in most provinces, individuals can grow their own cannabis plants, and cannabis can be shared legally by another adult of legal age or a medical caregiver, either of whom may remove the product from its original packaging.[22,23] These legal sources would not provide opportunities for exposure to the warning labels.

Second, it is possible that some respondents believed an illicit cannabis retail source to be legal. Indeed, recent data show that many Canadian consumers still have trouble distinguishing between legal and illegal retail sources.[24] This would have led to lower levels of exposure among those who erroneously reported obtaining their cannabis from legal sources. However, given that there was no significant increase in noticing warning labels in US "legal" or "illegal" states—as hypothesized—the significant increase in noticing in Canada from pre- to post-legalization is noteworthy and suggests an increase in exposure after implementation of the warnings on legal products.

Third, exposure to cannabis health warnings may be more limited than is the case with warnings on other products, such as cigarettes, for which there is more extensive research. In general, cigarette packages are seen each time consumers remove a cigarette from the package,[1] whereas it is unclear whether cannabis consumers retain the original packaging of cannabis products. Among consumers of each substance, exposure to health warnings on cannabis products may therefore be lower than exposure to health warnings on cigarette packages. Future research should examine whether consumer awareness and knowledge of health warnings increase with the increasing shift from illegal to legal cannabis products in Canada, and the consequent increased exposure to warnings.

Strengths and limitations

The study benefited from a large sample size, a natural experimental design and the recruitment of participants across Canada and the US.

There were, however, some limitations. For example, the analysis examined differences between states with and without legalization of nonmedical cannabis. However, labelling policies also differ by medical cannabis legalization, which was not assessed in the study. Moreover, some states that have legalized nonmedical cannabis have yet to establish legal retail sales schemes (e.g. Vermont and the District of Columbia).[6] In addition, revised health warning labels in Canada came into effect two weeks before the end of the 2019 survey period. However, given that the central messages of the health warnings remained constant, it is unlikely that any exposure to the updated warnings influenced results among Canadian respondents.

This study was also subject to limitations common to survey research. Respondents were recruited using nonprobability sampling; therefore, the findings do not provide nationally representative estimates. The data were weighted by age group, sex, region, education and smoking status in both countries and region-by-race* in the US. However, compared to the national population, the US sample had fewer respondents with low education levels and people identifying as Hispanic.* Cannabis use estimates were within the range of national estimates for young adults, whereas estimates among the full ICPS sample were generally higher than national surveys in the US and Canada. This is likely due to the fact that the ICPS sampled individuals aged 16 to 65 years, whereas the national surveys included older adults, who are known to have lower rates of cannabis use. In both countries, the ICPS sample also had poorer self-reported general health compared to the national population, which is a feature of many nonprobability samples,[25] and may be partly due to the use of web surveys, which provide greater perceived anonymity than in-person or telephone-assisted interviews, which are often used in national surveys.[26]

Conclusion

Mandating health warning labels on cannabis products in Canada was associated with higher noticing of warnings, particularly among consumers who obtained their products from legal sources. Future research should examine the potential impact on downstream outcomes, including changes in health knowledge, perceptions of risk and social norms related to cannabis.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

DH conceptualized the project, sought research funding and contributed to the manuscript. SG led the analysis and manuscript writing.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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* Terminology used in the US census and original research questions.

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Original quantitative research

Socioeconomic factors and substances involved in poisoning-related emergency department visits in British Columbia, Canada

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Abstract

Introduction: Canada's opioid crisis has taken thousands of lives, increasing awareness of poisoning-related injuries as an important public health issue. However, in British Columbia (BC), where overdose mortality rates are the highest in Canada, studies have not yet identified which demographic populations most often visit emergency departments (ED) due to all poisonings, nor which substances are most commonly involved. The aim of this study was to explore these gaps, after developing a methodology for calculating ED visit rates in BC.

Methods: Poisoning-related ED visit rates during fiscal years 2012/13 to 2016/17, inclusive, were calculated by sex, age group, poisoning substance and socioeconomic status, using a novel methodology developed in this study. ED data were sourced from the National Ambulatory Care Reporting System and population data from Statistics Canada's 2016 (or 2011) census profiles.

Results: During the study period, there were an estimated 81 463 poisoning-related ED visits (351.2 per 100 000 population). Infants, toddlers, youth and those aged 20–64 years had elevated risks of poisoning-related ED visits. Rates were highest among those in neighbourhoods with the greatest material (607.8 per 100 000 population) or social (484.2 per 100 000 population) deprivation. Over time, narcotics and psychodysleptics became increasingly common poisoning agents, while alcohol remained problematic.

Conclusion: A methodology for estimating ED visit rates in BC was developed and applied to determine poisoning-related ED visit rates among various demographic groups within BC. British Columbians most vulnerable to poisoning have been identified, emphasizing the need for efforts to limit drug overdoses and excessive alcohol intoxication to reduce rates of these preventable injuries.

Keywords: poisoning, emergency service, social class, drug overdose, alcohol intoxication, adolescent

Introduction

Many emergency department (ED) presentations in Canada are due to preventable injuries. In Ontario, Alberta and the Yukon, there were nearly 2 million injury-related ED visits in the 2017/18 fiscal year, 43 678 of which were unintentional poisonings.[1] In British Columbia (BC), unintentional and self-harm poisonings are both significant concerns,[2] though poisonings in BC have often been described by mortalities

Highlights

- Between 1 April, 2012 and 31 March, 2017, there were about 81 463 poisoning-related emergency department visits in British Columbia, Canada.
- The highest poisoning-related emergency department visit rates were among individuals aged 25 to 44 years for males and 15 to 19 years for females, while for both sexes the lowest rate was among children aged 5 to 9 years.
- Broken down by age group and substance, the highest poisoning-related emergency department visit rate resulted from alcohol consumption among those aged 15 to 19 years.
- Poisoning-related emergency department visits were highest among those living in neighbourhoods with the greatest material and social deprivation.
- Overall, alcohol was the substance that most commonly resulted in poisoning-related emergency department visits; however, in 2016/17, narcotics and psychodysleptics surpassed alcohol as the substance type associated with the highest rate of poisoning-related emergency department visits.

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and hospitalizations, rather than by ED visits. For example, the most recent analysis of all-cause poisonings in BC looked at poisoning-related mortalities and hospitalizations, finding that they differed by cause and intent.[3]

It is often posited that many patients seen in the ED for poisonings are middle-aged illicit drug users from marginalized communities such as Vancouver's Downtown Eastside.[4] Supporting this supposition is evidence that residing in more deprived BC neighbourhoods increases the risk of drug overdose mortality.[5] Notably, 90% of those overdose deaths in 2016 involved opioids.[5] Similarly, opioid poisoning hospitalization rates across Canada were highest among those who were unemployed, resided in single-parent households or had the lowest income or education level.[6]

Although socioeconomic status has been assessed for poisoning mortality and hospitalizations, since no relationship between deprivation and poisoning-related ED visits has yet been explored, we chose to include socioeconomic status in this study. Due to the current opioid crisis,[7] much of the recent poisoning work conducted in BC has focussed on opioids. However, because literature from other jurisdictions has found alcohol, rather than opioids, to be responsible for the greatest number of poisoning-related ED visits,[8] we selected poisoning substance as another variable of interest. These knowledge gaps highlight the need for determining not only the quantity of poisoning-related ED visits, but also how socioeconomic status may be involved and which substances most often lead to these visits.

The ability to compare ED utilization among different BC populations is limited. While a national database, the National Ambulatory Care Reporting System (NACRS), exists, there is currently no systematic approach to using this data to calculate ED visit rates in BC. This is because many hospitals in BC do not report to NACRS and therefore the data are underestimated and incomplete. Accordingly, we developed a method for estimating ED visit rates in BC, aiming to inform poisoning prevention efforts by identifying subpopulations at high risk for poisoning ED presentations, including the socioeconomic characteristics of high-risk neighbourhoods, and the substances that commonly result in these presentations.

Methods

Study design

In this retrospective study, we analyzed trends in poisoning-related ED visits in BC for five fiscal years between 1 April, 2012 and 31 March, 2017. Poisoning-related ED visits were defined as visits to the ED by patients for whom the most responsible or primary diagnosis was poisoning, which includes overdoses or ingesting substances in error. There may have been instances in which patients were suffering from a chronic condition due to substance use or substance disorder, and overdosed. These patients were included in the study, but further analysis of these patients was beyond scope of this study. The rates of poisoning-related ED visits were calculated by year, sex, age group and poisoning substance, as well as by material and social deprivation, according to dissemination area (DA) of residence. This study was approved by the UBC Children's and Women's Research Ethics Board (#H13-01321).

Data sources

ED data were obtained from NACRS, which began reporting in BC during the 2012/13 fiscal year, for the period 1 April, 2012 to 31 March, 2017, inclusive. BC hospitalization data were extracted from the Discharge Abstract Database, BC Ministry of Health, for the same period. For every patient in the NACRS system, demographic, administrative and clinical characteristics were collected. NACRS data are collected while patients are treated in the ED, and this information is held to a high standard by the internationally recognized Canadian Institute for Health Research's Data and Information Quality Program. However, this dataset is limited because not all EDs in BC report to NACRS, resulting in the underrepresentation of certain regions and demographic groups. Discharge diagnosis in NACRS is captured using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA).[9] NACRS data were accessed via the Ministry of Health, and ICD-10-CA poisoning codes T36 to T65 were extracted. These codes cover a variety of substances, for example poisoning by drugs, medicaments and biological substances (T36–T50), toxic effect of alcohol (T51), toxic effect of organic solvents (T52), toxic effect of soaps and detergents (T55) and toxic effect of pesticides (T60).

Material and social deprivation quintiles obtained from Statistics Canada's 2016 Census Profile (or from the 2011 profile if 2016 information was missing), the source from which BC population data were also obtained, were assigned to each patient according to their DA of residence.

Deprivation interpretation

In Canada, DAs are geographic regions inhabited by approximately 400 to 700 individuals.[10] Each DA is associated with a quintile on the deprivation index, which was developed and validated[11] by the Institut national de santé publique du Québec (INSPQ). The index is divided into metrics describing material and social deprivation of those living within a DA. We selected a composite scoring system over individual measures of socioeconomic status, as this is favoured in the literature.[12] Material deprivation reflects the ownership of everyday goods and commodities, while social deprivation reflects social connectedness.[13] The index is based on six measurements for those aged 15 years or older that relate to health and either material or social deprivation. Metrics describing material deprivation include (1) the proportion of people without a high school diploma; (2) the employment-to-population ratio; and (3) average income. Metrics describing social deprivation include (4) the proportion of individuals living alone; (5) the proportion of people separated, divorced or widowed; and (6) the proportion of single-parent households.[13]

Material and social deprivation quintiles range between one and five, each representing approximately 20% of the BC population. The first and fifth quintiles represent the least and most deprived neighbourhoods, respectively.

Poisoning-related ED visit rate calculations

Since many BC hospitals do not report to NACRS, our poisoning-related ED visit rate calculations included the number of poisonings at EDs that do report (NACRS hospitals) and estimates for those that do not (non-NACRS hospitals). Using the concept of the injury pyramid,[14] these estimates for non-NACRS hospitals were calculated using hospitalization numbers at all BC hospitals extracted from the Discharge Abstract Database.

First, the ratio of poisoning ED visits to poisoning hospitalizations was determined

for NACRS hospitals (Figure 1, equation 1). For rate calculations throughout BC by year, sex, age group and deprivation quintile, one ratio encompassing all poisoning cases was used. Unique ratios were applied in calculations for each poisoning substance, as the ratios greatly varied among substances (from 0.43 for antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs to 38.22 for alcohol).

Second, estimates for the number of ED visits at non-NACRS hospitals were generated using these ratios (Figure 1, equation 2). Finally, poisoning-related ED visit rates per 100 000 population were determined (Figure 1, equation 3). Currently, about 30% of hospital emergency departments report to NACRS in BC. Using this subset of hospitals that do report to NACRS (for which we know the actual number of ED visits), we determined the robustness and accuracy of the estimates using simulations in which only 30% of hospitals in this subset were reporting to NACRS. The hospitals were chosen at random for each simulation. Ten thousand simulations were conducted, and 95% of simulations resulted in estimates that fell within 40% of the actual number of ED visits.

Data analysis

We calculated annual and total poisoning ED visit rates per 100 000 population, along with Wald 95% confidence intervals. Non-BC residents were excluded from analyses, as were patients whose age or sex information was missing. When DAs were missing information from 2016, data from the 2011 Census Profile were used.

For deprivation analyses, patients were excluded when information was missing from both the 2016 and 2011 census profiles.

Results

Total poisoning incidences

Between 1 April, 2012 and 31 March, 2017, there were approximately 81 463 (Table 1) poisoning-related ED visits in BC (351.2 per 100 000 population). Of these poisoning-related ED visits, 61 647 were at NACRS hospitals and an estimated 19 816 were at non-NACRS hospitals. For ED visits at NACRS hospitals, 2 and 25 patients were excluded due to missing age-group or sex information, respectively, resulting in a sample size of 81 436 patients.

Analyses by year, sex and age group

Throughout the study period, the overall poisoning-related ED visit rate was 406.6 and 296.5 per 100 000 population among males and females, respectively. The highest rates were among individuals aged 25 to 44 years for males and 15 to 19 years for females. For both sexes, the lowest rate was among children aged 5 to 9 years (Table 2).

Yearly rates increased 1.9-fold from 2012/13 to 2015/16, levelling off in 2016/17 (Table 2). From 2012/13 to 2016/17, the rates among males and females significantly increased 1.9-fold and 1.5-fold, respectively (Table 2).

Annually, rates for males were higher than those for females within all age groups,

except those aged 10 to 14 and 15 to 19 years. From 2012/13 to 2015/16, rates increased for every age group, before slightly decreasing in 2016/17. The increases of largest magnitude were among infants, toddlers and young children (aged 0–9 years), youth (aged 15–19 years) and those aged 20–64 years (Table 3).

Analyses by deprivation index

Because DA information was missing for some patients, 0.28% (174/61 647) of poisonings were excluded when calculating poisoning-related ED visit rates by deprivation. Among the remaining patients, DA reconfiguration led to missing quintile information, resulting in the exclusion of 7.93% (4873/61 473) of poisoning-related ED visits in 7.86% (599/7617) of DAs. Of the deprivation cases that were included, 94.74% (53 625/56 600) were calculated using data from the 2016 Census Profile, while the remaining 5.26% (2975/56 600) were calculated using data from the 2011 Census Profile.

For material deprivation, there was no significant difference in rates from the first to the second quintile. There were significant increases between each of the subsequent quintiles, the largest being between the fourth and fifth quintiles, with a significant 1.6-fold increase (383.4 [95% CI: 370.6–396.2] to 607.8 [589.2–626.4] per 100 000 population; Figure 2A).

For social deprivation, rates were significantly higher among those living in the least connected neighbourhoods (484.2 [470.0–498.4] per 100 000 population), followed by the most connected neighbourhoods (323.1 [311.3–334.8] per 100 000 population). There were significant reductions in rates from the first to the second and third quintiles, leading to a slight parabolic relationship between poisoning ED visits and increasing social deprivation (Figure 2B).

When assessing patients simultaneously by material and social deprivation, individuals in the fifth material and social quintiles (i.e. most deprived) had the highest rate (1102.0 [1034.1–1169.8] per 100 000 population). The lowest rate was among people in the first material quintile and second social quintile (161.4 [141.3–181.5] per 100 000 population; Figure 2C).

FIGURE 1
Formulas for calculating poisoning-related emergency department visit rates

$$(1)\ \text{Ratio} = \frac{ED_{NACRS}}{Hospitalizations_{NACRS}}$$

$$(2)\ ED_{non-NACRS} = \text{Ratio} \times Hospitalizations_{non-NACRS}$$

$$(3)\ \text{Rate} = \frac{ED_{NACRS} + ED_{non-NACRS}}{Population} \times 100\ 000$$

Abbreviations: ED, emergency department; ED_{NACRS}, number of poisoning ED visits at hospitals reporting to NACRS; Hospitalizations$_{NACRS}$, number of poisoning hospitalizations at hospitals reporting to NACRS; Hospitalizations$_{non-NACRS}$, number of poisoning hospitalizations at hospitals not reporting to NACRS; NACRS, National Ambulatory Care Reporting System.

Note: This figure shows the equations used for calculating (1) the ratio of poisoning-related ED visits to poisoning-related hospitalizations at NACRS hospitals; (2) the estimated number of poisoning-related ED visits at non-NACRS hospitals ($ED_{non-NACRS}$); and (3) the rate per 100 000 population of poisoning-related ED visits in all British Columbia EDs.

	Total		2012/13		2013/14		2014/15		2015/16		2016/17	
	n	%	n	%	n	%	n	%	n	%	n	%
Overall	81 436	100.00	10 557	12.96	13 667	16.78	18 132	22.27	20 318	24.95	18 762	23.04
Age group (years)												
0–4	2 197	2.70	259	2.45	321	2.35	485	2.67	604	2.97	528	2.82
5–9	654	0.80	48	0.45	62	0.45	159	0.88	206	1.01	180	0.96
10–14	1 954	2.40	264	2.50	312	2.28	411	2.27	509	2.50	458	2.44
15–19	7 948	9.76	1 074	10.17	1 401	10.25	1 894	10.45	1 846	9.08	1 734	9.24
20–24	8 332	10.23	1 085	10.28	1 423	10.41	1 782	9.83	2 102	10.35	1 940	10.34
25–44	29 746	36.53	3 712	35.16	4 699	34.38	6 344	34.99	7 697	37.88	7 294	38.88
45–64	23 540	28.91	3 149	29.82	4 178	30.57	5 357	29.54	5 652	27.82	5 204	27.74
65–74	4 132	5.07	521	4.93	721	5.28	1 015	5.60	999	4.92	877	4.67
75+	2 933	3.60	446	4.23	550	4.02	686	3.78	704	3.47	547	2.92
Sex												
Female	34 949	42.92	5 030	47.64	6 056	44.31	7 755	42.77	8 413	41.41	7 695	41.02
Male	46 487	57.08	5 528	52.36	7 611	55.69	10 377	57.23	11 905	58.59	11 066	58.98
Poisoning substance												
Alcohol	28 017	43.44	3 982	49.40	5 594	49.98	7 409	51.82	6 870	43.07	4 162	27.77
Unspecified drugs, medicaments and biological substances	15 902	24.66	1 743	21.62	2 539	22.68	2 910	20.35	4 569	28.65	4 140	27.63
Narcotics and psychodysleptics	12 975	20.12	1 383	17.15	1 689	15.09	1 983	13.87	2 897	18.16	5 024	33.52
Nonopioid analgesics, antipyretics and antirheumatics	4 073	6.32	406	5.04	739	6.60	1 300	9.09	813	5.10	816	5.44
Antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs	3 524	5.46	547	6.78	631	5.64	697	4.87	803	5.03	846	5.65
Material quintile												
1	10 629	14.03										
2	12 088	15.95										
3	15 603	20.59	N/A		N/A		N/A		N/A		N/A	
4	17 097	22.56										
5	20 362	26.87										
Social quintile												
1	14 542	19.19										
2	13 230	17.46										
3	11 930	15.74	N/A		N/A		N/A		N/A		N/A	
4	13 902	18.35										
5	22 174	29.26										

Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.

Note: Annual poisoning-related emergency department visits by material and social deprivation quintile were not included within the scope of this study.

TABLE 2
Poisoning-related emergency department visit rates per 100 000 population, by sex, fiscal year and age group, British Columbia, 2012/13 to 2016/17

	Overall rate (95% CI)	Male rate (95% CI)	Female rate (95% CI)
Fiscal year			
2012/13	232.2 (227.8–236.6)	244.7 (238.2–251.1)	219.9 (213.8–226.0)
2013/14	300.4 (295.3–305.4)	339.7 (332.1–347.3)	262.2 (255.6–268.8)
2014/15	390.2 (384.6–395.9)	449.7 (441.0–458.3)	331.6 (324.2–339.0)
2015/16	432.8 (426.8–438.7)	511.0 (501.8–520.1)	355.8 (348.2–363.3)
2016/17	394.3 (388.7–400.0)	468.7 (460.0–477.4)	321.1 (313.9–328.3)
Age group (years)			
0–4	196.9 (188.7–205.2)	207.0 (195.3–218.8)	186.2 (174.7–197.7)
5–9	57.4 (53.0–61.8)	63.9 (57.4–70.3)	50.5 (44.6–56.4)
10–14	169.9 (161.1–176.1)	80.1 (73.0–87.3)	262.7 (249.3–276.1)
15–19	569.2 (556.8–581.7)	403.7 (389.1–418.3)	748.4 (727.8–769.0)
20–24	538.4 (526.9–549.9)	556.9 (540.3–573.3)	519.6 (503.5–535.7)
25–44	475.2 (469.9–480.6)	601.8 (593.1–610.4)	350.8 (344.3–357.3)
45–64	353.7 (349.2–358.2)	452.9 (445.6–460.1)	256.8 (251.4–262.2)
65–74	187.2 (181.5–192.9)	212.4 (203.7–221.1)	162.9 (155.4–170.3)
75+	170.8 (164.7–177.0)	205.6 (195.3–215.8)	143.9 (136.3–151.4)

Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.

Abbreviation: CI, confidence interval.

Analyses by poisoning substance

Throughout the study period, the five most common poisoning substances resulting in ED visits were: (1) alcohol; (2) unspecified drugs, medicaments and biological substances (e.g. appetite depressants); (3) narcotics and psychodysleptics (e.g. opioids); (4) nonopioid analgesics, antipyretics and antirheumatics (e.g. acetaminophen); and (5) antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs (e.g. central nervous system depressants; Table 4). Compared with females, males demonstrated higher rates for all substances except nonopioid analgesics, antipyretics and antirheumatics (Table 4).

Common poisoning substances varied by age group. Rates among those aged 0 to 14 and over 75 years were greatest for unspecified drugs, medicaments and biological substances. Among those aged 15 to 74 years, rates were greatest for alcohol (Table 4).

Over the study period, rates followed different trends for the five most common substances (Figure 3A). Alcohol resulted in the highest rate from 2012/13 to 2015/16, reaching a peak in 2014/15 at 159.5 per 100 000 population (Figure 3A). In the 2014/15 fiscal year, the rate of alcohol-related poisoning ED visits was over 3.7-fold greater than that for narcotics and psychodysleptics (42.7 per 100 000 population); however, in 2016/17, narcotics and psychodysleptics became the most common substance resulting in poisoning ED visits (Figure 3A). Throughout the study period, the greatest increase was observed for narcotics and psychodysleptics poisonings, which had a 3.5-fold increase from 30.4 per 100 000 population in 2012/13 to 105.6 per 100 000 population in 2016/17 (Figure 3A).

As material deprivation increased, high poisoning-related ED visit rates were largely attributable to alcohol intoxication (Figure 3B). Of all material or social quintiles, the fifth (most deprived) material quintile had the highest rate of alcohol poisoning ED visits (222.4 per 100 000 population), while the fifth social quintile had the highest rate due to unspecified drugs, medicaments and biological substances (97.6 per 100 000 population), as well as narcotics and psychodysleptics (93.5 per 100 000 population; Figure 3C). Within the social quintiles, the highest rate resulted from alcohol intoxication of those living in the least connected neighbourhoods (146.0 per 100 000 population).
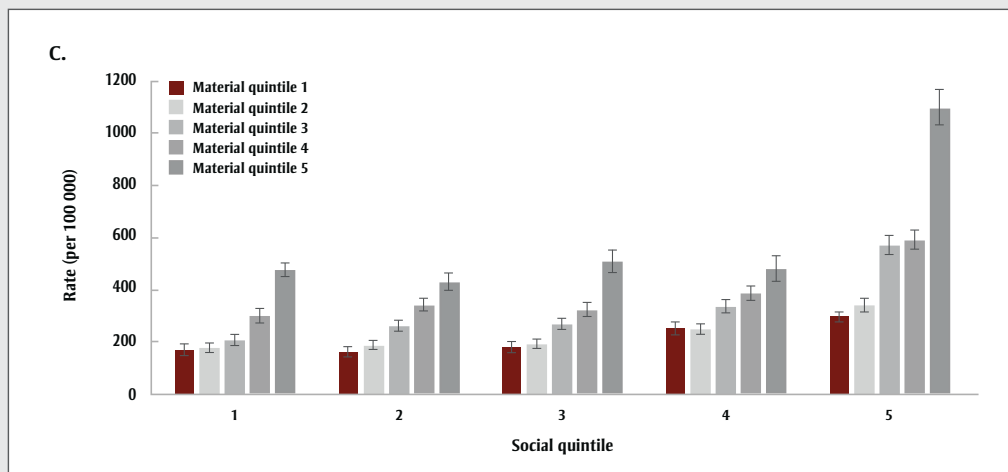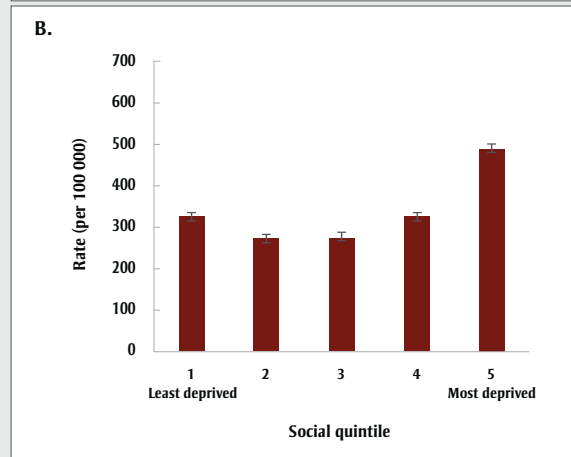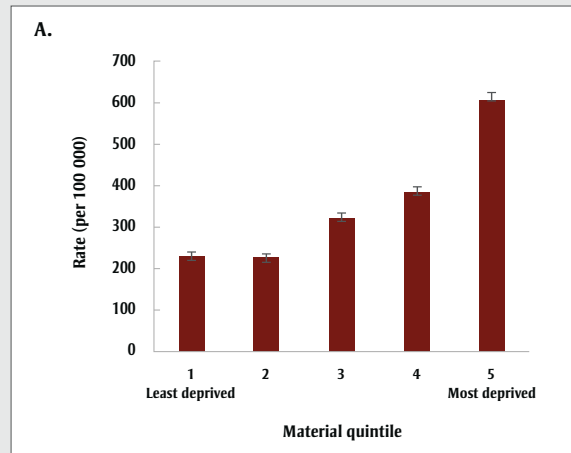
TABLE 3
Poisoning-related emergency department visit rates per 100 000 population, by age group and fiscal year, British Columbia, 2012/13 to 2016/17

	2012/13 rate (95% CI)	2013/14 rate (95% CI)	2014/15 rate (95% CI)	2015/16 rate (95% CI)	2016/17 rate (95% CI)
Age group (years)					
0–4	116.2 (102.0–130.4)	144.7 (128.9–160.5)	218.6 (199.2–238.1)	270.7 (249.1–292.3)	233.5 (213.6–253.4)
5–9	21.6 (15.5–27.7)	27.5 (20.7–34.4)	69.7 (58.9–80.6)	89.2 (77.0–101.3)	76.8 (65.6–88.0)
10–14	119.0 (105.1–133.0)	134.8 (119.8–149.7)	178.4 (161.2–195.7)	221.1 (201.9–240.3)	197.2 (179.1–215.2)
15–19	377.4 (354.9–400.0)	496.4 (470.4–522.3)	676.4 (646.1–706.8)	666.5 (636.2–696.8)	635.9 (606.1–665.7)
20–24	352.7 (331.7–373.6)	523.0 (495.9–550.1)	558.7 (532.9–584.6)	653.2 (625.4–681.0)	593.1 (566.8–619.4)
25–44	299.3 (289.7–308.9)	377.7 (367.0–388.5)	506.7 (494.2–519.1)	613.1 (599.4–626.7)	575.6 (562.4–588.8)
45–64	239.3 (230.9–247.6)	316.1 (306.5–325.7)	402.6 (391.8–413.3)	422.3 (411.3–433.2)	386.0 (375.5–396.4)
65–74	131.6 (120.3–142.9)	171.8 (159.2–184.3)	229.4 (215.3–243.5)	215.0 (201.6–228.3)	181.0 (169.0–192.9)
75+	138.2 (125.4–151.0)	165.3 (151.5–179.2)	200.2 (185.2–215.2)	199.3 (184.6–214.0)	149.7 (137.2–162.2)

Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.

Abbreviation: CI, confidence interval.

FIGURE 2
Poisoning-related emergency department visit rates per 100 000 population,
by (A) material quintile, (B) social quintile and (C) material quintile, controlling for social quintile,
British Columbia, 2012/13 to 2016/17

Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.
Note: Error bars display 95% confidence intervals.

Poisoning-related emergency department visit rates per 100 000 population for the five most common poisoning substances, by sex and age group, British Columbia, 2012/13 to 2016/17

	Alcohol rate (95% CI)	Unspecified drugs, medicaments and biological substances rate (95% CI)	Narcotics and psychodysleptics rate (95% CI)	Nonopioid analgesics, antipyretics and antirheumatics rate (95% CI)	Antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs rate (95% CI)
Overall	120.8 (119.4–122.2)	68.5 (67.4–69.6)	55.9 (54.9–56.8)	17.6 (17.0–18.1)	15.1 (14.6–15.6)
Sex					
Male	164.7 (162.3–167.0)	69.4 (67.9–70.9)	72.7 (71.2–74.3)	12.7 (12.0–13.3)	17.0 (16.3–17.8)
Female	77.6 (76.0–79.2)	67.6 (66.1–69.1)	39.3 (38.2–40.5)	22.4 (21.5–23.2)	13.3 (12.6–13.9)
Age group (years)					
0–4	1.4 (0.7–2.1)	69.5 (64.7–74.4)	6.2 (4.7–7.6)	36.1 (32.5–39.6)	2.2 (1.3–3.1)
5–9	–	9.6 (7.8–11.4)	–	2.0 (1.2–2.8)	0.5 (0.1–0.9)
10–14	40.7 (37.0–44.3)	43.1 (39.3–46.8)	2.7 (1.8–3.7)	19.7 (17.1–22.2)	4.2 (3.0–5.4)
15–19	168.2 (161.4–175.0)	133.7 (127.6–139.8)	40.4 (37.0–43.7)	54.7 (50.8–58.6)	20.5 (18.1–22.9)
20–24	156.9 (150.6–163.1)	123.8 (118.3–129.3)	104.0 (99.0–109.1)	32.3 (29.4–35.1)	29.8 (27.0–32.5)
25–44	155.5 (152.4–158.6)	89.6 (87.2–91.9)	99.3 (96.9–101.8)	17.3 (16.3–18.3)	25.8 (24.5–27.0)
45–64	162.5 (159.4–165.5)	52.8 (51.0–54.5)	53.5 (51.8–55.3)	11.6 (10.8–12.4)	12.9 (12.0–13.7)
65–74	71.8 (68.2–75.3)	33.4 (31.0–35.8)	27.3 (25.2–29.5)	7.7 (6.6–8.9)	5.4 (4.4–6.4)
75+	36.3 (33.4–39.1)	50.5 (47.2–53.9)	17.6 (15.6–19.6)	7.8 (6.5–9.1)	5.8 (4.7–6.9)

Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.

Abbreviation: CI, confidence interval.

Note: "–" signifies fewer than 5 cases.

Discussion

This study identified demographic characteristics and poisoning substances associated with increased poisoning-related ED visits in BC for the five fiscal years from 2012/13 to 2016/17. Poisoning-related ED visit rates for males and females appeared to diverge throughout the study period, with males having significantly higher rates over time, as is consistent with existing literature.[15]

Rates of poisoning-related ED visits increased significantly for both sexes between 2012/13 and 2015/16, especially for infants, toddlers and young children (aged 0–9 years), youth (aged 15–19 years) and those aged 20–64 years. A marked increase in poison centre calls in the United States was noted from 2000 to 2010 concerning children aged 0 to 5 years, largely due to increasing numbers of prescription and nonprescription drug ingestions,[16] which could help explain the findings in this study. The growing number of opioid overdoses has also contributed to increasing ED visits in other jurisdictions,[17] which may offer an explanation for the increased rate among those aged 15 to 64 years.

Opioids are narcotics, the substances that increased most in frequency throughout the study period, particularly in the two fiscal years 2015/16 and 2016/17, coinciding with the emergence of the opioid crisis in BC. Narcotics and psychodysleptics surpassed alcohol as the leading cause of poisoning-related ED visits for the first time in 2016/17. At that time, a decrease in alcohol-related poisoning ED visits may have resulted from a liquor policy review that gradually reformed BC liquor laws between 2014 and 2017.[18] Nevertheless, alcohol is a key poisoning substance resulting in ED visits in BC, where alcohol-related hospitalizations are higher than in all other Canadian provinces,[19] highlighting the lack of attention to safe alcohol consumption in BC. Meanwhile, existing alcohol regulation policies at the federal level in Canada fail to target the most vulnerable populations.[20]

Alcohol was the substance most commonly involved in poisoning-related ED visits over the study period, particularly among youth. This is of great concern, as youth aged 15 to 19 years demonstrated the highest rates of alcohol-related ED visits compared with all other age groups. Youth aged 15 to 19 years also had the highest rate for all poisoning-related ED visits, regardless of substance, identifying youth poisoning prevention as an important public health focus.

Individuals in their teenage years are susceptible to the influences of peer pressure when choosing to participate in underage alcohol consumption and illicit drug use,[21-22] raising concerns that as more adolescents engage in such activities, the number of poisoning-related patients may continue to increase. The increase in poisonings among youth aged 15 to 19 years is worrisome, not only because of the harm caused to young lives, but also because poisoned youth require more health care resources relative to peers with other health concerns.[23]

A large portion of this burden can be attributed to youth living in families of lower socioeconomic status, as evidence supports that these individuals are at higher risk for engaging in substance use.[24] For context, the per capita hospital care cost in Manitoba was 73% higher for those living in neighbourhoods with the lowest socioeconomic statuses, compared to those with the highest.[25]

Such findings help to explain our results that poisoning-related ED visit rates
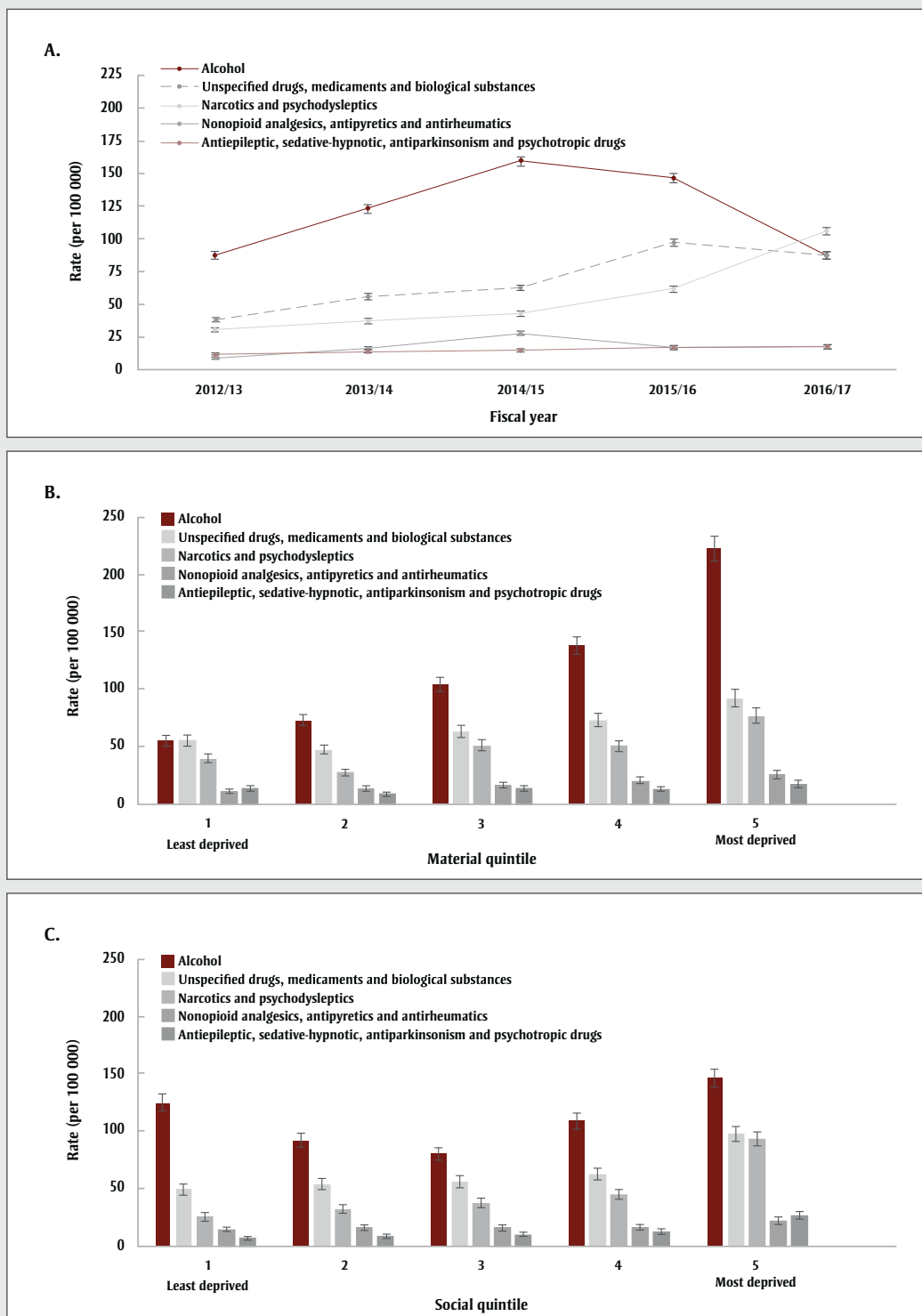
Data sources: Emergency department data were obtained from the National Ambulatory Care Reporting System; population data were obtained from Statistics Canada.
Note: Error bars display 95% confidence intervals.

generally increased with material deprivation. However, there was a less prominent relationship between poisoning-related ED visit rates and social deprivation. Counterintuitively, rates were significantly higher for those in the most socially connected quintile (the first one) than those in the second and third quintiles. While this result was unexpected, previous work identified a significant positive association between social capital and binge drinking among high school students,[26] aligning with our findings that high poisoning-related ED visit rates resulted from alcohol consumption among youth and all age groups living in the most socially connected neighbourhoods. This evidence may assist in identifying demographic populations that would benefit from poisoning prevention initiatives, particularly those related to alcohol. Given the high rates of alcohol-related ED visits among youth aged 15 to 19 years, additional policies to restrict those under the age of majority from accessing alcohol may be useful to decrease the number of poisoning events in BC.

As hinted at by the increasing rate of poisoning-related ED visits attributed to narcotics and psychodysleptics throughout the study period, efforts to reduce the severity of the opioid crisis in BC may in turn decrease ED burden. Accordingly, the province could implement opioid prescription monitoring programs, to help reduce the likelihood of opioid prescriptions leading to overdoses. An alternative approach may be to continue pursuing the decriminalization of illicit drugs, which was shown to decrease drug-related morbidity and mortality in Portugal since being implemented in 2001.[27]

Future studies may focus on developing a multivariable modelling methodology to improve calculations of ED visit rates in BC. Such a methodology could be used in the future to further identify demographic groups in BC at high risk for poisoning-related ED visits, by conducting analyses that consider additional factors such as ethnicity or psychometric properties. As well, the need still exists to identify regional poisoning-related ED visit rates in the province. This additional information would contribute to a better understanding of which BC areas and demographic groups would benefit the most from poisoning prevention strategies.

It is important to continue to enhance efforts to prevent poisonings, which are a leading cause of hospitalization and death in BC.[3] Evidence from public health and injury prevention literature suggests that much can be done to prevent poisonings at all ages, including the positive impact that physicians can have in direct patient counselling and as a credible voice in the community.[28,29] The importance of prevention efforts to reduce the social and economic burden of these injuries, and in particular, to help reduce ED wait times to improve patient care, cannot be understated.

Strengths and limitations

One strength of this study is that it explored the relationships between deprivation and all causes of poisoning-related ED visits, topics that were lacking in the existing Canadian literature. Additionally, we developed and used a methodology for estimating ED visit rates using NACRS data in BC.

Although this study explored novel public health issues, it is not without limitations. NACRS data are neither systematically nor comprehensively collected by BC hospitals. Because the number of ED visits at hospitals not reporting to NACRS had to be estimated, ED visit rates were influenced by the number of poisoning ED visits and admissions at NACRS hospitals, which may disproportionately represent certain regions and demographics. This effect may be more pronounced when comparing rates by sex, because hospitalizations and ED visit trends differed; while poisoning ED visits were greater for males, hospitalizations were greater for females.

The ED visit rate calculation methodology requires a statistical assumption that the ED-to-hospitalization ratio for poisonings is the same (or very similar) at NACRS and non-NACRS hospitals. Without accessible ED data from non-NACRS hospitals, it is impossible to compare the two ratios empirically. This methodology has not been formally validated, although in our assessment of its robustness, we found that 95 % of simulations produced estimates within 40 % of the actual number of ED visits, which by itself is a limitation. In addition, the method used to calculate poisoning-related ED visits is not a multivariable modelling approach, and does not adjust rates for important covariates such as ethnicity or geography.

An additional limitation is that external causes of injury are not reported to NACRS in BC. This means that ED visits relating to poisoning by intent could not be assessed.

Material and social deprivation quintiles were assigned to each patient based on their DA of residence, creating an ecological fallacy that applies neighbourhood characteristics to individuals. The deprivation index measures household material and social factors, but does not account for external support. Additionally, patients with missing DAs that could not be matched to their associated deprivation quintiles were excluded from the analyses.

Finally, because de-identified data were used, events with multiple ED visits may have been double counted.

Conclusion

Poisoning-related ED visit rates in BC increased dramatically in the five fiscal years from 2012/13 to 2016/17. High-risk groups include infants, toddlers, youth, those aged 20 to 64 years, those with high material deprivation and those with the least or greatest social connectedness. While the opioid crisis is a BC public health emergency, alcohol intoxication, as suggested by this study, is also a problematic public health issue for local EDs. This study indicates the need for future research and consideration of the role that physicians can play regarding poisoning prevention strategies targeted at vulnerable demographic populations in BC, including specific messages focussed on safe alcohol consumption, particularly among teenagers and young adults.

Conflicts of interest

None.

Authors' contributions and statement

SB and AZ conceptualized the study. FR led data curation. AZ developed the rate calculation methodology. SP conducted data analysis and visualization, guided by FR, AZ and IP. SP drafted the manuscript. All authors contributed to reviewing the manuscript and read and approved the final manuscript.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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Original quantitative research

Improving smoking cessation support for Quebec's smokers: an evaluation of Quebec's telephone quitline

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Abstract

Introduction: Quitlines are an important and widespread intervention that support smokers in their efforts to quit smoking and engage them into treatment services. Quebec's quitline, called *la ligne J'ARRÊTE,* has been in operation since 2002. The objectives of this study were to evaluate treatment reach, provide a description of caller characteristics and to provide results on cessation outcome measures for Quebec's smoking cessation quitline.

Methods: We collected data at intake, assessing new caller volume, caller characteristics and treatment reach. We used a one-group quasi-experimental design to assess 30-day and six-month quit rates, at six-month follow-up. Intake data were collected for 1292 new quitline callers, 18 years of age and older, over a one-year period.

Results: Results indicated that the service reached 9 in 10 000 Quebec smokers. With respect to the total population of smokers in Quebec, the quitline reached proportionately higher numbers of smokers who were women, were 55 years of age and older and had a high school diploma or less. At follow-up, the 30-day point prevalence abstinence rate was 26.7%, while the six-month prolonged abstinence rate was 18.8%.

Conclusion: These results indicate that the quitline contributed to helping callers quit smoking. They are in line with findings for other quitlines in Canada and the United States. However, quitline reach is comparatively limited, suggesting that additional investment in promotional efforts and research into ways of recruiting underserved populations into the service would increase public health impact.

Keywords: smoking cessation, quitline, population health intervention, health promotion, program evaluation

Highlights

- Results of this study indicated a 26.7% smoking cessation rate at six-month follow-up for smokers that used Quebec's quitline service.
- Quebec's quitline reaches 9 out of 10 000 smokers (0.09%) in Quebec, putting it at the lower range of Canadian quitlines, where reach ranges from 0.07% to 1.45%.
- While the quitline reaches proportionately more callers with a high school education or less, men, younger adults and those with higher education are subgroups of smokers for whom improved promotion of quitline services appears necessary.

Introduction

Cigarette smoking remains one of the leading causes of preventable illness and death in Canada and throughout the world.[1-3] Quitlines are an important and widespread evidence-based smoking cessation intervention that support smokers in their efforts to quit and engage them into treatment services.[4,5] Smokers can use quitlines by calling (i.e. reactive) or by signing up to receive a call (i.e. proactive) from a smoking cessation counsellor. Supports include information, advice and help to quit smoking.

Around the globe, quitlines have become part of national tobacco control infrastructures that provide population-based cessation treatment to smokers.[6,7] Considerable evidence shows that quitlines are an effective intervention strategy.[5]

Owen[8] found that at one-year follow-up, 22% of smokers reported having quit smoking (95% CI: 18.4%–25.6%; quit rate adjusted for an estimated 20% failed biomedical validation and refusals: 15.6%), 41% of ex-smokers reported that they were still not smoking (95% CI: 34.3%–47.7%; adjusted quit rate: 29%) and that

of those who had resumed smoking, 28% were smoking less than before. Comparing proactive and reactive components of the Swedish National Tobacco Quitline, Nohlert and colleagues found that both services were similarly effective. Point prevalence was 27% and continuous abstinence was 21% when treating nonresponders as smokers, and 47% and 35%, respectively, in responder-only analyses.[9]

The most recent Cochrane review on the topic, which included 104 trials with 111 653 participants, found moderate-quality evidence that proactive telephone counselling helps smokers who seek help from quitlines.[5] According to grades of evidence from the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) Working Group, moderate-quality evidence implies that further research is likely to have an

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important impact on the estimate of effect.[10] The review further found that proactive telephone counselling increased quit rates in smokers, independent of their motivation to quit or whether they received other quit support. Overall, those who received telephone calls increased their chances of quitting between 11% and 14%. Compared to other cessation supports, telephone quitlines have been found to be more effective than minimal interventions such as self-help leaflets and as effective as receiving brief cessation advice.[5]

Quitlines have also been shown to be cost-effective interventions.[11] In a one-year randomized trial that evaluated the cost-effectiveness of the American Cancer Society's telephone quitline service, McAlister and colleagues[12] reported that counselling nearly doubled smokers' odds of quitting and maintaining cessation over a one-year period. The direct cost for each case of maintained smoking cessation attributable to the quitline was approximately CAD $1300.[12]

Across the US, average treatment reach has ranged from a high of 1.19% in 2009 to a low of 0.87% in 2017.[13] In Canada, quitlines tend to have lower reach and consequently lower relative impact. The latest available numbers indicate that the 10 of 12 Canadian quitlines that responded to the survey reached and provided treatment to 0.30% of the adult smoking population, with reach levels ranging from 0.07% to 1.45% over individual provincial quitlines in 2011.[14]

This study reports on the results of the first evaluation of Quebec's quitline since its inception. Evaluation goals were to (a) evaluate treatment reach, (b) provide a description of caller characteristics and (c) provide results on cessation outcome measures.

Methods

Intervention description

Quebec's quitline, *la ligne J'ARRÊTE* (I QUIT NOW helpline), in operation since 2002, is a free, bilingual and confidential telephone service that offers information and personalized smoking cessation support. The quitline service was developed based on the transtheoretical model of change.[15] This model suggests that smokers move through a series of motivational stages before they make changes to their smoking

behaviours. These stages are precontemplation (no thought of quitting), contemplation (thinking about quitting), preparation (planning to quit in the next 30 days) and action (quitting successfully for up to six months).[16] Quitline personnel of *la ligne J'ARRÊTE* use motivational interview techniques[17] to support callers who wish to quit smoking, posing a multitude of questions related to caller cigarette consumption (e.g. negative health effects, withdrawal symptoms, pharmacotherapy, second-hand smoke exposure). Additionally, the quitline offers information packages containing information on cigarette consumption, interactive tools to support cessation efforts, and information on Quebec's quit-and-win contest, a yearly initiative providing the opportunity to win three prizes for those who quit smoking and stay quit for six weeks. Finally, the quitline refers callers to other smoking cessation services offered within the Quebec tobacco control strategy, such as the in-person support offered by Quebec's local community service centres. The quitline service is offered on weekdays for a total of 64 hours per week. It is funded by the Quebec Ministry of Health and Social Services and administered by the Canadian Cancer Society (CCS).

Study design

Following the North American Quitline Consortium (NAQC) protocol for quitline evaluation,[18] we used a one-group quasi-experimental, pre–post intervention design to evaluate the effectiveness of Quebec's quitline service. We collected data at two time points: (1) intake data were collected by quitline staff when smokers first called the quitline; and (2) computer assisted telephone interviews (CATI) were conducted at six-month follow-up. The latter permits assessment of the six-month quit rates, a metric that is commonly used in clinical trials of smoking cessation.[19] CATI data were collected seven months after a person's initial call to the quitline. This allows for a one-month treatment period followed by a six-month follow-up survey with respect to the approximate end of treatment.[20] To reach a critical number of callers at follow-up, up to 20 call attempts were made to reach callers who had consented to participate in follow-up interviews. Intake data, collected between October 2014 and October 2015, were used to calculate reach and to provide a description of the quitline's caller profile. The six-month follow-up data were collected between June 2015 and May 2016 and used

to evaluate service outcomes. Interviews lasted on average 7.5 minutes and were conducted in French only.

Measures

We collected data using the 2012 version of the Minimal Data Set (MDS) for evaluating quitline intake and follow-up provided by the NAQC.[21] The MDS for quitlines was developed to provide a standardized instrument and protocol that allow for comparisons and polling of data across quitlines.[22,23] The MDS is a "best practice" in quitline evaluation[22,23] and is revised and expanded based on evidence and experience on a regular basis.[22,24]

Demographics

Age, sex and education data were collected at intake for new callers.

Smoking and promotion measures

Smoking status (daily or occasional), cigarette consumption and quit intention data were collected at intake for new callers.[22,25] To assess which promotional methods worked best, we asked callers how they had learned about the quitline. Smoking status and cigarette consumption data were used to calculate Heaviness of Smoking Index (HSI)[26] scores for smokers.

At time of evaluation, the quitline defined smokers as individuals who smoked cigarettes. Other tobacco products and vaping devices such as electronic cigarettes were identified as "other tobacco products" and not directly addressed through the interventions. In the present study, smoking is consequently defined as cigarette use only, and excludes other tobacco products and vaping devices.

Study eligibility

In addition to age, smoking status and intention to quit at intake, questions used to determine eligibility for study participation asked the following: "How can I help you?"; "Is this your first call to the quitline in the past 12 months?"; and "Are you calling for yourself, or calling on behalf of or to help someone else?" Administrative data from the CCS were used to determine if callers had in fact received evidence-based treatment from the quitline, defined as having received any level of counselling.

Smoking cessation abstinence measures

For the quitline to be considered effective in helping smokers quit, quitlines users would have to quit smoking at a higher

rate than that of the population of Quebec smokers (from 2015–2016 in Quebec, adult current smokers quit smoking at a rate of 8.9%[27]). In addition, 30-day point prevalence abstinence rates would have to be comparable to those of other quitlines. As a point of reference, the 30-day point prevalence abstinence rates for US quitlines have been shown to be 28.5%.[14]

To assess smoking cessation abstinence at follow-up, we used three questions to assess smoking cessation rate, our main outcome measure. It was first measured by asking participants whether they currently smoked "every day," "occasionally" or "never." To assess 30-day point prevalence abstinence rate, we asked those who indicated they were nonsmokers at follow-up if they had smoked a cigarette, even a puff, within the past 30 days. Finally, to assess six-month prolonged abstinence rate, we asked participants who indicated they had not smoked within the past 30 days if they had smoked a cigarette, even a puff, within the past six months. All three measures have demonstrated some degree of concurrent validity and have established predictive validity with respect to long-term health benefits.[28]

Cessation supports and methods used

We asked quitline users at follow-up what services or cessation supports, other than the quitline, they had used to quit smoking since they first called the quitline. Response options for nonpharmaceutical support included self-help materials, support group with animation, hypnosis/acupuncture, audio materials, Internet, self-help group, laser treatment, videos and others. Response options for items related to pharmacotherapy included nicotine inhaler, nicotine gums, nicotine patch, e-cigarette and Zyban.

Treatment reach

To determine the extent to which the telephone quitline was accessed by Quebec smokers to help them quit smoking, we calculated treatment reach, defined as the number of new incoming eligible callers over the 12-month period who received evidence-based treatment, divided by the total number of smokers in the Quebec population.[18] The prevalence of smoking in Quebec was based on the Canadian Community Health Survey (CCHS)[27] data for current smokers aged 18 years and older for the 2015-2016 cycle. While the CDC estimates that quitlines should be able to treat 6% of all adult smokers,[29] the

latest data for Canadian quitlines indicate that in 2012, quitlines reached between 0.07% and 1.45% of smokers.[14] We expected Quebec's quitline treatment reach would fall into the range of other Canadian quitlines, though higher treatment reach would be desirable.

Inclusion criteria

In line with NAQC recommendations,[30] data collected at intake were analyzed for all new quitline callers who (1) were aged 18 years and over; (2) smoked cigarettes daily or occasionally and intended to quit within the next six months or had not been quit at intake for more than 30 days; (3) were seeking smoking cessation help; and (4) had received evidence-based treatment from the quitline. Additionally, only callers who consented to participation were included in the follow-up surveys.

Statistical analyses

In line with NAQC recommendations,[30] the *30-day point prevalence abstinence rate* was calculated as the number of respondents who said they had not smoked a cigarette, even a puff, within the past 30 days at six-month follow-up divided by the number of participants reached at follow-up, as the primary outcome measure. The *point prevalence rate* was calculated by dividing the number of respondents who said that they were nonsmokers at follow-up by the number of participants reached at follow-up. Finally, the *six-month prolonged abstinence rate* was calculated by dividing the number of respondents who said that they had not smoked a cigarette, not even a puff, within six months of follow-up by the number of participants reached at follow-up. Both latter measures are reported as secondary outcome measures.

To assess the impact of dropout on the estimated rates in this study, we calculated intention-to-treat (ITT) rates that assume all nonrespondents did not quit smoking[30] for all abstinence measures. The ITT rates represent conservative lower limits on the different quit rates.[31] In addition, we calculated imputed rates, taking into account a host of service, health and sociodemographic variables measured at baseline. The imputed rates account for the effect of differences in characteristics between respondents and dropouts; they were calculated using the *mice* (Multiple Imputation by Chained

Equations) package in R.[32] The ITT and imputed rates represent possible limits on the values of the quit rates and provide insight into the potential magnitude of selection bias effects.[31,33]

We used the following criteria to select covariates or caller characteristics for the imputation model: (1) a statistically significant association (chi-square test) with dropout (i.e. missing data or nonresponse at follow-up); (2) a statistically significant correlation (Pearson r^2) with the probability of abstinence; (3) a perceived association with abstinence based on a priori knowledge and the scientific literature (the latter resulted in the addition of three covariates).

The following variables were retained for the imputation model: gender, age, education, whether or not the caller received a referral, past use of smoking cessation methods or pharmacological tools, current use of smoking cessation methods or pharmacological tools, number of withdrawal symptoms, having at least one supportive person in personal network, number of medical conditions, number of mental health conditions, experience of situations that induce restarting of smoking, receipt of promotional cessation materials, number of cessation support elements received, whether the quitline fulfilled expectations, and smoking status at intake.

The R function *mice* was used to calculate 20 multiple imputations of the outcome (abstinence) variables; 25 iterations were specified, and the R function *stripplot* was used to verify convergence.[32]

Results

Over the one-year evaluation period, quitline staff collected intake data from 1292 new callers. Of those, 1030 agreed to participate in the six-month follow-up survey and 494 actually participated, for a response rate of 48%.

Treatment reach for *la ligne J'ARRÊTE* for the reported year of evaluation was 0.09%, indicating that the service provided evidence-based cessation treatment for 9 in 10 000 Quebec smokers. An analysis of the ways in which callers accessed the service showed that 29.3% of callers had been referred to the quitline by health professionals through service agreements

with hospitals, clinics, health centres or collective agreements, or electronically by Quebec's text-to-quit program, the *Service de Messagerie texte pour Arrêter le Tabac* (SMAT). The majority of referrals (57.8%) came from settings within Montréal. Other regions contributed from 0.8% to 5.8% of quitline referrals.

Those who had not been referred to the service predominantly indicated having learned about it through the quitline number being printed on their cigarette packages (47.2%), a measure the federal government introduced across Canada in 2012. Other means through which callers had learned about the quitline include the *J'ARRÊTE* website (10.3%), their physician's office (4.8%), family and friends (4.1%), Quebec's quit and win contest (2.8%), cessation centres (2.8%), pharmacies (2.6%) and the quit and win contest's website (2.4%).

Caller characteristics

Table 1 presents caller characteristics at baseline in comparison with Quebec adult smokers and recent ex-smokers who quit smoking in the last year. As shown in the table, results indicate that compared to current smokers aged 18 years and older in Quebec, quitline callers were more often women (56.7% vs. 46.2% in the population). Callers within the age groups of 18 to 24 and 25 to 34 years were underrepresented and callers in the age groups of 55 to 64 and 65 and older were overrepresented. Callers with a high school education or less were also overrepresented among quitline callers (53.4% vs. 41.8%). Quitline callers also showed a higher level of nicotine dependency compared to Quebec's population of daily smokers[27] (high HSI: 52.3% vs. 28.8% in the population). Of the 1292 callers, 1272 indicated they spoke French. A comparison of caller characteristics between participants at intake and six-month follow-up did not yield statistically significant differences in any of the demographic variables.

Smoking cessation

Quit rates

At six-month follow-up, the 30-day point prevalence abstinence rate was 26.7%. The point prevalence abstinence rate (i.e. callers who said that they were nonsmokers) was 29.8%. Finally, the six-month prolonged abstinence rate (i.e. callers who said that they had not smoked a cigarette,

TABLE 1
Characteristics of new incoming callers to smoking cessation quitline, October 2014 to October 2015, at baseline (intake) compared to Quebec adult (aged 18 years and older) smokers and recent ex-smokers, CCHS 2015-2016

Caller characteristics	Quitline callers at baseline (N = 1292) % (n)	Quebec adult smokers and recent ex-smokers (CCHS 2015-2016) % (95% CI)
Sex		
Men	43.1 (557)	53.8 (51.9–55.8)
Women	56.7 (733)	46.2 (44.2–48.1)
Age (years)		
18–24	5.6 (72)	11.4 (9.9–12.8)
25–34	13.1 (169)	21.9 (20.2–23.7)
35–54	35.2 (455)	36.6 (34.7–38.6)
55–64	28.2 (364)	18.7 (17.1–20.2)
65+	18.0 (232)	11.4 (10.4–12.5)
Level of education		
High school not completed	27.2 (351)	20.2 (18.5–21.8)
High school diploma	26.2 (339)	21.6 (19.9–23.4)
Postsecondary education	43.4 (561)	58.2 (56.1–60.3)
Smoking status		
Daily smokers	65.8 (850)	65.8 (63.6–68.0)
Occasional smokers	0.5 (7)	25.3 (23.3–27.2)
Recent ex-smokers	33.7 (435)	8.9 (7.6–10.3)
HSI (daily smokers)		
0–1 (low)	11.2 (92)	32.8 (30.3–35.3)
2–3	36.4 (298)	38.3 (35.9–40.8)
4–6 (high)	52.3 (428)	28.8 (26.4–31.3)
Number of cigarettes smoked (daily smokers)	20.6 (SD = 14.2)	15.1 (SD = 8.5)

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval; HSI, Heaviness of Smoking Index; SD, standard deviation.
Note: Percentages may not total to 100% due to missing data (nonresponse).

not even a puff, in the past six months) was 18.8%. These directly calculated rates, as well as their ITT and imputed values, are presented in Table 2.

Other cessation supports and methods used

A little more than 3 out of 4 callers (76.9%) reported having used at least one pharmacological cessation aid to help them quit smoking or to refrain from smoking again after having quit. The most frequently used pharmacological cessation aids were nicotine patches (47.4%),

followed by electronic cigarettes with nicotine (30.2%) and nicotine gums (28.3%). Other cessation aids reported were nicotine lozenges (16.4%), varenicline (7.3%), nicotine inhalers (4.3%), nicotine aerosols (3.6%), and bupropion (3.2%). Nearly four out of five callers (79.4%) indicated having used at least one other support to help them quit, such as information materials (55.5%), support from a health professional (48.2%) or other cessation services provided through Quebec's *Tobacco Control Act* (52.8%).

TABLE 2
Direct quit rates, ITT rates and imputed rates for point prevalence, 30-day point prevalence and six-month prolonged abstinence rate at six-month follow-up for 1292 callers to Quebec's smoking quitline, October 2014 to October 2015

	Direct rate	ITT rate	Imputed rate
Point prevalence	29.8%	11.4%	28.4%
30-day point prevalence abstinence rate	26.7%	10.2%	26.0%
Six-month prolonged abstinence rate	18.8%	7.2%	19.7%

Abbreviation: ITT, intention to treat.

Discussion

This paper reports results of the first evaluation of Quebec's quitline since its inception. Evaluation results showed that Quebec's quitline reached 9 in 10 000 Quebec smokers over a one-year period in 2014-15. Compared to the overall population of smokers in Quebec, smokers reached by the service are predominantly women, older adults (55 years of age and older) and individuals with a high school education or less. Smoking cessation outcomes, as measured by the six-month prolonged abstinence rate, indicate that 18.8% (direct rate) of Quebec smokers successfully quit after having accessed the quitline. This number decreases to 7.2% Quebec smokers if using the ITT rate and increases to 19.7% if using the imputed rate.

Treatment reach is an important measure because it can provide a sense of how well an intervention and its promotional campaigns are doing in reaching their population of interest.[18] The latest data for Canadian quitlines indicate that in 2012 quitlines reached between 0.07% and 1.45% of smokers.[14] Thus, at 0.09%, Quebec's quitline treatment reach during the year of evaluation lies within the range of other Canadian quitlines. However, quitline use in Canada is not as high as in the United States, where quitline use ranged from 0.16% to 4.41% in 2012,[14] and it is far below CDC estimates that quitlines should be able to treat 6% of all adult smokers.[29] Various factors might explain the increased reach of quitlines in the US. These include offering free cessation medication and increased spending on promotion and outreach (in the US spending is over 10 times higher per smoker compared to Canada). Finally, in many US states, quitlines represent a key component of government funded tobacco cessation programs, giving them a central place in comprehensive tobacco control strategies.[34]

Researchers have examined various ways to increase quitline reach over the years. In Canada, the introduction of a quitline toll-free number on cigarette packages in 2012 increased reach in the year of its inception, though this increase declined somewhat in each following year.[34] Other strategies that have been shown to increase reach of telephone quitlines are running media campaigns, providing nicotine replacement therapy without requiring enrollment in telephone counselling, adding text messaging programs, offering online cessation programs and adding email support programs.[35]

In fact, due to the rise and diffusion of Internet- and mobile-based technology, an increasing number of new and innovative approaches for promoting tobacco cessation have recently been developed. These include cell phone text messaging, mentioned above, as well as Internet-based behavioural support services. These are promising approaches, due to their broad reach and accessibility.[11] Some of these services have been developed and are implemented by quitlines around the world,[11] including in Quebec, for example, the SMAT program that has been added to existing cessation services.

A comparison of caller characteristics between our study and the most recent data provided by the NAQC for quitlines in the US and Canada[14] shows that women are overrepresented among users not only in Quebec (56.7%) but across North American quitlines (58% in the US and 55% in Canada). The mean age for Quebec's quitline users was 50.6 years of age, which is higher than the mean age for callers to US quitlines (44.2 years; n = 52) and similar to the mean age for callers to other Canadian quitlines (51.1 years; n = 10).[14]

The fact that Quebec's quitline reaches fewer smokers with postsecondary education than the general population of adult smokers in Quebec (43.4% vs. 58.2%)

also seems to be typical for quitlines across North America. In the US, quitline callers with some level of postsecondary education represent approximately 45% of callers, while they represent 39.7% of callers to other Canadian quitlines.[14] These results indicate that quitlines do reach at least one of the groups that experiences a disproportionate share of the tobacco health burden, namely those with a high school diploma or less (53.4% vs. 41.8% in the population of Quebec smokers) relatively well. Overall, however, these results stress that efforts need to be made to reach certain segments of the population where smoking rates are alarmingly high, including young adult men.

In terms of smoking cessation outcomes, Quebec's quitline callers fared better than the overall population of smokers in the province, with a six-month prolonged abstinence rate of 18.8% as compared to 8.9% in Quebec adult current smokers.[27] Furthermore, a comparison of the 30-day point prevalence abstinence rates shows that the 26.7% rate for Quebec's quitline is comparable to the 28.5% rate measured for US quitlines.[14] Thus, while the magnitude of abstinence rates for Quebec's quitline are moderate, they are comparable to those found for quitline users across North America.

The combination of poor reach and moderate quit rates indicate that the number of Quebec smokers that benefit from the quitline is, overall, small. Quitline services are thus underused in Quebec (as in other provinces and across North America) and significant improvements need to be made to reach more smokers. Furthermore, the demographics of quitline participants indicate a mixed level of use among priority populations.

Evidence suggests that providing quality outreach and treatment to smokers in priority populations is paramount.[36] Strategies to reach specific populations include offering quitline services in various languages, initiating mass-reach health communications that include a quitline number, offering free cessation medications and creating referral systems for health care systems and providers. Examples of tailored promotional campaigns that target outreach efforts to specific populations include the use of trusted messengers such as faith-based organizations, community and social service organizations, community leaders

or elders, health care providers and clinics and community health workers among priority populations. Partnerships that engage new allies may also improve quitline reach.[36]

Finally, to improve services, quitlines can offer training specific to the population (e.g. people experiencing mental health issues, chronic health conditions, disability, poverty or homelessness; those with low education level or belonging to specific ethnic or sexual identity groups, etc.) and training in culturally responsive counselling techniques to quitline staff.[36] Ongoing research on the effectiveness of new and innovative approaches to cessation, such as cell phone text messaging and Internet-based behavioural support services, will shed light on their potential to reach underserved, high risk populations.

Strengths and limitations

The most notable strength of our work is that it is the first evaluation study of Quebec's quitline since its inception. By following NAQC guidelines for reach and effectiveness of quitlines, we ensured methodological rigour to meet our objectives as well as comparability with other quitline studies done elsewhere. Another strength of our study is that we conducted a multiple imputation procedure to estimate limits on plausible quit rates.

However, a number of limitations should be considered. First, to identify the proportion of the quit rate attributable to quitline use would require a randomized control study or the inclusion of a comparison group. However, rigorous evaluations of quitline services are difficult because service providers remain reluctant to conduct randomized controlled trials that imply refusing callers who contact the quitline for support.[7] Thus, one-group quasi-experimental designs are frequently used to evaluate quitlines across North America and follow NAQC guidelines.[18] The absence of a comparison group in the quasi-experimental design implies threats to internal validity including self-selection, history and maturation bias.

Second, the proportion of individuals lost to follow-up was 52%. Even though this presents a high percentage of loss to follow-up, it is typical of quitline studies[37,38] and in line with the NAQC's recommended threshold of 50%.[30]

Third, although Quebec's quitline offers services both in English and French, follow-up surveys were conducted in French only. This may limit generalization, though the effect is likely small, as only 20 out of 1292 smokers measured at intake did not speak French.

Conclusion

Over the past four decades, increasing evidence has supported the effectiveness of public health tobacco control interventions such as taxation, smoke-free laws, restrictive marketing of tobacco products, mass media campaigns and cessation support.[11] This includes evidence that supports the effectiveness of quitlines for smoking cessation,[5] which have become an integral part of provincial and national tobacco control strategies in North America and around the world.[6,7] The fact that relatively few smokers utilize available smoking cessation resources such as tobacco quitlines means that service promotion needs to be improved, in particular for segments of the population with higher prevalence rates. Quitlines also should be tailored to match the specific needs of these populations and to expand their services to include new and innovative approaches to cessation, using web and mobile technologies (e.g. Internet-based counselling, text messaging programs). Ultimately, the success of cessation supports is intimately related to spending, reinforcing the need to increase quitline funding to levels commensurate with provincial cessation goals,[39] and for their integration into a comprehensive tobacco control strategy.

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Conflicts of interest

The authors were all employed by the Institut national de santé publique du Québec at the time of the data collection. They have no conflicts of interest to declare.

Authors' contributions and statement

CS's contributions to this work included the study design, project administration, data acquisition, analysis and interpretation and writing of the original draft of the publication. BL's contributions included data analysis, interpretation and writing of the original draft. EL contributed to data analysis, interpretation and review and editing of the initial draft.

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At-a-glance

Population coverage of the Canadian Chronic Disease Surveillance System: a survey of the contents of health insurance registries across Canada

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Abstract

Introduction: Health insurance registries, which capture insurance coverage and demographic information for entire populations, are a critical component of population health surveillance and research when using administrative data. Lack of standardization of registry information across Canada's provinces and territories could affect the comparability of surveillance measures. We assessed the contents of health insurance registries across Canada to describe the populations covered and document registry similarities and differences.

Methods: A survey about the data and population identifiers in health insurance registries was developed by the study team and representatives from the Public Health Agency of Canada. The survey was completed by key informants from most provinces and territories and then descriptively analyzed.

Results: Responses were received from all provinces; partial responses were received from the Northwest Territories. Demographic information in health insurance registries, such as primary address, date of birth and sex, were captured in all jurisdictions. Data captured on familial relationships, ethnicity and socioeconomic status varied among jurisdictions, as did start and end dates of coverage and frequency of registry updates. Identifiers for specific populations, such as First Nations individuals, were captured in some, but not all jurisdictions.

Conclusion: Health insurance registries are a rich source of information about the insured populations of the provinces and territories. However, data heterogeneity may affect who is included and excluded in population surveillance estimates produced using administrative health data. Development of a harmonized data framework could support timely and comparable population health research and surveillance results from multi-jurisdiction studies.

Highlights

- All reporting Canadian health insurance registries contain data going back to at least 1996. The earliest year of available data was 1968, in Saskatchewan.

- Some features of registry data, such as change in coverage, primary address, date of birth and sex, were consistent across all reporting jurisdictions. Other features, such as family unit identifiers, socioeconomic status and population identifiers, varied across reporting jurisdictions.

- Differences in Canadian health insurance registries present opportunities for studies that compare the populations covered by provincial/territorial health insurance plans. Creation of a harmonized data framework would benefit national surveillance initiatives and multi-jurisdiction studies.

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Introduction

Administrative health data are data originally collected for purposes of managing and monitoring the health care system. However, these data are also commonly used to measure and describe population health within Canada,[1-7] because they are routinely collected, inexpensive to use and have nearly complete population coverage. Administrative health data include physician billing claims, hospital discharge abstracts, prescription medication dispensations and health insurance registries.[8] Health insurance registries are a critical component of population-based surveillance and research studies in Canada, because they contain information about members of provincial or territorial populations who are eligible to receive publicly funded health services.[9] Understanding the populations captured in health insurance registries and the data that are collected about these populations is essential for comparing health measures between jurisdictions and over time, as well as determining generalizability of these comparisons.

Health care coverage in Canada primarily falls under provincial or territorial jurisdiction.[10] There is no standard for how data in health insurance registries are collected and coded, or for how different populations, such as those covered by federal health insurance, are identified in registry files. Differences in health insurance registries across Canada can present challenges to the comparability of surveillance and research studies.

The Canadian Chronic Disease Surveillance System (CCDSS) is a network supported by the Public Health Agency of Canada (PHAC) that aims to further the use of Canadian administrative health data for chronic disease surveillance and supports health care planning and health policies and programs.[8] Through the CCDSS, the provinces and territories provide PHAC with aggregate data derived from administrative health data that are then used to generate national estimates and trends over time for over twenty chronic diseases and conditions. Heterogeneity in the data contained within health insurance registries can affect who is included in or excluded from the CCDSS estimates. It also impacts which jurisdictions can conduct health research and surveillance on specific subpopulations (e.g. First Nations individuals).

There has been limited research on the data contained in Canadian provincial and territorial health insurance registries. The few studies that do exist primarily focus on health insurance registries from a single jurisdiction.[5,9,11] Two studies focus on the Manitoba health insurance registry,[9,11] and one provides a brief description of the Quebec registry as part of that province's Integrated Chronic Disease Surveillance System.[5] Studies that include multiple jurisdictions are limited to reviews; no direct comparisons across jurisdictions have been made.[12,13] Detailed information about identifiable populations and those individuals who are included in or excluded from population-based health insurance registries could (1) improve our understanding of surveillance estimates produced from CCDSS data, and (2) inform the potential uses of registry data to describe specific subpopulations.

The purpose of this study was to assess the data contained within health insurance registries across Canadian provinces and territories. The objectives were to describe the populations covered and document registry similarities and differences.

Methods

Data were collected using a survey developed by the project team with input from content experts and advisors at PHAC. As well, the project team received input from research staff at the Manitoba Centre for Health Policy with experience working with population health insurance registry data. The survey included five sections: (1) general information (i.e. indication of province or territory); (2) temporal data coverage; (3) start and end dates of coverage for residents of the province or territory; (4) population characteristics captured in registry data; and (5) population identification. The final draft of the survey was approved by PHAC before distribution. A copy of the survey is available upon request.

A list of key informants from each of the provinces and territories was identified by the project team with input from PHAC. Informants were primarily identified from members of the CCDSS Science Committee and Data Quality Working Group. Informants who held positions that involved working with administrative data were contacted, as they were most likely to be knowledgeable about the registry data in their jurisdiction. In cases where two contacts were available with similar expertise, both were contacted.

In April 2019, the project team emailed the survey to the key respondents, who were given one week to complete it; extensions were provided as needed. Key informants were free to consult other experts in their jurisdiction to complete the survey if needed. If key informants were unable to complete the survey, they were asked to recommend an alternative informant. Phone and email follow-ups were conducted by the project team to clarify responses when needed.

This study was conducted out of the University of Manitoba. Research ethics approval was not required as data were collected on health insurance registry contents, not human participants.[14]

Results

Thirteen key informants from the 10 provinces responded to the survey (two from Saskatchewan, Manitoba and New Brunswick), and one key informant from the Northwest Territories provided limited information. Where two key informants were consulted, informants worked together to fill out a single survey, which was returned to study researchers. No survey response was received from Yukon or Nunavut, as no one with sufficient expertise (i.e. knowledge of registry data) to address the questions was identified. Key informants included individuals employed by provincial ministries of health and experts associated with population-based research data repositories, such as ICES. Both Saskatchewan and Prince Edward Island indicated that registry staff were consulted when completing the survey.

Temporal data coverage

Information about temporal coverage of the health insurance registries is provided in Figure 1. The earliest available year of data was reported by Saskatchewan (1968). While Manitoba's key informant reported that the earliest available year of data was from 1984, other published sources indicate this province's health insurance registry data extends back to 1970.[9,15] However, data from these early years may not be consistently available to all data users and may be difficult to use when generating surveillance and research reports. All provinces reported that "snapshots" (i.e. a

FIGURE 1
Timelines of data available in Canadian health insurance registries for each participating jurisdiction (excluding the Northwest Territories)
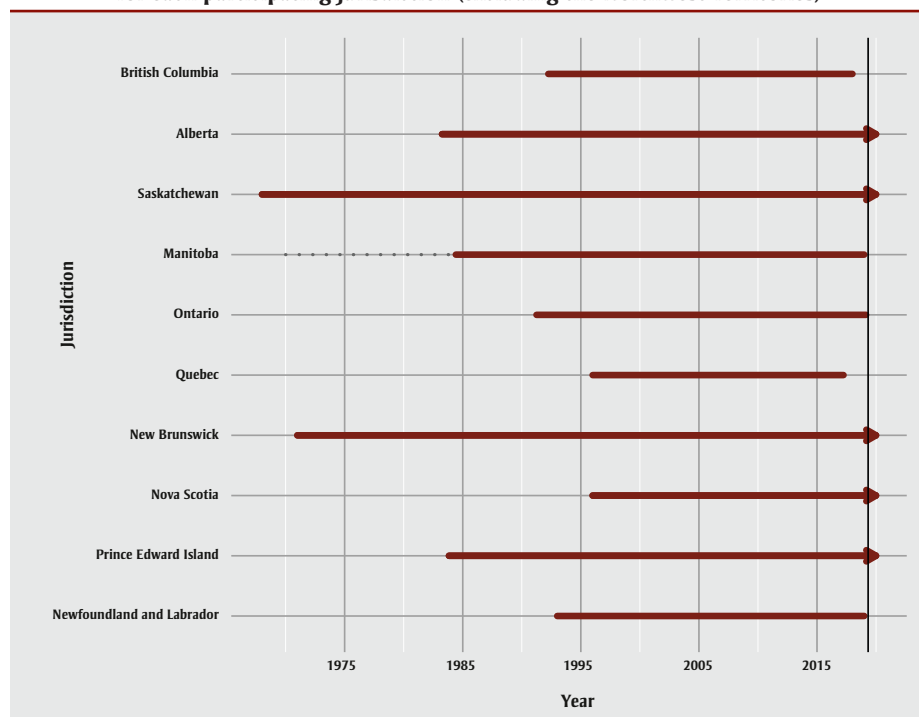
Notes: Arrows indicate registry data are continually updated daily or weekly and data are available as of the last update. Dotted gray line indicates data availability may be limited. Vertical black line indicates date of survey administration (i.e. April 2019). Dates of data availability are current as of survey response date (May 2019); updates may be available after this date.

file to preserve the registry data at that point in time) of their registries are regularly saved and stored.

Start and end of coverage

Table 1 summarizes the responses provided around start and end dates of health insurance coverage for individuals. There was heterogeneity across the reporting jurisdictions on the capture of information about mobility of health-insured residents (i.e. where an individual moved to when leaving the jurisdiction and where they moved from when entering the jurisdiction). For most jurisdictions, individuals were added to the registry three months after moving into the jurisdiction and flagged for end of coverage three months after moving out of the jurisdiction. The timeline for being added to the registry and being flagged for end of coverage in cases of birth and death were variable across jurisdictions. There was substantial diversity in the end-of-coverage cancellation codes (e.g. deceased, left country, duplicate record) provided by the key informants; only Ontario indicated no end-of-coverage codes were available. While data quality checks for start and end of coverage were implemented in a number

of jurisdictions (i.e. British Columbia, Alberta, Saskatchewan, Ontario, Quebec, Nova Scotia and Newfoundland and Labrador), key informants did not always have information about data quality assessment processes or did not report that data quality assessments were undertaken.

Population characteristics and attributes captured

All jurisdictions reported that their registries contained a primary address, birth date and sex for health-insured residents (Table 2).

A family unit identifier, that is, a code to indicate familial relationships, was reported for Alberta, Saskatchewan, Manitoba, New Brunswick and the Northwest Territories. Prince Edward Island reported having a household identifier, but noted limitations in its use (e.g. individuals in a group home have the same household identifier). British Columbia indicated that familial relationships among residents could be ascertained from other administrative data sources. Family relationship codes (i.e. indication of relationships among residents, such as parent, offspring, spouse or sibling) were available

in Alberta, Saskatchewan, Manitoba and New Brunswick.

Only Ontario reported having information about ethnicity in its health insurance registry. Identifiable categories for ethnicity were general, Chinese and South Asian. These categories are derived from an algorithm applied to the data and not directly collected.

Measures of socioeconomic status (e.g. income quintile) were available in the health insurance registries of Ontario and Quebec; Ontario's measure was algorithm-driven. British Columbia indicated socioeconomic status could be determined for a subset of individuals by linking to a supplementary database.

Lastly, place of birth was available in Alberta and Prince Edward Island, although other jurisdictions did note that linkage of registry data with other sources could aid in identifying this information.

Population identification

Table 3 provides information about the populations identifiable in health insurance registries. All jurisdictions indicated they could identify at least some of the populations in question, except for Quebec. Quality of population identifiers was heterogeneous. For example, the First Nations identifier in Manitoba's health insurance registry may result in misclassification of individuals, because it is based on self-report. This means that a First Nations individual would only be flagged as such if that individual disclosed this information to insurance registry staff. In Alberta, the federal government had previously verified First Nations status, but stopped when Alberta eliminated health insurance premiums in 2009. To aid in preserving data quality, Alberta has maintained the flag for those present prior to the change, and any offspring are conferred unofficial status for reporting purposes. However, misclassification may still occur.

Discussion

The results of this survey provide important insights about the data contained within health insurance registries across Canada (i.e. 10 provinces and the Northwest Territories). Health insurance registry data go back as far as 1968 (in the case of Saskatchewan). All reporting jurisdictions had data going back to at least 1996.

Start and end of coverage	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
For residents moving into jurisdiction:											
Where the individual moved from	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes, if within Canada	NR
Length of time after moving that newcomers (from within Canada) are added to registry[a]	3 months	Added immediately but must live in AB for 3 months before eligible	3 months (i.e. first of the third month after arrival)	Added once applied for but must live in MB for 3 months (i.e. first day of full third month) before eligible[b]	3 months	3 months	90 days	3 months	3 months	3 months	NR
Length of time after moving until immigrants are added to registry	3 months	Varies	Varies	Unsure	3 months	3 months	90 days[c]	Date of arrival	First day of arrival or first day granted permanent residence, whichever is later	Date of arrival	NR
For residents moving out of jurisdiction:											
Where the individual moved to	No	Yes	Yes, if within Canada	Yes	No	No	Yes, if within Canada	Yes	Yes, if within Canada	No	NR
Length of time after moving that residents are flagged for end of coverage[a]	Until residents submit request of cancellation	When coverage begins in the new province, OR the day they leave the country	3 months (i.e. covered for remainder of month of departure plus 2 more months)	3 months (i.e. covered for remainder of month of departure plus 2 more months) for Canadian citizens and permanent residents. Day of permanent move for work and study permit holders	Unclear from the data	3 months	When coverage begins in the new province OR when NB Medicare is notified they left the country	3 months	The day before coverage begins in the new province	3 months	NR

Start and end of coverage	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
For births and deaths:											
Length of time after birth before added to registry	Before 2008: varies After 2008: immediately	Within 24 hours	Immediately as of 1998	Unsure	3 months	2–5 months	Until parent submits completed registration form	Typically within 10 business days	24–48 hours	Until parent submits completed registration form	NR
Length of time after death before flagged in registry	Unsure	Varies	Varies	Unsure	Up to 3 months	Unsure	New deaths are flagged daily, but will be confirmed through Vital Statistics bi-weekly report	Varies	24–48 hours	Typically a day after death	NR
End-of-coverage descriptions in registry data, as provided by the informant	Deceased

Group cancel coverage

Expired temporary permit

Opted out

Left the province

Left the country | Deceased

Armed Forces

Federal penitentiary

Illegal resident

Added in error

Fraud

Residency questioned—good faith policy

Opted out of AHCIP

Duplicate registration

Left AB—normal extended coverage

Left AB—includes travel time | Deceased

Canadian Armed Forces

Incarcerated in federal institution

Mail return and current address unknown

Left the province | Deceased

Military/RCMP

Inmate of federal institution

Registered in error

Unable to locate

Duplicate PHIN

Coverage cancelled—reclaimed reg. #

Nonresident

Other (custody unknown—minor dependant)

Temporary resident/non-Canadian

Adopted

Left province—unknown location

Left province—NL | No reason for end of coverage given[d] | End of eligibility

Cancellation of health insurance | Deceased

Noncompliance

Adopted

Left the province

Left the country

To be determined | Deceased, confirmed through Vital Statistics

Deceased, family notified

Terminated eligibility

Temporary absent

Terminated student

Terminated employment

Terminated over age (dental)

Left NS (new province notify)

Left NS (pay claim)

Left NS (correspondence)

Left NS (phone) | Deceased

Federal government

Federal penitentiary

Left the province | Deceased

Not eligible for coverage, or Armed Forces

Neonatal coverage terminated

Work permit expired

Student visa expired

Visitor's permit expired

Minister's permit expired

Immigration documents expired

Refugee documents expired

Child of immigrant parents | Transferred to Armed Forces

Employed by RCMP

Division of NWT/creation of Nunavut, April 1999

Visa expired

Duplicate registration

Registration year too old[f]

Address unknown—moved

Registered in error

Immigrant

Expiry date of HCP card

Failed to renew |

Continued on the following page

Start and end of coverage	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
		Left AB—circumstances unknown		Left province—PEI						Out of province coverage	HCP card unclaimed/undeliverable mail
		Left AB—notified by other provincial health office		Left province—NB						Inactive[e]	
				Left province—NS						Left the province	NWT inmate released
		Left Canada		Left province—QC						Left the province and under social services	Coverage suspended
		Left Canada—maximum three months		Left province—ON							
				Left province—SK							Address box closed
		Left Canada—coverage extended 1 month		Left province—AB							Address incomplete
				Left province—BC							No such address
				Left province—YT							
		Left Canada—coverage extended 3 months		Left province—NWT							
				Left province—NU							
		Other		Left province—USA							
				Left province—other country							

Abbreviations: AB, Alberta; AHCIP, Alberta Health Care Insurance Plan; BC, British Columbia; HCP, health care plan; NB, New Brunswick; NL, Newfoundland and Labrador; NR, no response; NS, Nova Scotia; NU, Nunavut; NWT, Northwest Territories; ON, Ontario; PEI, Prince Edward Island; PHIN, personal health information number; QC, Quebec; RCMP, Royal Canadian Mounted Police; SK, Saskatchewan; YT, Yukon Territory; USA, United States of America.

[a] Criteria for "3 months" varies among jurisdictions. Specifications added where jurisdictions provided information.

[b] For Canadian citizens and permanent residents. For work permit holders and their dependants coming to Manitoba from another Canadian jurisdiction, coverage begins on the date of arrival if they provide proof of arrival date.

[c] Date of arrival for refugees.

[d] End-of-coverage codes are captured by the Ontario Ministry of Health, but are not available to the research data holders at ICES.

[e] No activity on medical care plan.

[f] Year of registration indicates health coverage has expired.

Population characteristics	British Columbia[a]	Alberta	Saskatchewan	Manitoba	Ontario[b]	Quebec	New Brunswick[c]	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
Residence											
Primary address	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Previous address available?	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Date of birth											
Date of birth	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sex											
Sex	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
New classifications implemented[d]	No	No	No	No	No	No	Yes	Yes	No	Yes	NR
Familial relationships											
Family unit identifier	No, but can link to other databases to determine	Yes	Yes	Yes	No	No	Yes	No	Yes[e]	No	Yes
Relationships available	N/A	Family unit	Head of family (max 2 per family) and dependents	Family unit containing registrant, and if applicable, spouse and dependents	N/A	N/A	Head of household identifier	N/A	NR	N/A	NR
Relationship coding	N/A	Family units are grouped together under a single account number Specific relationships codes: Unknown; Subscriber; Spouse; Dependent aged < 21 yrs; Student aged 20 yrs, 8 months to 25 yrs; Permanent dependent due to mental/physical infirmity; Student status under review	All members have the same family number and individuals are listed as either head of family or dependent	All family members residing in MB are assigned the same MB health registration number Specific relationships are indicated by number (from 0–8) for the following: purged or non res[e]; family head; legal spouse; common law spouse; child; stepchild; incapacitated child; grandchild	N/A	N/A	There is a "Head of Household" ID that can be linked to all family members	N/A	N/A	N/A	NR

Population characteristics	British Columbia[a]	Alberta	Saskatchewan	Manitoba	Ontario[b]	Quebec	New Brunswick[c]	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
Ethnicity											
Ethnicity	No	No	No	No	Yes	No	No	No	No	No	No
Identifiable ethnicities	N/A	N/A	N/A	N/A	General[f], Chinese, South Asian	N/A	N/A	N/A	N/A	N/A	N/A
Socioeconomic status											
SES available	No, but can link for a subset to determine	No	No	No	Yes	Yes	No	No	No	No	No
Information used to define SES	N/A	N/A	N/A	N/A	Income	Other[g]	N/A	N/A	N/A	N/A	N/A
SES coding	N/A	N/A	N/A	N/A	1,2,3,4,5 (quintiles)	Deprivation index	N/A	N/A	N/A	N/A	N/A
Place of birth											
Place of birth	No	Yes	No	No	No	No	No	No; can link to other databases/ sources to determine if born in NS	Yes	No; can link to other databases/ sources to determine if born in NL	NR
Coding	N/A	Structured text field	N/A	N/A	N/A	N/A	N/A	N/A	Country/ province	N/A	NR

Abbreviations: BC, British Columbia; MB, Manitoba; N/A, not applicable; NL, Newfoundland and Labrador; NR, no response; NS, Nova Scotia; RCMP, Royal Canadian Mounted Police; SES, socioeconomic status.

[a] Populations British Columbia can identify include: active Armed Forces dependents, active RCMP dependents, RCMP pensioners, federal government employees, federal government pensioners, BC full-service annuitants, BC correctional facilities investigation unit, and First Nations.

[b] All "yes" responses are obtained by linking to other databases; data are not directly available in registry.

[c] New Brunswick is officially bilingual (English and French). Therefore, language data are also captured in the registry.

[d] "New classifications implemented" refers to including an additional nonbinary option in addition to the "Male" and "Female" classifications.

[e] Household identifier.

[f] Individuals not included in the Chinese or South Asian category are included in the General category.

[g] SES is determined using a material and social deprivation index, which is assigned based on geographical location.

Population identification	British Columbia[a]	Alberta	Saskatchewan	Manitoba	Ontario[j]	Quebec	New Brunswick[k]	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
Population											
Full-time members of the Canadian Armed Forces	NR	Yes	Yes[d]	Yes[g]	No	No	Yes[l]	No[o]	No	No	NR
Part-time members of the Canadian Armed Forces	NR	No	Yes[d]	Yes[g]	No	No	No	No	No	No	NR
Veterans	No	Yes	No	NR	No	No	No	No[o]	No	No	NR
Royal Canadian Mounted Police	No	Yes	No	Yes	No	No	Yes	No[o]	No	No	NR
Federal penitentiary inmates	NR	Yes	Yes[e]	Yes[h]	No	No	No	No	Yes	No	NR
Provincial penitentiary inmates	Yes	Yes[b]	Yes	NR	No	No	Yes	No	No	No	NR
First Nations on reserve	NR	Yes[b]	Yes[f]	Yes[i]	Yes	No	No[m]	No	No	No	Yes
First Nations off reserve	NR	Yes[b]	Yes[f]	Yes[i]	Yes	No	No[m]	No	No	No	Yes
Inuit	No	Yes[b]	No	NR	Yes	No	No	No	No	No	Yes
Métis	No	No[c]	No	NR	Yes	No	No	No	No	No	Yes
Nonpermanent residents											
Refugee claimants	Yes	Yes	Yes	NR	Yes	No	No	No	Yes	Yes, upon termination of coverage	NR
Persons with a study permit	No	Yes	Yes	NR	No	No	Yes	Yes	Yes	Yes, upon termination of coverage	NR
Persons with a work permit	No	Yes	Yes	NR	No	No	No	Yes	Yes	Yes, upon termination of coverage	NR

Population identification	British Columbia[a]	Alberta	Saskatchewan	Manitoba	Ontario[j]	Quebec	New Brunswick[k]	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Northwest Territories
Immigrants											
Landed immigrants	NR	Yes	Yes	NR	Yes	No	Yes[n]	Yes	Yes	Yes, upon termination of coverage	NR
Permanent residents											
Economic immigrants	No	No	No	NR	Yes	No	No	No	Yes	No	NR
Family members of permanent residents	NR	Yes	No	NR	No	No	No	No	Yes	No	NR

Abbreviations: BC, British Columbia; FN, First Nations; MB, Manitoba; NB, New Brunswick; NR, no response; RCMP, Royal Canadian Mounted Police; SK, Saskatchewan.

[a] BC can identify the following: active Armed Forces (dependents only); active RCMP (dependents only); RCMP pensioners; federal government employees; federal government pensioners; BC full-service annuitants; BC correctional facilities investigation unit; First Nations individuals.

[b] Active capture of this flag was discontinued in January 2009.

[c] Can link to database to determine for analytic purposes.

[d] There is no distinction between part-time and full-time members of the Armed Forces.

[e] Only flagged if covered by SK prior to incarceration.

[f] Flagged if self-identified as FN. Residence or correspondence address or both can be used to determine if on or off reserve; however, many addresses can be ambiguous for on vs. off reserve.

[g] There is no distinction between part-time and full-time members of the Armed Forces.

[h] Can only see whose coverage was cancelled for the reason "Code 8–Inmate of Federal Institution."

[i] A First Nations municipal code is assigned at time of registration if and only if the registrant voluntarily produces proof of First Nations status. Because this is a voluntary declaration of First Nations status, it is generally estimated that only about 60% of MB's First Nations population is identified as First Nations in Manitoba Health's registry population.

[j] For all "yes" responses, data are obtained by linking registry data to other databases; data are not directly available in registry.

[k] NB is officially bilingual (English and French). Therefore, language data are captured in the registry.

[l] Some full-time members are identified, but not all.

[m] As of February 2020, New Brunswick Department of Health is working with First Nations on the creation of a First Nations identifier.

[n] Landed immigrants and permanent residents are not differentiated in the NB medicare system.

[o] Only recorded if self-identified. Not a reliable source of population identification, as this information is not comprehensive.

Individuals moving in or out of the jurisdiction are generally added or flagged for end of coverage three months after moving; timelines are more variable for beginning or ending of coverage due to births and deaths. Events recorded for end of coverage differ among jurisdictions. All jurisdictions record a primary address, date of birth and sex. Family identifiers, ethnicity, socioeconomic status and place of birth are recorded in select jurisdictions. Ability to identify members of certain populations, such as First Nations, the Canadian Armed Forces and inmates of federal penitentiaries, is variable across jurisdictions.

Previous research has compared data contained in physician services databases across Canada.[16] However, there has been limited research on provincial and territorial health insurance registry data and its quality. Publications on registry data have reported on Manitoba's and British Columbia's health insurance registries.[9,11,17] However, the most recent Manitoban publication was in 1999,[9] and British Columbia's paper focussed on the development of a research registry to which the provincial health insurance registry contributed.[17] Tang et al.[18] reported on ethnic classifications available in Canadian health insurance registries and found that flags only existed on First Nations people in the registries. In contrast, we found that Ontario had flags derived from an algorithm for subpopulations of South Asian and Chinese descent. A systematic review conducted by Hinds et al.[13] did not identify any studies that had investigated the quality of health insurance registry information.

Capture of population characteristics and attributes allows for surveillance measures to be stratified by potential risk factors (e.g. social determinants of health such as socioeconomic status, immigration status and ethnicity). Results reported here help summarize the jurisdictions that are suitable for these analyses. However, heterogeneity among jurisdictions in population identification also has implications for who is included in the CCDSS estimates, and suggests that inclusions and exclusions may not be consistent across jurisdictions.

A major value of the health insurance registry comes from preserving snapshots, or timestamped records, of registry data.[9] Our study results indicate that over 20 years of registry data are available in all reporting jurisdictions, with snapshots available to capture changes in the registry. There are challenges associated with using health insurance registries for longitudinal studies: health insurance registries are not static, registry data and data quality change over time, and older data are not always linkable. Nonetheless, the benefits of being able to use these data to conduct longitudinal cohort and intergenerational studies with minimal cost and data collection far outweigh the challenges.

Strengths and limitations

This study is unique in providing insights about the data contained within health insurance registries across Canada using a standardized survey with near complete coverage of the provinces and territories. Surveys were completed by individuals with in-depth knowledge of the registry data and access to other informants to provide additional information if needed.

However, there are some limitations. Our study did not employ a validated survey for information capture, as no such survey exists. This hinders international comparisons. As well, health insurance registries are complex databases, and it is not possible to capture all nuances of their features in a survey conducted at a single point in time. Not all elements collected during the registration process will be available to potential data users. Many of these elements are administrative in nature. Many systems are dynamic, being continually updated, so extracts or snapshots are created with a methodology to provide the most accurate and consistent view of the population.

Future research

Future studies could be undertaken to validate key population characteristics included in health insurance registry data, including dates of birth and death, coverage cancellation codes, location of residence and identifiers for specific populations. Another research opportunity lies in assessing the timeliness of characteristic updates. However, a key challenge with such studies is identifying and accessing appropriate population-based validation data sources that can be linked to health insurance registration data. While vital statistics data could be used to assess the accuracy of dates of birth and death, validation data sources for other key population characteristics may not be readily available in all jurisdictions.

Previous studies have compared aggregate population counts obtained from health insurance registries to counts from Statistics Canada census data.[19,20] However, potential sources of inaccuracies were not determined. Therefore, future research could look at potential sources of discrepancy between population counts in registry and census data, and estimate the impact of these discrepancies on health measures.

Exploring changes in health insurance registration coverage over time is another potential area of future research. Registries are not static; exclusions may not be consistent over time. Comprehensive information about changes in the data can help ensure accuracy of health trend estimates.

Future research should investigate the feasibility of a common data framework, such as the Generalized Data Model proposed by Danese et al.[21] to facilitate the systematic and standardized capture of information in health insurance registries. However, access to some registry data elements may be subject to privacy legislation, and data are primarily collected for administrative, not research, purposes. This could lead to challenges in implementing a common data framework.

Finally, there is a potential role for a national organization to facilitate the harmonization or standardization of data in health insurance registries. Examples of such organizations include the Canadian Institute for Health Information, which has recently proposed standards for collecting data on patient ethnicity,[22] and Health Data Research Network Canada, which aims to support multi-jurisdiction studies by connecting and establishing research data infrastructure.[23]

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

NCH and LML drafted the manuscript and all authors contributed to its revisions. LML, CR, JE, SO, LM and KH defined the scope of the survey. NCH, LML, CR, JE, SO, LM and KH developed the survey. LML and NCH contacted key informants and collected completed surveys. LR, KAMP, MA, MS, RP, MM, AY, JS, YL, LWS, FS, AA, BZ and JA reviewed the manuscript for accuracy and ensured appropriate interpretation of health registry data.

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Release notice

Brain Tumour Registry of Canada (BTRC): Incidence (2013–2017) and Mortality (2014–2018) Report

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In recognition of Brain Tumour Awareness Month in Canada, held in May 2021, the *Brain Tumour Registry of Canada (BTRC): Incidence (2013–2017) and Mortality (2014–2018) Report* was released on May 26, 2021.

Using data from the Canadian Cancer Registry and the Canadian Vital Statistics Death Database, this report provides comprehensive information on the incidence and mortality of central nervous system (CNS) tumours in Canada. It was developed through a partnership between the University of Alberta, the Brain Tumour Foundation of Canada and the Public Health Agency of Canada.

The report presents estimates of incidence and mortality by histology group, site of origin, tumour behaviour and demographics (sex, age, geography), as well as over time.

Highlights

- Between 2013 and 2017, the average annual age-standardized incidence rate for all primary CNS tumours in Canada (excluding Quebec) was 21.05 per 100 000. Rates increased across life-course age groups from 4.99 in children (aged 0–14 years) to 34.63 in adults (aged 40+ years).

- Age-standardized incidence rates for all CNS tumours combined were similar for males (20.73 per 100 000) and females (21.40 per 100 000), but sex differences were observed by type of CNS tumour.

- Between 2014 and 2018, an average of 2599 Canadians died each year from primary CNS tumours. The average annual age-standardized mortality rate was 6.73 per 100 000. These deaths were predominantly the result of malignant tumours.

Visit the Brain Tumour Registry of Canada for more information.

Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals. Look for the following articles published in 2021:

Algahtany M, **McFaull S**, Chen L, et al. The changing etiology and epidemiology of traumatic spinal injury: a population-based study. World Neurosurg. 2021. https://doi.org/10.1016/j.wneu.2021.02.066

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