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Original quantitative research

The distribution of hunger in Canadian youth

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Abstract

Introduction: As a foundation for prevention, evidence is required to establish the contemporary distribution of hunger in Canadian adolescents. We present findings from a nationally representative survey of young Canadians on how perceived hunger is distributed demographically, socially and contextually.

Methods: A probability-based sample of 15 656 young Canadians aged 11 to 15 years who completed the 2017/18 cycle of the Health Behaviour in School-aged Children study was used. Descriptive statistics and multivariable regression analyses were used to profile the study population and the distribution of hunger attributed to "not having enough food at home."

Results: Overall, one in six (16.6%) survey participants reported experiencing hunger. There was a strong and significant correlation between low socioeconomic status and hunger ($p < 0.001$ for the low and middle socioeconomic groups, compared to the high socioeconomic status group). Notably, 12.5% of participants with high levels of affluence also reported such experiences of hunger; however, this was not a statistically significant finding. Hunger was less frequently reported in older participants and in higher grade levels, with some level of significance. Regression analyses indicated that, within the sample, some demographic characteristics correlated with experiences of hunger: lower levels of affluence, identifying as male or nonbinary gender, long-term immigrant status, and identifying as Black, Latin American or mixed ethnicity.

Conclusion: Clear disparities exist in the self-reported experience of hunger among young people in Canada.

Keywords: *adolescent, epidemiology, hunger, food insecurity, pediatrics, youth*

Highlights

- Self-reported experience of hunger is a known indicator of social deprivation during childhood.
- One in six Canadian adolescents reported experiencing hunger due to a lack of food at home.
- At-risk groups included nonbinary, long-term immigrant, Black, Latin American and mixed ethnicity adolescents.
- Adolescents from affluent families sometimes reported hunger, suggesting that this indicator has different meanings to different groups of children.

Introduction

Hunger and food insecurity are recognized public health priorities in Canada.[1] They are complex issues that extend beyond the basic need to have reliable access to safe and adequate nutrition to the social and emotional circumstances within a young person's environment.[2] In 2021, 18.4% of Canadians lived in a food-insecure household[3] and 16.8% of Canadians aged under 18 years lived in households experiencing moderate to severe food insecurity.[3] Risk of experiencing food insecurity varies by sociodemographic factors; certain demographic, social and contextual factors may individually or cumulatively impact the likelihood that an individual is exposed to hunger at some point in their life.[1,4] Children and adolescents appear to be at a disproportionately high risk relative to adult populations.[5]

Within Canadian adolescent populations, groups at an increased risk of experiencing food insecurity include those who identify as Black or Indigenous, those who come from single-guardian homes, and those who live in rented accommodation, in households where the highest level of education is secondary school and in households in which the guardian requires government social or disability-related supports.[6]

The impacts of hunger on the health and development of young people have been established.[7,8] Adolescence represents a critical and sensitive period of the life course.[9] Prolonged experiences of food insecurity and hunger can lead to an inability to meet certain "critical checkpoints"[10] during this life stage, which may lead to negative health trajectories.[11] Looked at in a more positive light, there is the real potential to impact hunger status if support is given at these critical points in time.[12] Finding ways to better assist families and children who are deprived of life's essentials will benefit populations

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from social, economic and health perspectives. Such initiatives are optimally based upon valid evidence describing patterns of hunger experienced by adolescent populations specifically, and not only descriptions of household food insecurity, because the two concepts, while highly related, are distinct. Yet, contemporary data on this public health issue are scarce in Canada.

We had a unique opportunity to address this issue via an original analysis of nationally representative health survey data. Our goal was to describe and highlight various sociodemographic characteristic groups of Canadian youth aged 11 to 15 years who reported higher levels of hunger, as a basis for future prevention efforts and policy initiatives.

Methods

Study base

The Health Behaviour in School-aged Children (HBSC) study is an ongoing, cross-national survey affiliated with the World Health Organization. Its protocol involves distribution of a standardized school-based survey every four years in up to 50 (mainly European) countries and regions.[13] HBSC has been administered within Canada since 1989, with the eighth cycle administered in 2017/18.[14] The survey protocol is available to the public.[15] Available data include self-reported measures describing the health and well-being of adolescents aged 11 to 15 years. Response rates for the survey have been fairly consistent at approximately 74% each cycle.[13]

Sample

The 2017/18 Canadian survey involved 21 745 students from 287 schools in 10 provinces and 2 territories (Nunavut was unable to participate due to ethical principles associated with studying its highly Indigenous population). The initial sample of 21 745 participants was reduced to a final sample size of 15 656 in a complete case analysis, after removing individuals who did not meet the inclusion criteria (i.e. being aged 11–15 years; attending Grades 6–10; completing items core to this analysis). In addition, some exclusions related to the fact that some regions (Yukon, Northwest Territories, other local school boards) administered an abbreviated questionnaire in order to respect local levels of literacy or a lack of acceptance of specific survey topics.

Human subjects

The HBSC study protocol holds ethics clearance from the Brock University Health Sciences Research Ethics Board (File No. 21-314), General Research Ethics Board at Queen's University (TRAQ # 6010236), as well as the Health Canada-Public Health Agency of Canada Research Ethics Board (file number REB 2013-022P).

Key measures

Hunger

A single questionnaire item asked participants to answer the following question: "Some young people go to school or to bed hungry because there is not enough food at home. How often does this happen to you?" Based on precedent, largely due to small cell sizes in more extreme categories (e.g. always), this item was dichotomized as those who had ever experienced hunger (responses of "sometimes," "often" or "always") versus those who had "never" experienced it.[16]

Demographic measures

Patterns of hunger were described within and across sociodemographic groups,[17,18] i.e. age, grade level, gender, ethnicity, urban-rural geographic status, socioeconomic status and immigration status. "Age" and "grade level" were estimated by asking participants their birth month and year and comparing these with the date of survey administration, as well as what school grade they were currently enrolled in. The youngest group (participants aged 11) was assigned as the reference group. "Gender identity" was identified by asking participants "Are you male or female?" Response options included "male," "female" and "neither term describes me" (interpreted as nonbinary gender). Males were assigned as the reference group.

To determine "ethnicity," 16 response options describing ethnicity, based upon a Statistics Canada classification,[19] were grouped as follows into eight categories: White, Black, Latin American, Indigenous (First Nations, Métis or Inuit), East and Southeast Asian (e.g. Cambodian, Indonesian), Indian and South Asian (e.g. Pakistani), Arab and West Asian (e.g. Afghan) and Other (including participants that selected multiple response options). Indigenous responses were suppressed in some analyses to adhere to ethics requirements. Participants within the largest group (those identifying as White) were assigned as the reference group.

"Urban-rural geographic status" was defined based on the census subdivision where the school a participant attended was located, and varied from rural settings (< 1000 persons and a population density of less than 400 persons per km^2) to large urban population centres (100 000+ persons per km^2).[20] Those within the most developed living centre (large urban population centre) were assigned as the reference group.

"Perceived socioeconomic status" (i.e. affluence) was determined by asking the following question: "How well off do you think your family is?" Responses were categorized into three groups based on precedent:[21] low ("not very well off" and "not at all well off"), middle ("average") and high ("very well off" and "quite well off"). Those in the group with the highest socioeconomic status were assigned as the reference group.

"Immigration status" was determined by asking the following questions: "In which country were you born?" Response options were "Canada," "Other (please specify)" and "I don't know." Participants were then asked, "If you were not born in Canada, how many years have you lived in Canada?" Five possible response options were collapsed into three groups, as per precedent:[22] born in Canada, recent immigrants (1–5 years) and long-term immigrants (> 5 years). Those born in Canada, the largest group, were assigned as the reference group.

Statistical analyses

The sample was profiled by sociodemographic characteristics. Experiences of hunger were first described in a bivariate manner according to available sociodemographic factors. We then explored variations in hunger via multivariable negative binomial regression models that examined hunger as a function of all key sociodemographic variables, with simultaneous control for all available variables (i.e. age, gender, ethnicity, urban-rural geographic status, socioeconomic status and immigration status) to account for mutual confounding. Adjusted prevalence ratios were presented as estimates of relative risk, consistent with the cross-sectional nature

of the data. All analyses were performed in SPSS version 29,[23] with the level of statistical significance for correlations set at $p < 0.05$. Confidence intervals were generated based on model estimates and available sample size, by multiplying the standard error around the estimates by 1.96, with an adjustment for clustering at the school level by including a school code as a random effect. The data were also weighted to ensure national representation.

Given the importance of considering intersecting social positions, we conducted exploratory analyses investigating the connection between socioeconomic status, gender and reports of hunger. Confidence intervals were generated around each prevalence estimate using the same methodology as the multivariable regression analyses.

Results

The available sample is described in Table 1. As per the recruitment strategy, there were five age groups, each with roughly the same number of participants, and five grade level groups, also with roughly the same number of participants in each. There were slightly fewer males than females, while self-identified nonbinary participants made up a very small proportion of the sample (1.2%). Most participants identified as having a White (71.2%) or Other or mixed (12.1%) ethnic identity. Most participants attended schools within a small (44.6%) or a large (36.2%) population centre. Finally, most participants were born in Canada (75.5%) or were long-term immigrants (19.5%).

Hunger and its patterns

Variations in hunger were described by sociodemographic factors, including the results of the fully adjusted negative binomial regression models (Table 2). Compared to the youngest participants, the oldest two groups (those aged 14 and 15 years), were significantly less likely to experience hunger. Males were significantly more likely than females to experience hunger. Those who identified as nonbinary appeared to be disproportionately at higher risk, although this finding was not statistically significant ($p = 0.07$).

Several ethnic groups were at a higher risk of experiencing hunger. Compared to those who identified as White, participants identifying as Black, Latin American

TABLE 1
Demographic characteristics of the study sample, 2017/18 Health Behaviour in School-aged Children study, Canada

	n	(%)
Total	15 656	(100.0)
Age (y)		
11	1 774	(11.3)
12	3 279	(20.9)
13	3 637	(23.2)
14	3 798	(24.3)
15	3 168	(20.2)
Gender		
Male	7 281	(46.5)
Female	8 180	(52.2)
Neither term describes me	194	(1.2)
Grade		
6	2 904	(18.5)
7	3 556	(22.7)
8	3 606	(23.0)
9	3 785	(24.2)
10	1 805	(11.5)
Ethnicity		
White	11 154	(71.2)
Black	657	(4.2)
Latin American	223	(1.4)
Indigenous (First Nations, Métis or Inuit)	483	(3.1)
East and Southeast Asian	469	(3.0)
Indian and South Asian	487	(3.1)
Arab and West Asian	295	(1.9)
Other (including mixed ethnicities)	1 889	(12.1)
Urban/rural status of school municipality[a]		
Rural area (< 1000)	161	(1.0)
Small population centre (1000–29 999)	6 986	(44.6)
Medium population centre (30 000–99 999)	2 848	(18.2)
Large urban population centre (100 000+)	5 661	(36.2)
Immigration status		
Born in Canada	11 818	(75.5)
Immigrant ≤ 5 y	779	(5.0)
Immigrant > 5 y	3 059	(19.5)
Self-reported family socioeconomic status		
High	8 829	(56.4)
Middle	5 565	(35.5)
Low	1 263	(8.1)

Abbreviation: y, years.

[a] A population centre is defined as having "a population of at least 1000 and a population density of 400 persons or more per square kilometre," according to Statistics Canada's current Census of Population.[20]

TABLE 2
Self-reported experience of hunger and its correlation with sociodemographic indicators, 2017/18
Health Behaviour in School-aged Children study, Canada

Characteristic	Total in group	Hunger status			
		n in group reporting hunger	% in group (95% CI)	PR[a] (95% CI)	p value
Overall	15 656	2 592	16.6 (15.90–17.30)	—	—
Age					
11 (reference)	1 775	314	17.7 (15.6–19.8)	1.00	—
12	3 279	579	17.7 (16.1–19.3)	0.96 (0.82–1.12)	0.63
13	3 637	623	17.1 (15.6–18.6)	0.91 (0.78–1.07)	0.26
14	3 798	593	15.6 (14.2–17.0)	0.84 (0.72–0.98)	0.03
15	3 168	484	15.3 (13.8–16.8)	0.81 (0.69–0.95)	0.01
Gender					
Male (reference)	7 281	1 255	17.2 (16.2–18.2)	1.00	—
Female	8 180	1 282	15.7 (14.8–16.6)	0.89 (0.81–0.97)	0.01
Neither term describes me	195	55	28.2 (20.6–35.8)	1.37 (0.97–1.92)	0.07
Ethnicity[b]					
White (reference)	11 154	1 717	15.4 (14.6–16.2)	1.00	—
Black	656	154	23.5 (19.6–27.4)	1.55 (1.27–1.89)	< 0.001
Latin American	222	54	24.3 (17.5–31.1)	1.51 (1.10–2.07)	0.01
East and Southeast Asian	469	54	11.5 (8.0–15.0)	0.75 (0.55–1.04)	0.08
Indian and South Asian	487	53	10.9 (7.6–14.2)	0.81 (0.60–1.10)	0.18
Arab and West Asian	294	42	14.3 (9.5–19.1)	0.88 (0.63–1.24)	0.47
Other (including mixed)	1 889	404	21.4 (19.2–23.6)	1.37 (1.19–1.57)	< 0.001
Urban/rural status of school municipality[c]					
Rural area (< 1000)	161	33	20.5 (13.0–28.0)	1.00 (0.65–1.53)	1.00
Small population centre (1000 to 29 999)	6 985	1 121	16.0 (15.0–17.0)	0.97 (0.87–1.08)	0.59
Medium population centre (30 000 to 99 999)	2 849	469	16.5 (14.9–18.1)	0.98 (0.86–1.11)	0.74
Large urban population centre (100 000+) (reference)	5 661	969	17.1 (15.9–18.3)	1.00	—
Immigration status					
Born in Canada (reference)	11 818	1 871	15.8 (15.0–16.6)	1.00	—
Immigrant ≤ 5 y	779	123	15.8 (12.7–18.9)	0.93 (0.74–1.18)	0.56
Immigrant > 5 y	3 058	597	19.5 (17.8–21.2)	1.20 (1.08–1.34)	< 0.001
Self-reported family socioeconomic status					
High (reference)	8 828	1 104	12.5 (11.7–13.3)	1.00	—
Middle	5 564	1 079	19.4 (18.2–20.6)	1.57 (1.43–1.73)	< 0.001
Low	1 262	408	32.3 (29.2–35.4)	2.58 (2.25–2.96)	< 0.001

Abbreviations: PR, prevalence ratio; CI, confidence interval; y, years.

[a] Prevalence ratios have been adjusted via binomial regression models for all other demographic variables presented in Table 2.

[b] Indigenous group suppressed to comply with ethical guidelines.

[c] A population centre is defined as having "a population of at least 1000 and a population density of 400 persons or more per square kilometre," according to Statistics Canada's current Census of Population.[20]

and Other or mixed reported the highest levels. Participants who attended schools in rural areas were the most likely to experience hunger (20.5%), followed by those at schools in a large urban setting (17.1%). However, there were no statistically significant differences in the risk of reporting experiences of hunger by population centre size. Long-term immigrants were significantly more likely to experience hunger compared with those born in Canada (19.5% vs. 15.8%, respectively; prevalence ratio [PR] = 1.20, $p < 0.001$).

As expected, the strongest correlation was observed with the measure of socioeconomic status; participants classified in the low socioeconomic group reported hunger 2.6 times as frequently as those in the high socioeconomic group (32.3% in low, 12.5% in high). This correlation was significant in both the middle and low groups (PR = 1.57 [$p < 0.001$] and PR = 2.58 [$p < 0.001$], respectively), compared to high.

Figure 1 presents the frequency of self-reported hunger stratified by socioeconomic group and gender. For males and females, as socioeconomic status decreased, the proportion within each gender group increased. In contrast, of all nonbinary participants affected by hunger, the largest proportion within this group (33%) were within the high socioeconomic group.

Discussion

This novel analysis examined experiences of hunger in a large, nationally representative sample of young Canadians, and profiled these experiences of hunger from a sociodemographic perspective. Rather than explaining the underlying reasons for observed variations, our goal was to identify important variations in experiences of hunger to inform both etiological research and eventual prevention efforts. The most important finding was that approximately one in six young Canadians aged 11 to 15 years reported that they experienced some level of hunger due to not having enough food at home. The strongest observed pattern within our analyses was the correlation between hunger with lower socioeconomic status. Nonbinary gender participants were disproportionately affected by hunger compared to participants who identified as male or female, providing further indication of the social stratification of hunger experiences by gender. Additional sociodemographic groups at

FIGURE 1
Frequency of hunger among Canadian youth, stratified by gender identity and socioeconomic status, 2017/18 Health Behaviour in School-aged Children study, Canada
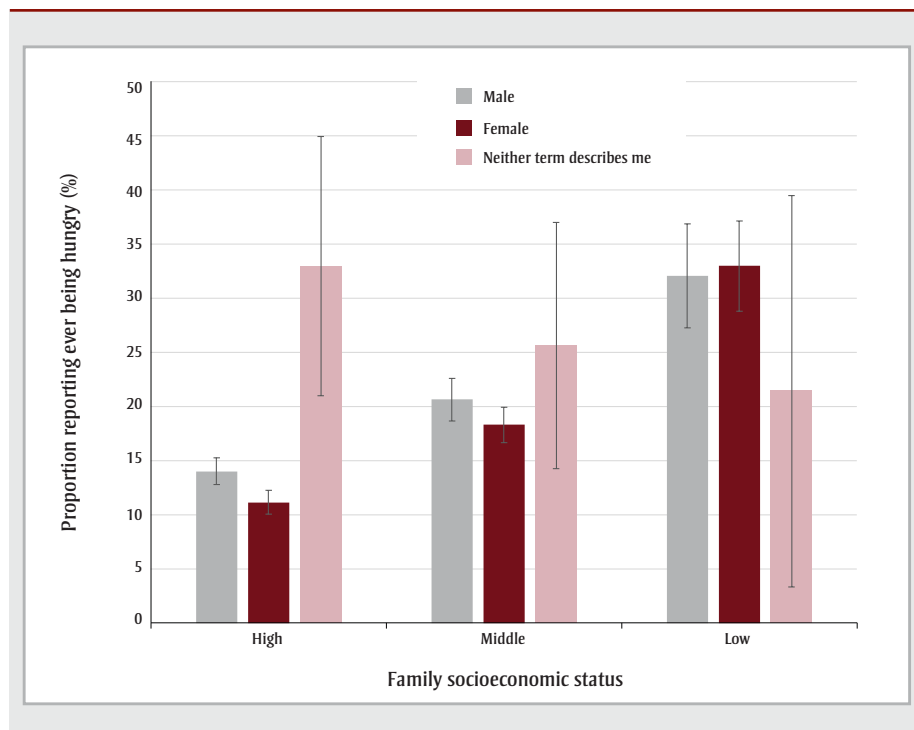
Note: Error bars indicate 95% confidence intervals.

higher risk for experiencing hunger included those who identified as male, Black, Latin American or Other or mixed ethnicity, those who were long-term immigrants, and those who attended schools in rural areas.

The relationship of hunger with socioeconomic status, while not unexpected,[18] is a particularly important finding. The questionnaire item used to establish experiences of hunger was introduced originally to the HBSC study as a measure of extreme deprivation,[16] as socioeconomic status has been closely linked with hunger in various adult, child and adolescent populations.[17,24] Our findings show that prevalence levels of self-reported hunger were highest in the lowest socioeconomic group, consistent with this past evidence.[25]

Interestingly, experiences of hunger were also reported by over one-tenth of young Canadians who reported having above average wealth. This finding suggests that the measure of hunger may have different meanings in different socioeconomic contexts, and with other factors (e.g. a lack of organization in the home[2]) potentially determining perceptions of hunger, even in the presence of affluence. To illustrate,

some families may have the means to purchase food, but they may not do so reliably.[2] Alternatively, this finding may reflect an expression of privilege bordering on entitlement;[26] there may be sufficient food in the home to satisfy nutritional needs, but the food may not fit with their taste or other preferences, and so, adolescents may opt to go hungry.[27]

Correlations between hunger and other sociodemographic factors were also identified. Males reported hunger marginally more often than females. This is unusual, as females typically report higher frequencies of food insecurity.[28] This result may have biological explanations in relation to sex differences in average nutrition needs; adolescent males require approximately 500 additional calories per day compared to females.[29] Alternatively, it may be attributable to the greater social acceptance of various forms of restrictive eating and dieting among girls than boys, given gendered differences in sociocultural appearance ideals.[30] More striking was the potential association of higher levels of hunger and identifying as nonbinary, which may be reflective of cumulative disadvantage among this at-risk group.[31] Nonbinary youth are more likely to

experience personal body dissatisfaction and low self esteem, and may also experience body dysmorphia.[32,33] This may lead to a disordered relationship with food and be partially responsible for this study's results.

Ethnicity was also correlated with hunger. Those who identified as Black, Latin American or Other or mixed ethnicity were at the highest risk of hunger, which is not uncommon among Canadian census studies.[34] Interestingly, some ethnic groups (East and Southeast Asian, Indian and South Asian, Arab and West Asian) were at a lower risk compared to White participants. This may be due to a variety of factors, including the presence of cultural food systems, household family structure or community ties.[34,35] Such hypotheses warrant focussed investigation. Similarly, relationships between hunger and immigration status are provocative. Consistent with the "healthy immigrant effect,"[36] after coming to Canada there is often a period when immigrants have better overall health compared to their native-born counterparts.[35] New immigrants may have access to resources and support that foster their assimilation in Canada, while long-term immigrants may experience various forms of hardship as they continue to live in the country, increasing the potential for disparities such as disproportionate hunger and food insecurity.[36]

Patterns of hunger by gender and socioeconomic status were also unexpected. The nonbinary participants who reported experiencing hunger most frequently were those who were part of the highest socioeconomic group. While unexpected, this finding demonstrates that the social roots of hunger do not always relate to poverty. Perhaps there are other hypotheses and pathways at work that underlie this pattern, such as the need for young people with nonbinary identities to conform with diets and lifestyles that undermine their health.[32] Potential misclassification by self-report may be responsible for some of this observation: a proportion of respondents may report that their family is "quite well off" when in reality they have faced financial struggle. This would explain the same respondent noting that they were in fact experiencing hunger due to a lack of food in the home.

Strengths and limitations

The strengths and limitations of this study warrant comment. In terms of strengths, first, the analysis highlights that hunger in children and youth is a topic of national importance and remains an endemic issue in our country.[37] Second, we profiled variations in hunger and identified several high-risk groups in a focussed equity analysis that included both bivariate and multivariable analyses. Third, the analysis benefited from the existence of an established cross-national research protocol with validated and well tested items and a robust national sample.

With respect to the limitations, first, because some jurisdictions shortened the questionnaire to respect local levels of literacy and cultural sensitivities, the effective sample size was reduced for this analysis. This may have also impacted groups who are often considered equity-denied populations,[38] and therefore has reduced the diversity and inclusivity of the sample. Second, due to privacy concerns, modelling results regarding Indigenous participants were suppressed to adhere to ethical research guidelines. Again, this may have impacted the inclusivity of the study sample.

Third, as the HBSC is a cross-sectional study, temporality cannot be inferred from many analyses, limiting the potential for causal inference. Hence, all effects that were estimated should be considered correlational. Fourth, prevalence estimates of hunger may be biased downward due to nonparticipation in the survey by at-risk children. The effects of this pattern of nonresponse on the sociodemographic patterns of hunger remain unknown, although we speculate it is likely that any effect of this nonparticipation would be to bias the results toward the null.

This study was able to highlight high risk groups of young Canadians who are more likely to experience hunger. While family income and hunger were highly correlated, access to nutrition may extend beyond income to other contextual factors. Future research on youth hunger and food insecurity may be guided by the goal of describing some of the complex interactions between the various demographic and social characteristics highlighted here that may lead to a young person experiencing hunger. Additionally, the results of this study may be beneficial to other research groups looking to develop hypotheses regarding health equity on a larger scale, as it is clear that there are systemic discrepancies in the ways various groups of people access basic resources such as adequate nutrition.

Conclusion

In this brief report, we have profiled experiences of hunger among young Canadians. Hunger is experienced in varying frequencies among different sociodemographic groups. The results of this analysis provide insight into hunger and its potential determinants, and foster hypotheses that support both etiological and interventional research in this important social field.

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Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions and statement

HC: conceptualization, formal analysis, project administration, writing—original draft.

VM, KP: conceptualization, supervision, writing—review and editing.

WP: conceptualization, data curation, funding acquisition, project administration, supervision, writing—review and editing.

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Original quantitative research

Characteristics of Canadians who use vaping products, by smoking status: findings from the Canadian Community Health Survey, 2020

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Abstract

Introduction: To date, surveillance of vaping among Canadians (using vaping products with or without nicotine) has largely been examined with respect to age and smoking status. However, a nationally representative examination of a broad set of characteristics is lacking. This study characterized Canadians aged 15 years and older who vape, stratified by smoking status.

Methods: Data from the 2020 Canadian Community Health Survey (unweighted analytical sample size: 28 413 respondents) were used to examine past-30-day vaping stratified by smoking status (current smoking, former smoking, and never/nonsmoking). A Sex- and Gender-Based Analysis Plus approach was used to select individual-level characteristics for analysis. Descriptive statistics were used to examine outcomes by each characteristic and multivariable logistic regression models were constructed to identify significant factors associated with each past-30-day vaping by smoking status category, using weighted data.

Results: In 2020, 2.0% (605 000) of Canadians aged 15 years and older reported vaping and current smoking (dual use), 1.2% (372 000) reported vaping and former smoking and 1.1% (352 000) reported vaping and never/nonsmoking. Within each past-30-day vaping by smoking status category, certain subgroups presented higher risks: youth and young adults, men, and those having a mood and/or anxiety disorder had higher odds of dual use. Vaping and former smoking was associated with self-identification as a man, having a mood and/or anxiety disorder and provincial region. Youth and young adults, men and those identifying as not a visible minority had higher odds of vaping and never/nonsmoking.

Conclusion: This analysis of Canadians who vape, stratified by smoking status, identifies high-prevalence subpopulations and informs us of the composition of vaping populations by select characteristics, deepening our understanding of Canadians who engage in vaping behaviours.

Keywords: electronic nicotine delivery systems, vaping, cigarette smoking, public health

Highlights

- We used a Sex- and Gender-Based Analysis Plus approach in this study to characterize Canadians who use vaping products, as a function of smoking status.
- Vaping and current smoking (dual use) was associated with young age, identification as a man and mental health disorders. Vaping and former smoking was associated with identification as a man, mental health disorders and provincial region. Vaping and never/nonsmoking was associated with young age and identification as a man and not belonging to a visible minority.
- Findings shed light on the composition of subpopulations that engage in vaping, which may inform equity considerations and research on interventions and public communications.

Introduction

In recent years, the use of vaping products (with or without nicotine) has increased substantially among Canadians, particularly youth. Vaping products are battery-operated devices that heat a liquid solution, usually containing nicotine and flavours, but not tobacco. The Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS) showed an approximate doubling of the prevalence of vaping among Canadian students, from 10% in 2016/17 to 20% in 2018/19, which remained stable through 2021/22.[1]

Data from the Canadian Tobacco and Nicotine Survey (CTNS) similarly reflect this stabilization of vaping among youth aged 15 to 19 years between 2019 and

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2022; in contrast, vaping among young adults aged 20 to 24 years increased between 2020 and 2022, while vaping among adults aged 25 and older remained stable from 2019 to 2022.[2] Evidence also reveals a central role of cigarette smoking status: it is a robust and consistent correlate of vaping,[3-6] and most Canadians aged 15 years and older who vape report currently or formerly smoking, although this also varies by age group.[2] Thus, age and smoking status have been critical to understanding the emergence of vaping in Canada to date.

These characteristics are also relevant to research on public health policy. Emerging evidence over the last decade reflects the challenge posed by vaping products: they present potential benefits as a smoking cessation tool to the millions of Canadians who smoke cigarettes, yet potential harms to individuals, particularly youth, who use the products but do not smoke.[7] The impact of vaping products on individuals who formerly smoked cigarettes—with respect to whether these products encourage or deter relapse to smoking—remains unclear.[7] Canada's Tobacco Strategy aims to provide people who smoke access to less harmful sources of nicotine, while protecting youth and nonusers of tobacco products from nicotine addiction.[8] In essence, rather than treating Canadians who vape as a homogeneous group, the Strategy considers the interplay of vaping and smoking status, recognizing that reasons for use, patterns of product use and, ultimately, associated public health impacts, will likely differ depending on the smoking status of the individuals who use them.

Tobacco control research has demonstrated that many factors are relevant to understanding the epidemiology of cigarette smoking. In Canada, smoking prevalence over time has varied by sex,[9] and disparities in smoking have been observed by household income and mental health.[10] However, it is less clear whether there are characteristics, other than age and smoking status, relevant to the epidemiology of vaping. To date, national surveillance of vaping among Canadian youth and adults has been limited, often assessing prevalence by age group or grade, sex or gender, and smoking status.[1,2,11] Several studies have assessed additional characteristics, including ethnicity, province of residence,

household income and perceived physical and mental health, although these have been limited to subpopulations, including Canadian students[4,6] and Canadians aged 15 years and older living in Ontario and Quebec.[5]

Additional studies have examined vaping among subpopulations of Canadians, examining various individual-, interpersonal- and environmental-level characteristics;[12-15] however, these are based on convenience samples, meaning the results have limited generalizability. Thus, a nationally representative examination of a broad set of characteristics is lacking. To address this evidence gap, this study aimed to characterize Canadians who use vaping products, stratified by smoking status.

Methods

Data source and study population

The Canadian Community Health Survey (CCHS) is a cross-sectional survey administered by Statistics Canada that collects information related to health status, health care utilization and health determinants of Canadians annually (January to December each year).[16] The survey covers approximately 98% of the Canadian population aged 12 years and older. Excluded from the sampling frame are individuals living on reserves and Crown lands in the provinces, institutional residents, full-time members of the Canadian Forces, youth aged 12 to 17 living in foster homes and residents of certain remote regions.[16]

Data were sourced from the 2020 CCHS Rapid Response file for examination of vaping using the Tobacco Alternatives and Vaping (TAV) module, given this was the first cycle of CCHS that reported on the use of vaping products across all Canadian provinces.[17] Access to the data was provided by Health Canada's Health Care Strategies Directorate. Ethical approval for population surveys conducted by Statistics Canada is based on the authority of the *Statistics Act* of Canada.

Data analysis

Key outcomes (there were 3) were past-30-day vaping stratified by smoking status—current smoking, former smoking and

never/nonsmoking—to align with the aims of Canada's Tobacco Strategy (Table 1).

Selection of individual-level characteristics was guided by a Sex- and Gender-Based Analysis Plus (SGBA+) approach, which is an intersectional approach to assessing how a range of factors impacts individuals' lived realities and differences in health outcomes,[18] as well as by data availability. The final set of characteristics included age, sex, gender, country of birth, province, first official language, visible minority* status, Aboriginal* (Indigenous) identity, education, household income and mood and/or anxiety disorder status (Table 1). Results are presented below in accordance with Statistics Canada release guidelines.

Analyses were conducted using weighted data. Statistics Canada survey sampling weights using the bootstrap method (1000 replicates) were applied to estimate standard error and account for the complex survey design. The analysis was limited to respondents aged 15 years and older to better align results with other surveillance tools used by Health Canada. Respondents with missing data for key outcomes (less than 0.5%) were excluded from the analysis, yielding an unweighted analytical sample size of 28 413 (n = 399 for vaping and current smoking, n = 309 for vaping and former smoking and n = 260 for vaping and never/nonsmoking; n = 27 445 for not vaping).

Descriptive statistics were generated to estimate the weighted prevalence of key outcomes across levels of SGBA+ characteristics, using Pearson chi-square tests with Rao-Scott correction to denote differences (e.g. for the outcome of vaping and current smoking by gender: prevalence of Canadian women and Canadian men who reported vaping and current smoking). We also described the proportion of each level of the SGBA+ characteristics among Canadians who reported each key outcome (e.g. for the outcome of vaping and current smoking by gender: proportion of Canadians who reported vaping and current smoking who identified as women and who identified as men).

Multivariable logistic regression models were estimated and assessed using the approach by Zhang[19] to examine correlates of each key outcome; a description

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* Terminology used in the Canadian Community Health Survey.

Description		Notes
Primary outcomes		
Past-30-day vaping, stratified by smoking status	Respondents were classified according to their vaping and smoking status, at the time of the survey: (1) Vaping and current smoking: included respondents who reported vaping in the past 30 days AND reported smoking cigarettes either daily or occasionally at the time of the survey. (2) Vaping and former smoking: included respondents who reported vaping in the past 30 days AND reported smoking more than 100 cigarettes in their lifetime, but had not reported smoking at the time of the survey. (3) Vaping and never/nonsmoking: included respondents who reported vaping in the past 30 days AND [(reported either never having smoked a cigarette in their lifetime) OR (had smoked a whole cigarette but had not smoked more than 100 cigarettes AND reported not smoking at the time of the survey)].	Vaping status based on responses to TAV_055. Smoking status based on responses to SMK_005, SMK_020, SMK_025.
Sex- and Gender-Based Analysis Plus (SGBA+) characteristics		
Age	Respondents provided their date of birth, which was used to create age groups: • Youth and young adults (15–24 years) • Adults (25 years and older)	Based on responses to DHH_AGE.
Sex	Respondents indicated their sex at birth: • Male • Female	Based on responses to DHH_SEX.
Gender	Respondents reported their gender: • Man • Woman	Based on responses to GDR_010. Response categories relabelled to "man/men," and "woman/women," to differentiate from the variable and concept of sex. Response category "gender diverse" excluded, as data were not reportable.
Visible minority[a] status	Respondents reported their visible minority status: • Visible minority • Not a visible minority	Based on SDCDVFLA (itself based on responses to SDCDVVM, and in turn, SDC_020). Visible minority status was based on a question that "collects information in accordance with the *Employment Equity Act* and its Regulations and Guidelines to support programs that promote equal opportunity for everyone to share in the social, cultural, and economic life of Canada."[b] Specifically, participants were asked whether they belonged to "one or more racial or cultural groups"[a,c] from a list provided by the interviewer (White, South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean, Japanese, Other).
Aboriginal[a] identity	Respondents reported their Aborigina[a] identity: • First Nations, Métis or Inuk (Inuit) • Not an Aborigina[a] person	Based on responses to SDC_015.
Country of birth	Respondents reported their country of birth: • Canada • Other	Based on SDCDVIMM.
Province of residence	Respondents indicated their provincial region of residence: • Western provinces (British Columbia, Alberta, Saskatchewan, Manitoba) • Ontario • Quebec • Eastern provinces (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador)	Based on responses to GEO_PRV.

Description		Notes
First official language spoken	Respondents reported their official language spoken: • English • French	Based on SDCDVFLS. First official language spoken takes into account (1) the knowledge of the two official languages; (2) the mother tongue; and (3) the home language.
Education	Respondents reported their highest level of education: • Less than secondary school graduation • Secondary school graduation with no postsecondary education • Postsecondary certificate or diploma, or university degree, or more	Based on responses to EHG2_01, EHG2_02, EHG2_03, EHG2_04.
Household income (CAD)	Household income quantiles: • Quantile 1 (0–70 000) • Quantile 2 (70 001–130 000) • Quantile 3 (130 001–12 000 000)	Based on responses to INC_021. Three income quantiles were created from total weighted income amounts that Statistics Canada provided based on tax records, from respondent-provided data, and from imputed data, to establish ranges of household income by all household members, from all sources, before taxes and deductions, following the recoding of negative values to zero.
Mood and/or anxiety disorder	Respondents reported their mood and/or anxiety disorder status: • Mood and/or anxiety disorder • Neither mood nor anxiety disorder	Based on responses to CCC_195 & CCC_200, which ask respondents about long-term conditions expected to last or that have already lasted 6 months or more and that have been diagnosed by a health professional. Mood disorders include depression, bipolar disorder, mania and dysthymia. Anxiety disorders include phobia, obsessive-compulsive disorder and panic disorder.

Abbreviation: CAD, Canadian dollars.

Note: Additional information about Canadian Community Health Survey questionnaires is available online.[16,17]

[a] Terminology used in the Canadian Community Health Survey.

[b] From Statistics Canada. Visible minority and population group reference guide, Census of Population, 2021 [Internet]. Ottawa (ON): Statistics Canada; 2022 [cited 2024 Aug 07]. Available from: https://www12.statcan.gc.ca/census-recensement/2021/ref/98-500/006/98-500-x2021006-eng.cfm

[c] From Statistics Canada. Canadian Community Health Survey (CCHS)–annual component – 2020 [Internet]. [Questionnaire.] Ottawa (ON): Statistics Canada, 2020 [cited 2024 Aug 07]. Available from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&a=1&&lang=en&Item_Id=1262397

of the final model for each key outcome is included alongside the results, in the next section. Given the extent to which sex and gender are correlated, we chose to include gender in our model-building exercise because socially constructed roles, behaviours, expressions and identities may be more relevant to shaping behaviours with respect to tobacco and vaping products than physiological sex differences.[18] Analyses were conducted using Stata version 17.0 (StataCorp LP, College Station, TX, US) with a p value set at < 0.05 to denote statistical significance.

Results

In 2020, 2.0% (605 000) of Canadians reported vaping and current smoking (dual use), 1.2% (372 000) reported vaping and formerly smoking and 1.1% (352 000) reported vaping and never/non-smoking (Table 2).

Vaping and current smoking (dual use)

As shown in Table 2, vaping and current smoking (i.e. dual use) varied significantly by age (p < 0.001). Prevalence of dual use was significantly higher among youth and young adults aged 15 to 24 years (4.2%) compared to adults aged 25 years and older (1.6%); however, adults aged 25 years and older made up the majority (70.7%) of Canadians who reported dual use.

Dual use varied significantly by sex at birth (p < 0.001) and self-reported gender identity (p < 0.001). Prevalence of dual use was significantly higher among males (2.7%) and men (2.7%), when compared to females (1.2%) and women (1.2%). Most Canadians who reported dual use were male (68.1%, vs. female, 31.9%) and identified as men (68.4%, vs. women, 31.6%).

Dual use did not vary by country of birth (p = 0.90), visible minority status (p = 0.15) or Aboriginal identity (p = 0.56). Most Canadians who reported dual use were born in Canada (73.1%) and identified neither as a visible minority (71.6%) nor as Aboriginal (96.4%).

Dual use did not vary by provincial region (p = 0.78). Most Canadians who reported dual use lived in Ontario (36.1%) or the western provinces (32.0%).

Dual use also did not vary by official language (p = 0.21); however, most Canadians who reported dual use indicated English as their first official language spoken (81.4%).

Dual use varied significantly by education (p < 0.01). Canadians with less than secondary school graduation (2.6%[†]) and with secondary school graduation (2.7%) had significantly higher prevalence rates

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[†] Moderate sampling variability; interpret with caution.

TABLE 2
Characterization of Canadians aged 15 years and older who reported past-30-day vaping, by smoking status, 2020

Characteristic	Vaping and current smoking		Vaping and former smoking		Vaping and never/nonsmoking	
	Prevalence of vaping and current smoking among Canadians	Distribution of characteristics among Canadians who vape and currently smoke	Prevalence of vaping and former smoking among Canadians	Distribution of characteristics among Canadians who vape and formerly smoked	Prevalence of vaping and never/ nonsmoking among Canadians	Distribution of characteristics among Canadians who vape and have never smoked/do not smoke
	Weighted % [95% CI] (weighted population estimate)					
Overall	2.0 [1.6–2.3] (605 000)	100.0 (605 000)	1.2 [1.0–1.4] (372 000)	100.0 (372 000)	1.1 [0.9–1.3] (352 000)	100.0 (352 000)
Age group (y)						
Youth and young adults (15–24)	4.2 [3.0–5.4] (178 000)	29.3 [21.9–36.7] (178 000)	1.9[a] [1.0–2.8] (80 000)	21.4[a] [12.6–30.2] (80 000)	6.3 [5.0–7.6] (267 000)	75.7 [67.3–84.0] (267 000)
Adults (25 and older)	1.6 [1.3–1.9] (428 000)	70.7 [63.3–78.1] (428 000)	1.1 [0.9–1.3] (292 000)	78.6 [69.8–87.4] (292 000)	0.3[a] [0.2–0.5] (86 000)	24.3[a] [16.0–32.7] (86 000)
Sex						
Male	2.7 [2.1–3.2] (412 000)	68.1 [60.2–76.0] (412 000)	1.5 [1.2–1.8] (227 000)	61.1 [53.6–68.7] (227 000)	1.5 [1.2–1.9] (231 000)	65.7 [57.7–73.7] (231 000)
Female	1.2 [0.9–1.6] (193 000)	31.9 [24.0–39.8] (193 000)	0.9 [0.7–1.1] (145 000)	38.9 [31.3–46.4] (145 000)	0.8 [0.6–1.0] (121 000)	34.3 [26.3–42.3] (121 000)
Gender						
Men	2.7 [2.1–3.2] (412 000)	68.4 [60.5–76.3] (412 000)	1.5 [1.2–1.8] (229 000)	61.7 [54.2–69.2] (229 000)	1.5 [1.2–1.9] (232 000)	66.0 [58.0–74.0] (232 000)
Women	1.2 [0.9–1.6] (190 000)	31.6 [23.7–39.5] (190 000)	0.9 [0.7–1.1] (142 000)	38.3 [30.8–45.8] (142 000)	0.8 [0.6–1.0] (120 000)	34.0 [26.0–42.0] (120 000)
Visible minority[b] status						
Visible minority	2.5[a] [1.5–3.6] (168 000)	28.4 [19.4–37.5] (168 000)	c	c	0.9[a] [0.5–1.2] (57 000)	16.3[a] [9.8–22.8] (57 000)
Not a visible minority	1.8 [1.5–2.0] (422 000)	71.6 [62.5–80.6] (422 000)	d	d	1.2 [1.0–1.5] (295 000)	83.7 [77.2–90.2] (295 000)
Aboriginal[b] identity						
Aboriginal	2.3[a] [1.2–3.3] (22 000)	3.6[a] [1.9–5.4] (22 000)	c	c	c	c
Not Aboriginal	1.9 [1.6–2.2] (571 000)	96.4 [94.6–98.1] (571 000)	d	d	d	d
Country of birth						
Canada	1.9 [1.6–2.2] (435 000)	73.1 [64.7–81.6] (435 000)	1.4 [1.1–1.6] (313 000)	84.9 [78.9–90.9] (313 000)	d	d
Other	2.0[a] [1.2–2.7] (160 000)	26.9 [18.4–35.3] (160 000)	0.7[a] [0.4–1.0] (55 000)	15.1[a] [9.1–21.1] (55 000)	c	c
Provinces						
Western provinces[e]	2.0 [1.5–2.5] (194 000)	32.0 [25.1–39.0] (194 000)	1.4 [1.1–1.7] (136 000)	36.6 [29.0–44.2] (136 000)	1.3 [1.0–1.6] (126 000)	35.9 [27.7–44.0] (126 000)
Ontario	1.8[a] [1.2–2.4] (219 000)	36.1 [27.5–44.7] (219 000)	0.7 [0.5–0.9] (81 000)	21.8 [15.5–28.0] (81 000)	1.0[a] [0.6–1.4] (119 000)	33.7 [24.3–43.1] (119 000)
Quebec	2.1[a] [1.4–2.8] (147 000)	24.2 [17.3–31.2] (147 000)	1.7[a] [1.2–2.3] (123 000)	33.1 [24.6–41.5] (123 000)	1.1 [0.8–1.5] (81 000)	22.9 [16.1–29.6] (81 000)
Eastern provinces[f]	2.3[a] [1.5–3.0] (46 000)	7.6[a] [4.9–10.4] (46 000)	1.6[a] [1.0–2.2] (32 000)	8.6[a] [5.2–11.9] (32 000)	1.3[a] [0.6–2.0] (27 000)	7.6[a] [3.9–11.3] (27 000)

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Characteristic	Vaping and current smoking		Vaping and former smoking		Vaping and never/nonsmoking	
	Prevalence of vaping and current smoking among Canadians	Distribution of characteristics among Canadians who vape and currently smoke	Prevalence of vaping and former smoking among Canadians	Distribution of characteristics among Canadians who vape and formerly smoked	Prevalence of vaping and never/ nonsmoking among Canadians	Distribution of characteristics among Canadians who vape and have never smoked/do not smoke
	Weighted % [95% CI] (weighted population estimate)					
Official language spoken						
English	2.0 [1.6–2.4] (464 000)	81.4 [76.1–86.7] (464 000)	1.1 [0.9–1.3] (254 000)	70.0 [61.5–78.5] (254 000)	1.2 [0.9–1.4] (268 000)	77.6 [71.0–84.2] (268 000)
French	1.6 [1.1–2.1] (106 000)	18.6 [13.3–23.9] (106 000)	1.7[a] [1.1–2.2] (109 000)	30.0 [21.5–38.5] (109 000)	1.2 [0.8–1.5] (77 000)	22.4 [15.8–29.0] (77 000)
Education						
Less than secondary school graduation	2.6[a] [1.7–3.5] (95 000)	16.3[a] [10.9–21.7] (95 000)	1.4[a] [0.5–2.3] (51 000)	13.8[a] [5.7–21.8] (51 000)	2.5 [1.9–3.1] (92 000)	26.3 [19.8–32.7] (92 000)
Secondary school graduation, but no postsecondary education	2.7 [2.0–3.5] (190 000)	32.7 [25.6–39.9] (190 000)	1.6 [1.2–2.1] (112 000)	30.3 [23.0–37.5] (112 000)	2.0[a] [1.3–2.6] (135 000)	38.4 [29.2–47.6] (135 000)
Postsecondary certificate/diploma or university degree or more	1.5 [1.1–1.8] (295 000)	50.9 [42.9–59.0] (295 000)	1.0 [0.8–1.2] (208 000)	55.9 [47.1–64.7] (208 000)	0.6[a] [0.4–0.8] (124 000)	35.4 [26.5–44.3] (124 000)
Household income (CAD)						
Quantile 1: 0–70 000	2.1 [1.6–2.7] (225 000)	37.2 [29.1–45.4] (225 000)	1.3 [0.9–1.7] (137 000)	36.9 [28.5–45.3] (137 000)	0.8[a] [0.5–1.2] (90 000)	25.5 [17.5–33.4] (90 000)
Quantile 2: 70 001–130 000	1.8 [1.4–2.3] (192 000)	31.8 [24.5–39.0] (192 000)	1.3 [1.0–1.6] (133 000)	35.8 [28.3–43.3] (133 000)	1.0[a] [0.7–1.4] (109 000)	31.1 [22.6–39.6] (109 000)
Quantile 3: 130 001–12 000 000	1.9[a] [1.3–2.5] (188 000)	31.0 [22.8–39.2] (188 000)	1.0 [0.7–1.4] (102 000)	27.3 [19.7–34.9] (102 000)	1.6 [1.1–2.0] (153 000)	43.4 [34.3–52.5] (153 000)
Mood and/or anxiety disorder						
Mood and/or anxiety disorder	4.3 [3.1–5.5] (196 000)	33.1 [25.2–40.9] (196 000)	2.3 [1.7–2.9] (105 000)	28.2 [21.2–35.1] (105 000)	1.5[a] [1.0–2.0] (67 000)	19.2 [13.3–25.0] (67 000)
Neither mood nor anxiety disorder	1.5 [1.2–1.8] (397 000)	66.9 [59.1–74.8] (397 000)	1.0 [0.8–1.2] (267 000)	71.8 [64.9–78.8] (267 000)	1.1 [0.9–1.3] (284 000)	80.8 [75.0–86.7] (284 000)

Source: 2020 CCHS—Rapid Response file.[17]

Abbreviations: CAD, Canadian dollars; CCHS, Canadian Community Health Survey; CI, confidence interval; y, years.

Note: Analyses conducted using weighted data. Respondents with missing data are not included in weighted estimates.

[a] Moderate sampling variability, interpret with caution. According to release guidelines for the 2020 CCHS published by Statistics Canada, estimates in this category were based on an unweighted numerator of at least 30 respondents and a coefficient of variation greater than 15.0% or less than or equal to 35.0%.

[b] Terminology used in the CCHS.

[c] High sampling variability; although an estimate may be determined, data should be suppressed. According to release guidelines for the 2020 CCHS published by Statistics Canada, estimates in this category were based on an unweighted numerator of less than 30 respondents or a coefficient of variation greater than 35.0%.

[d] Complementary data suppression applied to prevent derivation of estimates suppressed for quality purposes.

[e] British Columbia, Alberta, Saskatchewan and Manitoba.

[f] New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

of dual use, compared to those with a postsecondary certificate/diploma or university degree or more (1.5%). Approximately half (50.9%) of Canadians who reported dual use had completed postsecondary education, while about one-third (32.7%) had completed secondary school,

and the remainder (16.3%[†]) had less than secondary school education.

Dual use did not vary by household income ($p = 0.71$). Among Canadians who reported dual use, household income was relatively evenly distributed.

Dual use varied significantly by mental health status ($p < 0.001$). Canadians with a mood and/or anxiety disorder had a higher prevalence rate (4.3%) than Canadians without these disorders (1.5%); however, most Canadians reporting dual use had neither a mood nor an anxiety disorder (66.9%).

† Moderate sampling variability; interpret with caution.

The final multivariable model examining vaping and current smoking was fitted with age group, gender and mental health. Results showed higher odds of dual use among youth and young adults (vs. adults: adjusted odds ratio [AOR] = 2.47, 95% CI: 1.71–3.58, $p < 0.001$), men (vs. women: AOR = 2.44, 95% CI: 1.64–3.64, $p < 0.001$), and those with a mood and/or anxiety disorder (vs. those without: AOR = 3.31, 95% CI: 2.27–4.82, $p < 0.001$).

Vaping and former smoking

As shown in Table 2, vaping and former smoking did not vary by age ($p = 0.09$); however, over three-quarters of Canadians who reported vaping and former smoking were aged 25 years and older (78.6%).

Vaping and former smoking varied significantly by sex ($p < 0.01$) and gender ($p < 0.01$), with higher prevalence among males (1.5%, vs. females, 0.9%), and men (1.5%, vs. women, 0.9%). Most Canadians who vaped and formerly smoked were males (61.1%) and identified as men (61.7%).

Findings examining vaping and former smoking by visible minority status and Aboriginal identity were not reportable nor releasable due to data reporting requirements.

Vaping and former smoking varied significantly by country of birth ($p < 0.001$); those born in Canada (1.4%) had a significantly higher prevalence of vaping and former smoking than those born outside Canada (0.7%[†]). Most Canadians who reported vaping and former smoking were born in Canada (84.9%).

Vaping and former smoking also varied by provincial region ($p < 0.001$); prevalence was significantly higher in the eastern provinces (1.6%[†]), the western provinces (1.4%) and Quebec (1.7%[†]), as compared to Ontario (0.7%). The largest proportion of Canadians who reported vaping and former smoking lived in the western provinces (36.6%), followed by Quebec (33.1%), Ontario (21.8%) and the eastern provinces (8.6%[†]).

Vaping and former smoking did not vary by official language ($p = 0.07$); however, most Canadians who reported vaping and former smoking (70.0%) indicated English as their first official language.

No significant differences were observed in vaping and former smoking by education ($p = 0.15$). More than half of Canadians who vape and formerly smoked had a postsecondary certificate/diploma or university degree or more (55.9%), almost one-third had secondary school education but no postsecondary education (30.3%), and the remainder had less than secondary school graduation (13.8%[†]).

Vaping and former smoking did not vary by household income ($p = 0.52$). Among Canadians who reported vaping and former smoking, household income showed a slightly skewed distribution, with a smaller share of respondents in the upper quantile.

Significant differences were observed in vaping and former smoking by mental health ($p < 0.001$); the prevalence of vaping and former smoking was significantly higher among those with a mood and/or anxiety disorder (2.3%), compared to those without such disorders (1.0%); however, the majority of Canadians who vape and formerly smoked had neither a mood nor an anxiety disorder (71.8%).

The final multivariable model examining vaping and former smoking was fitted with age group, gender, provincial region and mental health. Results showed higher odds of vaping and former smoking among men (vs. women: AOR = 1.81, 95% CI: 1.33–2.45, $p < 0.001$); those living in Quebec (vs. Ontario: AOR = 2.84, 95% CI: 1.75–4.62, $p < 0.001$), the eastern provinces (vs. Ontario: AOR = 2.37, 95% CI: 1.42–3.94, $p < 0.01$), and the western provinces (vs. Ontario: AOR = 2.14, 95% CI: 1.41–3.23, $p < 0.001$), and those with a mood and/or anxiety disorder (vs. those without: AOR = 2.55, 95% CI: 1.82–3.56, $p < 0.001$).

Vaping and never/nonsmoking

As shown in Table 2, vaping and never/nonsmoking varied significantly by age ($p < 0.001$), with higher prevalence among youth and young adults (6.3%), compared to adults (0.3%[†]). Youth and young adults (75.7%) also represented most Canadians reporting this outcome.

Vaping and never/nonsmoking also varied significantly by sex ($p < 0.001$) and gender ($p < 0.001$). Prevalence was higher among males (1.5%, vs. females, 0.8%), and men (1.5%, vs. women, 0.8%). Most Canadians who vaped and were never/nonsmokers were males (65.7%) and identified as men (66.0%).

Vaping and never/nonsmoking did not vary by visible minority status ($p = 0.12$); however, most Canadians who reported this outcome did not identify as a visible minority (83.7%).

Findings examining vaping and never/nonsmoking by Aboriginal identity and country of birth were not reportable or releasable due to data reporting requirements.

No significant differences were observed in vaping and never/nonsmoking by provincial region ($p = 0.52$). Most Canadians who reported this outcome lived in the western provinces (35.9%) or Ontario (33.7%).

Vaping and never/nonsmoking did not vary by official language ($p = 0.92$); however, just over three-quarters of Canadians who reported this outcome indicated English (77.6%) as their first official language.

Significant differences were observed in vaping and never/nonsmoking by education ($p < 0.001$); Canadians with a postsecondary certificate/diploma or a university degree or more (0.6%[†]) had a significantly lower prevalence of vaping and never/nonsmoking, compared to those with less than secondary school graduation (2.5%), and those with secondary school graduation but no postsecondary education (2.0%[†]). Level of education was variably distributed among Canadians who reported vaping and never/nonsmoking: 38.4% had a secondary school graduation but no postsecondary education, 35.4% had a postsecondary certificate or diploma or a university degree or more, and 26.3% had less than secondary school graduation.

Vaping and never/nonsmoking varied significantly by household income ($p = 0.02$): prevalence was significantly higher among Canadians in the upper household income quantile (1.6%), compared to the lower quantile (0.8%[†]). Among Canadians who reported this outcome, household income

† Moderate sampling variability; interpret with caution.

showed a skewed distribution, with a greater share of respondents in the upper quantile.

No significant differences were observed in vaping and never/nonsmoking by mental health ($p = 0.13$). Among Canadians who reported this outcome, 80.8% did not have a mood and/or anxiety disorder.

The final multivariable model examining vaping and never/nonsmoking was fitted with age group, gender and visible minority status. Results showed higher odds of vaping and never/nonsmoking among youth and young adults (vs. adults: AOR = 22.62, 95% CI: 14.06–36.39, $p < 0.001$); men (vs. women: AOR = 1.76, 95% CI: 1.21–2.56, $p < 0.01$); and among those not identifying as a visible minority (vs. those identifying as a visible minority: AOR = 2.31, 95% CI: 1.39–3.85, $p < 0.01$).

Discussion

To our knowledge, the study findings present one of the first in-depth, nationally representative characterizations of Canadians who vape, stratified by smoking status.

While previous analyses of vaping correlates among Canadians aged 15 years and older showed no association with sex,[3,5] our multivariable analysis yielded significant gender associations, with men having greater odds compared to women for each of the vaping outcomes stratified by smoking status. Previous research has identified an association between vaping and male sex among Canadian students.[4,6] Results from the 2021/22 CSTADS[1] showed differences in vaping by gender, with higher rates of vaping among girls/women compared to boys/men. While vaping prevalence was also high among students who identified as transgender, gender diverse and/or questioning, the contrast with boys/men did not reach statistical significance.[1] Taken together, the findings suggest emerging trends in vaping by gender, which may be particularly important to monitor in young populations, given that they are substantially more likely to be nonbinary in gender identity and/or expressions.[20]

Dual use, as well as vaping and former smoking, were significantly associated with mood and/or anxiety disorders. These associations are perhaps unsurprising, given

that these outcomes reflect present or past experiences with cigarette smoking, which is itself highly prevalent among individuals living with mental health issues.[10] The common belief that smoking helps reduce stress and mental health symptoms or issues may cause concern that smoking cessation could worsen these outcomes. Evidence shows, however, that quitting smoking does not worsen and in fact may, in the long term, improve mood, mental health and abstinence from other substances.[21,22]

Evidence also shows that vaping products containing nicotine can help people quit smoking.[23] Therefore, people who smoke should continue to be encouraged to quit, whether via vaping products or other forms of assistance. While an association between vaping and never/nonsmoking and mental health was not observed in the current analysis, research examining youth populations—the majority of whom do not have a history of smoking—suggests vaping is associated with poor well-being and greater delinquency,[24] psychiatric comorbidities[25] and lower perceived mental health.[1] Thus, continued monitoring of mental health among individuals without a smoking history who vape, particularly youth, is warranted.

Our results show that dual use was also significantly associated with young age (15–24 years). This finding is somewhat surprising, given that the rise in youth vaping between 2016/17 and 2018/19 was observed alongside continuing declines in cigarette smoking.[1] However, this finding likely reflects the conflation of youth (15 to 19 years) and young adult (20 to 24 years) respondents into a single category. While this was done to yield reportable results, it is important to note that young adults who vape are a distinct group with a prevalence trajectory that differs from both youth and older adults, and among whom the main reasons cited for vaping reflect a mixture of recreational use and use for smoking cessation.[2]

The outcome of vaping and former smoking also showed significant variation by provincial region. This result likely reflects the variation seen among Canadian provinces in the prevalence of former smoking, which has, over time, generally been lower in Ontario and higher in other regions, including in the western provinces and particularly in the eastern provinces and Quebec.[2,11] As noted earlier, the

impact of vaping products remains unclear for individuals who formerly smoked cigarettes;[7] thus, more research is needed to understand the role these products play in smoking cessation and relapse, including longitudinal studies that examine motivations for use.

The findings of this study deepen our understanding of the potential public health impacts of vaping products. First, the findings identify subpopulations with relatively higher and lower prevalence rates. For instance, vaping and never/nonsmoking was more prevalent among youth and young adults, men, and those who did not identify as a visible minority. Greater prevalence among young people is concerning, given that nicotine is an addictive substance, and exposure to nicotine during adolescence can harm the developing brain and may impact cognition.[26,27] The findings may inform discussions regarding equity and research into effective communications and interventions for specific at-risk subpopulations, including primary prevention communications, such as media campaigns,[28] as well as vaping cessation guidance.[29]

Second, study findings shed light on the composition of subpopulations that engage in these behaviours. For instance, analyses show that most Canadians reporting dual use were 25 years or older, identified as men, had higher levels of education and reported not having mental health issues. These results may further research into effective communications that encourage complete switching from cigarettes to vaping products.

Strengths and limitations

This study has several strengths, including the use of nationally representative data reporting on the use of vaping products across all Canadian provinces for the first time. In addition, examination of vaping by smoking status provides a nuanced understanding of this behaviour in terms of risk. Furthermore, the SGBA + framework provides a rich and diverse lens through which to examine Canadians who vape.

However, there are also some limitations. To begin with, analyses were conducted using self-reported data, which may be subject to bias. Next, while the vaping question was sourced from the Tobacco Alternatives and Vaping (TAV) Rapid

Response module of the CCHS, and thus aimed to assess the use of vaping products with or without nicotine, the question did not include a preamble to explicitly exclude cannabis; thus, it is possible that results may reflect vaping of various substances. In addition, while we acknowledge the limitations of interpreting past-30-day vaping as a measure of regular use,[30] it is a commonly used measure and was the optimal measure available for analysis, given survey limitations.

The use of the SGBA + approach addresses individual-level factors; however, there may be interpersonal and societal factors related to vaping behaviour that were not addressed. Next, despite using a data source with a large sample size, we were limited in our ability to examine certain characteristics, such as sexual orientation and labour force activities, given reportability requirements, and disability status, which was not assessed in the 2020 cycle. Finally, data collection in the 2020 cycle occurred during the COVID-19 pandemic; data collection was interrupted between mid-March and September, which lowered response rates. Thus, results should be interpreted with caution, and continued monitoring of vaping among Canadians is warranted.

Conclusion

The findings from our study allow for the identification of high-prevalence groups and deepen our understanding of who vapes in Canada, as a function of smoking status. The findings may inform further research in the areas of vaping prevention and cessation, including in relation to specific at-risk subpopulations, equity, and effective communications and interventions for specific audiences.

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Conflicts of interest

None to declare.

Authors' contributions and statement

CDC, TM: conceptualization.

CG, DD, NF, GL, GW: formal analysis.

CDC, TM, CG, DD, NF, GL, GW: interpretation of results.

CDC: writing—original draft.

CDC, TM, CG, DD, NF, GL, GW: writing—review and editing.

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Original qualitative research

Perceptions of overdose response hotlines and applications among rural and remote individuals who use drugs in Canada: a qualitative study

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Abstract

Introduction: The overdose epidemic continues to be one of the largest public health crises in Canada. Various harm reduction supports have been implemented to curb this epidemic; however, they remain concentrated within urban settings. To address this limitation, overdose response hotlines and applications (ORHA) are novel, technology-based harm reduction services that may reduce drug-related mortality for people who use substances (PWUS) living in rural communities through virtual supervised consumption. These services enable more timely and remote activation of emergency responses, should an individual become unresponsive. We aimed to explore the experiences, perceptions and attitudes surrounding ORHA of individuals living in rural areas.

Methods: We conducted semistructured interviews with 15 PWUS (7 [46.7%] male, 9 [60%] Indigenous) who lived in rural, remote or Indigenous communities. Interviews were conducted until data saturation was reached. Data were analyzed using thematic analysis.

Results: Six key themes emerged: (1) participants viewed ORHA as a pragmatic intervention for rural areas but noted potential limitations to its uptake and effectiveness; (2) rural geography may hinder EMS response times, reducing the efficacy of ORHA; (3) ORHA uptake may be limited due to significant stigma faced by PWUS in these communities; (4) lack of access to technology remains a barrier to ORHA access; (5) harm reduction awareness is often limited in rural communities; and (6) there are unique social implications around substance use and harm reduction for rural Indigenous PWUS.

Conclusion: While participants believed that ORHA may be a feasible harm reduction strategy for rural PWUS, limitations, including response times, technological access and substance use stigma, remain.

Keywords: overdose, drug poisoning, overdose response hotlines and applications, harm reduction, supervised consumption, public health, rural health, Indigenous health

Highlights

- There are significant gaps in harm reduction services and awareness in rural areas.
- Significant stigma faced by people who use substances in rural communities drives additional caution in these individuals with respect to accessing harm reduction services, if they are even available.
- Overdose response hotlines and applications (ORHA) may be the only harm reduction services accessible to people who use substances in rural communities.
- Rural geography may pose challenges to emergency responses from ORHA services.
- Technology ownership and connectivity by people who use substances in rural communities may be limited, reducing service uptake.

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Introduction

The substance use mortality (also termed "overdose" or "drug poisoning") epidemic crisis is arguably one of the largest public health issues currently facing North America.[1] To combat the soaring mortality rate associated with this epidemic, various harm reduction strategies have been implemented across Canada which continue to prove effective at attenuating this crisis.[2-4] Services such as drug-checking services, supervised consumption sites and risk mitigation guidance have resulted in reductions in morbidity and mortality rates.[5-7]

Access to these resources, however, remains a continuous challenge. As highlighted in a modelling study by Irvine et al., increasing uptake of harm reduction interventions, such as take-home naloxone kits, would likely lead to significant reductions in mortality rates from this epidemic.[8] While the current literature remains mixed on the association between geospatial location and fatal overdose/drug poisoning,[9,10] more recent data indicate that there is a 30% increase in the odds of fatal overdose within rural locations in British Columbia.[9] The authors of the latter study hypothesize these differences originate most prominently from both a lack of harm reduction access and an increasingly toxic drug supply.[9] Moreover, even within large urban centres, reductions in mortality attributed to supervised consumption services have only been documented within a 500-metre radius.[11]

Accordingly, people who use substances (PWUS) and policy makers have looked to novel strategies to increase the current reach of harm reduction in North America by leveraging the use of technology.[12-17] Indeed, in an effort to keep communities of PWUS safe, the practice of virtual "spotting" was adopted: PWUS would call other members of the community or other trusted individuals from their social networks to witness their substance use session virtually and to activate an emergency response should the individual become unresponsive.[18]

Programs such as overdose response hotlines and applications (ORHA) aim to provide more timely responses to overdoses, particularly for those who do not currently access harm reduction services. ORHA programs provide remote interventions for overdose response that comprise both smartphone applications and telephone hotlines, and aim to decrease response times. Overdose response hotline services available in Canada include the National Overdose Response Service (NORS) and Brave app. In contrast, overdose response applications operate in select Canadian provinces, including the Digital Overdose Response Service (DORS) app and Lifeguard app, available in Alberta and British Columbia, respectively.[19] In the United States, services similar to NORS exist, including the Never Use Alone and "SafeSpot" services.

Due to the relative novelty of these services, there is currently a dearth of literature on their effectiveness; however, a study on one of the aforementioned services (NORS) provided early evidence of this service as a harm reduction strategy, with no reported fatalities across 3994 substance use sessions and 77 overdoses.[20] Additionally, these interventions broadly have demonstrated a reduction in fatal overdose events and a favourable cost-benefit analysis.[19,21] They have also served to support individuals with concurrent disorders, including methamphetamine psychosis.[22] While these services have been beneficial for PWUS, one study of Canada's National Overdose Response Service has found that uptake of this service is limited within rural communities (< 1%).[20]

To determine how best to improve harm reduction access through ORHA, we set out to explore (1) the values, perceptions and beliefs among PWUS who live in rural, remote or Indigenous communities regarding the potential utility of ORHA in their communities; and (2) ways of improving the acceptability and effectiveness of ORHA to better meet the needs of PWUS in rural, remote or Indigenous communities.

Methods

Ethics approval

This qualitative study employed the COREQ guidelines for methods and results reporting,[23] and ethics approval was obtained from the University of Alberta (Pro00118444). Participation was voluntary and verbal consent was obtained from all participants after a discussion about the implications and risks associated with the study.

Research team characteristics and reflexivity

The core research team consisted of a research assistant (DV) and a student (MM), with two internal medicine residents (FJ and AL), as well as a specialist-trained physician (MG) with master's level training in qualitative analysis. DV and MG had previous experience in conducting and evaluating qualitative studies and guided the trainees in qualitative methodology. Interviews were conducted by DV and MM, who also conducted the analysis thereafter.

Study design and research paradigm

We employed a qualitative descriptive design for this study. We constructed a semi-structured interview guide, informed by previous research conducted around rural harm reduction as well as professional knowledge and the experiences of PWUS. PWUS reviewed the content of the interview guide to ensure appropriateness and respectfulness. We used grounded theory and inductive reasoning to analyze the content of the interviews. Given that ORHA is a new technology with limited penetration, we chose this methodology because it allowed us to examine these novel technologies and evaluate their use and adaptation grounded in data.[24,25]

Recruitment and sampling strategy

We utilized purposive and snowball sampling between March and July 2023 to recruit and interview study participants. Sites of recruitment included rural harm reduction facilities and outreach programs. Additional participants were recruited from a large national harm reduction survey conducted by the research team (forthcoming), through addiction clinics and word of mouth. We approached participants through email or telephone. We focussed on recruiting participants from across Canada and from among individuals who lived in rural communities and small population centres with populations of less than 10 000. Participants were provided a $30 honorarium for their participation in the study. Participants were able to choose to have interviews conducted by a female (MM) or male (DV) interviewer, according to their preference. Eligibility and exclusion criteria are outlined below.

Eligibility criteria

To be included in the study, a participant must

- be a resident of a rural or Indigenous community or remote area across Canada;

- be aged 18 years or older;

- have reported use of unregulated substances (current or past);

- be able to communicate effectively in English and provide informed verbal consent;

- have a telephone number or email address; and

- have access to either a phone or a device with web chat features.

Participants were excluded if they

- were unable to speak English;

- were currently at risk of harming themselves; or

- required someone else to make decisions for them.

Interview process

After obtaining consent, interviews were conducted either via telephone or Zoom. All participants were informed that they could leave the interview anytime, for any reason, and remain eligible for an honorarium. A list of mental health and substance use support numbers was provided to support clients. A short survey was administered before the interview to obtain baseline sociodemographic information. Interviewers took field notes. Audio files were then transcribed by a third-party transcription service with identifying information redacted and stored on a secure and private hard drive at the University of Calgary.

Data analysis

We used NVivo software version 12 (QSR International, Denver, CO, US) for the transcript coding process. All transcripts were coded by two independent members of the research team (DV and MM). The research team conjointly discussed all emerging nodes and themes to ensure alignment with coding and to analyze for saturation. Recruitment continued until saturation was reached, which was determined by a lack of new themes emerging across all participants. Member checking was conducted through comparisons with previous literature and a discussion of results with PWUS. Due to the large

proportion of Indigenous participants within our study, the interview guide, study results and discussion were reviewed by two Indigenous partners (ET and KW) to ensure validity, cultural sensitivity and accurate interpretation of themes.

Results

Fifteen participants (mean age = 38 years, SD = 10.74; n = 7 [46.7%] male) were recruited nationally. Nine (60.0%) identified as Indigenous and the remaining six as White (40.0%). On average, participants estimated that ambulances would take between 25:50 (± 19:53) and 31:40 (± 27:38) minutes to arrive at their homes in an emergency. Additional demographic and response data are outlined in Table 1.

Six themes were identified from our thematic analysis, described below and summarized in Table 2.

Theme 1: ORHA can be a pragmatic intervention in rural areas but there are limitations to its uptake and effectiveness

Within rural areas, participants felt that ORHA provided an additional (or possibly the only) harm reduction service that could potentially save lives. Despite concerns

that the risk of delayed response could be harmful, it was deemed that this risk was much lower than that of using substances alone. Interviewees saw ORHA as a pragmatic solution, similar to other telecommunication or digital interventions employed to provide opportunities and services in rural communities.

> It's like you use and you die, or you use and if you OD someone might come and rescue you. Which one would you rather have? No one's coming, or someone might come? I feel like that would be a better option … (Participant #12, male)

Many participants had previously engaged in informal spotting or used ORHA. There was unanimous support for using peers as service operators, which they felt added legitimacy to the program. Almost all supported having lay responders as an optional feature, as it could potentially be a faster alternative. However, they were still in favour of having emergency medical services (EMS) as a backup plan. Most participants said they would hypothetically be interested in being a lay responder for ORHA in their area. It was suggested that ORHA might need to help facilitate connecting known lay responders to PWUS, as finding a lay responder could

TABLE 1
Sociodemographic data of participants in ORHA study in rural and remote areas, Canada, 2023

Variable	n (%) Total (N = 15)
Age, mean years (SD)	38 (10.7)
Gender	
Man	7 (46.7)
Woman	8 (53.3)
Other	0
Ethnicity	
White	6 (40.0)
Indigenous	9 (60.0)
Province of residence	
Alberta	10 (66.7)
British Columbia	2 (13.3)
Manitoba	2 (13.3)
Ontario	1 (6.7)
Used ORHA previously	3 (20.0)
Has rescued others from overdose	11 (73.3)
Average ambulance arrival time estimates (min), n = 12 (SD)	Minimum: 25:50 (±19:53) Maximum: 31:40 (±27:38)

Abbreviations: min, minutes; ORHA, overdose response hotlines and applications; SD, standard deviation.

TABLE 2
Major themes and key takeaway recommendations for ORHA engaging with rural, remote or Indigenous communities in Canada

1. ORHA can be a pragmatic intervention in rural areas but there are limitations to its uptake and effectiveness.
Participants had realistic expectations about arrival times for EMS services or lay responder assistance.
Participants supported the idea of lay responders as an alternative to or combined with EMS.
ORHA can help reduce the burden on existing informal lay-spotters.
Peers in the community would be a source of potential lay responders.
ORHA may need to help facilitate connections between potential lay responders and clients, who may not be aware of each other.
Community stigma around substance use needs to be reduced to help improve uptake.
ORHA must remind PWUS that they are not entirely safe when using substances just because they are being witnessed by ORHA.
Different personalities may prefer either hotlines or applications.
2. Rural geography may impact the effectiveness of ORHA.
Callers should pre-plan travel routes to account for rural navigation difficulties (home address discrepancies, alternative routes, etc.).
Weather needs to be accounted for when discussing time until help arrives.
3. The rural context can amplify substance use stigma and has broader implications for individuals and their families.
ORHA service providers must be aware of the complex ways substance use stigma affects families and individuals in small communities.
Local agencies and health providers may not always be supportive of ORHA being used in the community.
ORHA must be careful since rescue work could possibly reveal secret PWUS.
4. There are concerns regarding technology ownership and connectivity in rural communities.
Rural PWUS may have less technology ownership or more connectivity issues than people in urban settings.
5. General harm reduction awareness and availability are often limited in rural communities.
Arranging rideshare opportunities may help rural PWUS improve access to harm reduction services.
The illegal drug market is often an access point for obtaining harm reduction equipment in rural areas.
Public harm reduction advertising may meet with pushback in some communities.
Pharmacies are often the primary point for harm reduction information or supplies.
6. There are unique social implications surrounding substance use and harm reduction for rural Indigenous PWUS.
PWUS in Indigenous communities may face additional barriers (e.g. community banishment, stigma).
ORHA should work together with local Indigenous leadership to achieve mutual goals.
Responders should be trained in cultural sensitivity, as negative interactions can lead to service avoidance.

Abbreviations: EMS, emergency medical services; ORHA, overdose response hotlines and applications; PWUS, people who use substances.

potentially be stigmatizing or impossible for PWUS without personal connections.

Participants who were currently receiving or providing spotting (virtually or in person) believed the use of ORHA would help reduce the burden on spotters, as volunteering to do this was viewed as disruptive of spotters' personal lives.

> And usually, for me, I usually call somebody or I'm messaging one of my friends on Messenger and I'm like, "Okay, I used today, and this is how much I used," or "This is how much I'm going to use." And they have their own lives, too, right? And they can't just sit there and watch me on video chat. (Participant #14, Indigenous female)

While engaging lay responders was mostly received positively, some interviewees did express that peers faced risks such as relapse during a response or burning out if they were constantly being the spotter for their community. Additionally, participants noted that they were not completely aware of others using substances in their community, making connecting to local spotters or using in a group less viable an option.

Despite the support for ORHA, participants were less optimistic about the uptake of these services in their communities, often citing that those with the highest risk of overdose were less likely to use ORHA. They cited that key characteristics of these individuals included being too intoxicated to remember to use ORHA, a general lack of care for their own safety,

or mistrust and stigma around harm reduction programs.

> I think it's a great idea and it could help save a lot of people, but I know from the state of mind I was in during the worst time, I wouldn't have cared. If that makes sense. I wouldn't have cared if I was going to die. (Participant #4, female)

Some participants were concerned that ORHA could lead to rural PWUS feeling a false sense of safety and they might begin using in riskier ways than when alone, unsupported by ORHA.

> That could definitely happen. Like, "Oh, I could use as much as I want when I want, I'm going to get saved." (Participant #12, male)

I feel like maybe if there's a safeguard there, I would have pushed it farther. I feel like I might have. (Participant #7, female)

Regarding which form of ORHA individuals would prefer to use, participants differed on whether they preferred hotlines or applications. In terms of hotlines, one participant mentioned:

I think that's actually fairly good because a lot of the time when they do use, they kind of go under, they start nodding, they're not really aware of what's going on in their surroundings. They're more, I guess, nodding off, that's how it is: falling asleep, going under. So I think that that would be a good idea because the loud noise might jolt them up out of it or if it's been so long then the EMS is already on its way, you know what I mean? (Participant #12, male)

Another participant preferred the applications, as they did not want to interact with others:

I think I would want to use the app, like, the one that beeped because it was like I would be by myself, even though it's like the operator on the other line is somebody who is also a drug user or recovering addict.… When I was in my, like, deepest active addiction, the last thing I would want, well, felt like talking to, [making] small talk with strangers. You know what I mean? (Participant #7, female)

Theme 2: Rural geography may impact the effectiveness of ORHA

The geographic isolation of rural communities was seen as a significant, but not insurmountable, barrier to the utilization of ORHA. Specifically, participants raised concerns about EMS arrival times to an overdose/drug poisoning event. Many rural participants had personal or secondhand experiences of longer EMS arrival times.

Literally by the time 45 minutes is up you're literally not going to make it, so that would be hard in the reserves. It would be really hard for an ambulance trying to find somebody living

in the reserve. (Participant #3, Indigenous male)

Besides physical distance and length of time to reach a destination, many participants stated that directing emergency help to their location would be difficult due to complexities such as EMS operators being unfamiliar with the terrain or rural road networks making it easy to get lost or miss the location. There were concerns about incorrect legal addresses (legal home addresses not matching the physical address on some houses). Some participants did not know how to easily give their locations, relying on landmark-based navigation instead of their official street address. It was suggested that ORHA consider discussing the entire travel route with rural PWUS, not just the end location, to minimize the aforementioned complications.

So, yeah, I just wanted to get them there. They're like didn't want them to get lost and like we're here, hurry up, we're here, just because some of the houses do not have numbers on them. I don't know why. (Participant #9, Indigenous female)

Adverse weather events were also listed as being a barrier to effective EMS arrival times. Even though these events were uncommon, the effects of adverse weather are often magnified in a rural setting. Adverse weather could potentially stop communication networks or worsen driving conditions, both of which would impact the effectiveness of ORHA.

Trees do come down, roads get blocked, so that could pose a problem. (Participant #11, Indigenous male)

Theme 3: The rural context can amplify substance use stigma and has broader implications for individuals and their families

Participants identified that rural communities were unique in that "everyone knows what everyone is doing," and this interplay between personal reputation in small communities and substance use stigma was often (but not always) listed as a major concern. The consequence of being a known substance user was described as an immediate decrease in social standing and reputation. This was experienced by various participants or

was witnessed through the treatment of other people who use substances in their community.

It might help a little bit just to know that they're not going to get in trouble because that's probably, the biggest thing for an addict—is people finding out. (Participant #3, Indigenous male)

Substance use was identified not only as affecting the reputation of the person who uses substances but also as a concern for one's entire family. Family members often distance themselves from people who use substances, or attempt to conceal the person's use. The fear of impacting an entire family's reputation was especially important, as most participants described themselves as being particularly close to their families.

They [families] don't want to … they might not even tell their other family members that they have a son that's messed up. They might not tell their brothers and sisters or even their mother or grandparents or whatever. They kind of keep it a secret because they feel ashamed, I guess.… (Participant #3, Indigenous male)

A lot of people are not able to be open and honest with their family. And then when they do, when family does find out about people using, I notice they get put into a stereotype or they get shunned, especially with meth, I noticed a lot of families push away their loved ones that are using. (Participant #14, Indigenous female)

Almost all participants (with the exception of two) expressed that their primary reason for staying in their community was their family. Even when they did temporarily leave, they continued to gravitate towards their home community because of family.

While generalized substance use stigma within rural communities remains a concern, participants did not feel as though rural community members would actively protest against ORHA.

The townspeople could get a little pissy, I guess, I don't know. They are, well, I guess it's virtual. It's like on your phone itself, it's not like a safe

injection site but like … I don't know. I don't think there would be any negative to it really. (Participant #12, male)

While ORHA were thought to be life-saving, occasionally they were described as stigmatizing, but no more so than any other harm reduction services. Stigma-based obstacles preventing ORHA included health care or social service providers who are not sympathetic to PWUS and could therefore deter patients from accessing services where they could be introduced to ORHA. Additionally, participants expressed the fear of being revealed as a PWUS by the arrival of EMS or rescuers to their home.

> Because if you see an ambulance going down the street, everybody stops and stares. Whose house are they going to? What happened there? And why is this person doing that? So nosey, it's unbelievable. (Participant #4, female)

Theme 4: There are concerns regarding technology ownership and connectivity in rural communities

Participant perspectives were mixed regarding access to technology, cellular reception or data and phone minutes needed to access ORHA in rural communities. Participants were split on whether rural PWUS were more or less likely to have technology compared to those in urban settings. Specifically, there existed a fear that technology was too easy to sell in exchange for substances, leading to situations in which the technology needed for improving safety would be absent when people were at their most vulnerable.

> I think if somebody can afford a phone, they can have a phone and keep a phone without selling it for drugs, I think it would be a really good thing. That's another thing, too. Do they have minutes? Can they call anybody? (Participant #9, Indigenous female)

In addition, a few participants raised concerns about data privacy and data protection while using the various ORHA.

Theme 5: General harm reduction awareness and availability are often limited in rural communities

Awareness of and access to harm reduction resources in rural communities was

highlighted as being particularly challenging. One of the most frequently recurring barriers was the difficulty of obtaining transportation to certain harm reduction supports, particularly due to the absence of any public transit or professional driving services. This lack led to the necessity of relying upon community members or family rideshares, which rarely were offered freely or in a timely manner. Some participants were already offering free rides for those beginning their addiction recovery, as they had personally experienced or observed the difficulty of making it to harm reduction service locations or attending recovery-oriented appointments.

> Like, it was so impossible. Like, I tried going to the hospital. I tried going to mental health services. And, like, all they said was, you got to go to Grand Prairie to this place. So I knew this magical place in Grand Prairie existed, I just didn't have any way to get there. (Participant #7, female)

Participants usually felt that they had fewer harm reduction service options than in urban areas. The most commonly listed harm reduction services were pharmacies providing sterile equipment or replacement medication treatment, followed by small community health centres containing minimal addiction resources. Some of the communities were said to have no resources at all or participants were unfamiliar with any resources in their area. Participants also highlighted that their personal harm reduction supplies often came from out of town via other mobile supply services, or they were provided conjointly with drug acquisition. Drug dealers would often provide harm-reduction supplies while selling substances. Other participants stated they would often stock up on harm-reduction supplies while visiting a larger community. ORHA as a harm reduction tool was seen as being a reasonable adjunctive option to ensure safety.

Though neither stigma nor ideology in smaller communities was seen as a barrier to implementing or using ORHA, stigma was still seen as a barrier in increasing general awareness of the service:

> Well, I wish I had more info I could hang up in the community, but I don't know how the people would take it. It's—some people would

accept it, and then there's other people are, like, "What? Why are you bringing that kind of negativity?" … Like, it's not negativity—I think it's just trying to help people from OD'ing, but … our community is always divided. (Participant #5, Indigenous male)

> I know that being in a small community there is this huge stigma around that, say you needed Narcan and clean needles, to go into the hospital and ask for that there. I've heard that it's a very tough situation because a lot of the nurses over there will look at the person and just be like, "Well, you know, there's that person." (Participant #4, female)

Additionally, participants felt that town or community approval might be required to disseminate advertisements on controversial topics such as harm reduction, which could further limit awareness of these services. It was felt that advertising harm reduction in some communities was essentially admitting that there was a problem in their community, which makes the community "look bad." Despite this, several suggestions were made regarding increasing general awareness of the service:

> I think I'm going to make a flyer and hang it in my community centre … right at the door. They got a big bulletin board. They hang everything. I put one there—I put one all over so they could see it, because if I could save a life, that'd be great just from … them copying that [NORS hotline] number. (Participant #5, Indigenous male)

Social media was another outlet seen as being reasonable for helping to create awareness of the service, especially as the participants believed that it would require less authorization and approval from local authorities. Many participants noted that the smaller communities did not have their own dedicated web pages and instead used the pages of nearby, larger communities to share information.

> The town of [redacted] has a [Facebook] page where they post things going on around, right? Stuff like that. (Participant #7, female)

Theme 6: There are unique social implications surrounding substance use and harm reduction for rural Indigenous PWUS

Over half of our participants identified as Indigenous or being from Indigenous communities. Most of the Indigenous participants shared experiences similar to those of non-Indigenous participants, such as transportation barriers and lack of harm reduction resources in town or nearby. Indigenous participants highlighted experiences of community stigma and the effectiveness of lay responses, impacted in part by their Indigenous culture, kinship and community bylaws.

All participants shared that substance use was often seen as a failure, and was frequently hidden due to shame, fear or other internalized negative feelings. Indigenous participants expressed pressure to conceal substance use to avoid feeling shame in their community, the consequences of which could impact obtaining community leadership positions such as chief and council positions. Participants referred to bylaws entrenched and enforced in some Indigenous communities that evict community members who are deemed to be contributing to the substance use problem, which can lead to cycles of substance use and increased movement between multiple communities.

> A lot of them get kicked out, and then they live on the streets in [small town], and then claim to get clean, and then they come back into the house, start stealing again, get kicked out. (Participant #5, Indigenous male)

The fear of one's home being labelled as a house where substance abuse occurs is a barrier to establishing a network of in-community lay responders; their vehicle in the driveway may be noticed by family or community members. The professional and societal consequences of the stigma may outweigh the benefits of ORHA. Additionally, establishing a lay response network without the inclusion of Indigenous community leadership could have negative implications, especially if they are supporting previously evicted community members.

> I would think, you know, that should be an actual thing where people with actual experience and knowledge in saving people in this aspect has really

benefits. Like, so many people now that have OD'd since my [female relative 2] and I have been evicted and banished from our home reserve. There's been so many deaths there. (Participant #9, Indigenous female)

Although it did not reach thematic saturation, participants expressed concern about racism compounding stigma, which could lead to decreased adoption of ORHA:

> I've heard it all. I've been in ambulances where they think I'm unconscious and they're talking about the "Indians" of [small town] and how it's so annoying to drive way out there to help somebody. Yeah. I know it has to do with the colour of my skin. (Participant #5, Indigenous male)

Discussion

Our evaluation demonstrates a complex interplay between the need for harm reduction resources such as ORHA in rural communities, and the difficulties in implementing them and increasing awareness and use of the program due to geographic practicalities, stigma, technology infrastructure and cultural complexities. Several key messages emerged, with implications for program implementation and public health policy.

All participants acknowledged the general barriers to obtaining harm reduction support in rural communities, highlighting transportation issues and lack of service provision as two prominent concerns. Previous literature has highlighted these same barriers and demonstrated an increased risk of paraphernalia sharing, paraphernalia reuse and use of substances while alone.[26] While ORHA may not yet mitigate concerns about risky paraphernalia use, they might help reduce risks associated with using substances alone.

Nonetheless, concerns about EMS arrival times, stigma from EMS services, and rescue services getting lost while being dispatched have been seen in the literature. One retrospective study conducted across the United States showed that emergency medical service response times in rural areas are nearly double those seen in larger urban settings.[27] Awareness of the limitations of EMS response in rural communities should be appropriately communicated to PWUS using ORHA, and efforts to reduce delays in overdose response in

these communities should be made. Though establishing community-based lay responders has been shown to be a viable strategy,[28] it is also seen as challenging to implement in rural and remote communities due to fears of burnout, lack of community-based responders or relapse among peer responders.

Participants expressed some concerns around data collection and surveillance from ORHA. Within the context of rural communities, people are often more mistrusting of the government, and therefore may not want to use government-sponsored services.[29] In Canada, various ORHA have different operation and funding models, with some providing direct operational support and funding, some providing only government funding and some being privately funded and operated.[19,30]

The importance of family was a unique theme not seen before in previous literature around rural harm reduction. Family not only motivated PWUS to stay in their communities but also impacted their willingness to seek support for their substance use, whether harm reduction or treatment, due to the risk of stigma and harm to their family's reputation. All participants shared the theme of bringing shame to one's family or community; however, the consequences and impact differed between Indigenous and non-Indigenous communities. Recognizing that each community faces unique challenges to developing and managing substance use can lead to increased program success, suggesting the need for further education around substance use with a stronger focus on destigmatization appropriate for the community of residence.

Previous work has highlighted the loss of social capital and the stigma associated with rural substance use in pregnant women, ethnic minorities and rural environments in general.[31-35] Because many of the participants reported a family member as their primary designated lay responder (e.g. "My dad is just upstairs and checks in on me"), we believe that the family of PWUS will likely be a primary source of sympathetic and competent community lay responders, which could help return social capital to those disenfranchised by other stigmatizing forces.

Access to harm reduction services in rural areas is limited in Canada and the US.[36,37]

The current distribution patterns of harm reduction supplies in rural communities (through official channels such as pharmacies and unofficial channels such as dealers and peer community sharing) were discussed and could be a vehicle for disseminating information on ORHA. Posters and social media were also considered reasonable strategies to disseminate information regarding these strategies; however, this messaging may not be permitted within communities with particularly stigmatizing attitudes towards substance use. Because almost all of the participants either had a naloxone kit, planned to obtain one or helped distribute them to others in their community, the use of stickers or other promotional materials within naloxone kits could potentially promote or remind PWUS to use ORHA.[38]

Both interpersonal and structural racism and discrimination were additional layers of stigma highlighted by Indigenous participants, which is aligned with other research.[39] Interpersonal racist attitudes towards racialized people, including Indigenous PWUS, are well documented in the literature,[40] and the development of substance use disorders is linked to racism.[41,42] Furthermore, Indigenous interviewees indicated that racism was a barrier to the use of ORHA, a finding consistent with previous work that has shown that racism is a barrier to calling 911 in overdose situations.[43] Antiracist approaches are needed at all levels, including among first responders, to address these barriers.[44,45]

While many other instances of structural or institutional discrimination were discussed by participants (such as lack of community economic development or infrastructure improvements to road systems) and have been noted in the Canadian literature,[46] they are beyond the scope of this paper. Our study highlighted how in Indigenous communities there are sometimes discrepancies between the legal and physical home address, which can cost precious minutes during an emergency response. Seen through an advocacy lens, it would be prudent to improve addressing in these areas to reach national parity.

Our study highlighted participant concerns regarding the ability of emergency medical services to locate clients within a reasonable time frame. While one of the most immediate concerns discussed by participants was giving EMS more specific information about how to reach a client, another option would be for EMS to use ambulance GPS technology in concert with smartphone technology. GPS units have been shown to significantly reduce EMS response times for motor vehicle collisions, which usually occur on a roadway, by one minute.[47] Some ORHA are directly connected to provincial EMS and enable sharing of GPS coordinates; future studies should examine whether these services may enable more rapid responses to individuals who have suffered an overdose event.

Another participant suggested that building a network of spotters and responders could enable greater connections and more peer-based support within smaller communities, possibly improving the community's overall wellness. While lay responders would likely benefit a community, it is imperative to consider the legal implications of reliance on lay responders under the *Good Samaritan Drug Overdose Act*[48] in order to protect both harm reduction services and the lay responders. In Indigenous communities, ORHA will likely need to consider community bylaws when connecting lay responders to avoid legal or cultural conflict arising from both assisting or being assisted by a person who is currently banished from the community.[49-51]

Another important aspect of ORHA highlighted by participants is the potential risk for PWUS to increase substance use while using these harm reduction services, due to perceptions of decreased risk associated with their use. Previous studies have shown that PWUS tend to underestimate the risk of overdose.[52,53] In contrast, studies of in-person supervised consumption sites note that there were no increases in harmful substance use in conjunction with using these harm reduction facilities.[54] This makes it difficult to conclude the effectiveness of ORHA for rural populations. Future studies should examine any potential changes in substance use patterns, both pre- and post-service use, in addition to any potential increased risk of overdose mortality in rural settings due to delayed response times.

Access to technology was presented as a barrier to the operation of ORHA in rural settings. Previous research on PWUS in downtown Vancouver noted that only 45% of individuals accessing supervised consumption services have access to mobile phones.[55] While this number may not represent PWUS in rural settings, it is important to note that the digital divide likely persists within these communities. Reducing the digital divide for these communities may not only help to reduce barriers to harm reduction through ORHA but also through other internet-based services, such as mail-order harm reduction programs,[56,57] social supports and treatment programs such as Alberta's virtual opioid dependency program.[56]

Strengths and limitations

Our study has several main strengths, including furthering knowledge of substance use and attitudes towards harm reduction in rural, remote and Indigenous communities in Canada. The results, however, should be interpreted in the context of a few limitations. While we focussed on a variety of rural PWUS, it should be noted that there was great heterogeneity among the types of rural communities within the study sample, and thus our results may not be generalizable to every community.[58] All respondents in our study had access to cell phones and technology, so their responses would represent a subpopulation of rural PWUS. Our recruitment methods tended to favour individuals already accessing harm reduction resources or treatment services, and we did not engage with individuals who did not have access to any supports. Many of the respondents were from British Columbia and Alberta, and their perspectives may not be generalizable to the rest of Canada.

Conclusion

The interviewed members of rural, remote and Indigenous communities suggested that ORHA could be a lifesaving and socially appropriate harm reduction resource, particularly as substance use stigma was perceived to be more intense in these communities. Most participants viewed ORHA as being safer than using substances alone and were hopeful that a combination of both EMS and in-community layperson rescues could save lives. ORHA should adopt the following features in rural settings: training in understanding rural addressing and rural (often informal) navigational strategies; factoring in adverse weather when describing potential wait times; and working to establish lay-responder allies in communities (with

proper mental health support and legal protection) to help mitigate the longer EMS arrival times while at the same time striving to provide anonymous and discreet services that protect the privacy of PWUS. Lastly, technology ownership and cellular connectivity were highlighted as continued barriers to access for PWUS within these communities.

Acknowledgements

Conflicts of interest

MG co-founded the National Overdose Response Service (NORS), and belongs to the Canadian Society of Addiction Medicine and has no personal financial conflicts of interest to disclose. The results of this work may be used to apply for funding for NORS or to make operational changes to NORS. The rest of the authors are unaffiliated with NORS in particular or any other ORHA, and have no competing interests to declare.

Authors' contributions and statement

DV, MG: conceptualization.

DV, MM, AL, FJ: data curation.

DV, WR, MM, AL, FJ: formal analysis.

MG: funding acquisition.

DV, MM, AL, FJ: investigation.

DV, MM, AL, FJ, SZ, MG: methodology.

MG: supervision.

DV, WR, MG: writing—original draft.

DV, WR, MM, KW, ET, AL, FJ, SZ, MG: writing—review and editing.

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At-a-glance

Temporal trends and characteristics of fall-related deaths, hospitalizations and emergency department visits among older adults in Canada

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This article has been peer reviewed.

Abstract

Falls among older adults (aged 65 years and older) are a public health concern in Canada. Fall-related injuries can cause a reduction in quality of life among older adults, and death. They also entail substantial health care costs. It is essential to monitor fall-related injuries and deaths among older adults to better understand temporal trends and characteristics and to evaluate fall prevention strategies. We used the most up-to-date data from the Canadian Vital Statistics–Death database, Discharge Abstract Database and National Ambulatory Care Reporting System to analyze the temporal trends of fall-related mortality, hospitalizations and emergency department (ED) visits among older adults in Canada over more than a decade. Age and sex characteristics were also examined. In 2022, 7189 older adults died due to a fall in Canada (excluding Yukon). From 2010 to 2022, deaths due to falls generally increased in both number and rates. In fiscal year 2023/24, there were 81 599 fall-related hospitalizations in Canada (excluding Quebec) and 212 570 fall-related ED visits in Ontario and Alberta. From fiscal year 2010/11 to 2023/24, even though the overall trend of the rates of fall-related hospitalizations and ED visits did not increase, the numbers generally rose year by year except in 2020/21, the early stage of the COVID-19 pandemic. As for the age and sex characteristics, the rates for deaths, hospitalizations and ED visits rose with advancing age for both men and women. With the aging population, continuous monitoring of the trends is crucial for fall prevention.

Keywords: *accidental falls, aged, death, mortality, hospitalization, emergency room visits, men, women*

Highlights

- In 2022, the number of deaths due to falls among older adults was 7189, representing a crude rate of 98.2 per 100 000 older adults in Canada (excluding Yukon). The age-standardized rate increased annually at 1.7% from 2010 to 2013, followed by an annual decrease of 2.8% from 2013 to 2016, and increased again annually at 6.8% from 2017 to 2019 and 4.1% from 2019 to 2022.

- In fiscal year 2023/24, the number of fall-related hospitalizations among older adults was 81 599, representing a crude rate of 14.1 per 1000 older adults in Canada (Quebec excluded). The age-standardized rate increased annually at 1.4% from 2010/11 to 2013/14 and decreased annually at 0.4% from 2013/14 to 2019/20. The 2020/21 rate showed a decrease (7.0%) compared to the pre-COVID-19 year 2019/20. After 2020/21, the age-standardized rate increased, 4.0% higher in 2021/22 compared to 2020/21, and 2.1% higher in 2023/24 compared to 2022/23.

Continued on the following page

Introduction

Falls among older adults (aged 65 years and older) are a public health concern worldwide. According to the WHO, about a third of older adults fall each year.[1] In Canada, 5581 older adults died due to falls in 2019, representing a crude mortality rate of 84.6 per 100 000 older adults. The age-standardized mortality rate increased by 111% from 2001 to 2019. Between fiscal years 2008/09 and 2019/20, the annual number of fall-related hospitalizations (FRHs) among older adults increased by

47% from 49 152 to 72 392 (Quebec data not available). However, the age-standardized FRH rate was relatively stable during this time period, at approximately 15 per 1000 older adults. FRHs represented 87% of all injury-related hospitalizations among older adults in Canada (excluding Quebec).[2]

Falls and their resulting injuries cause loss of life, reduce quality of life and entail substantial health care costs. In 2018, the annual direct cost of injurious falls among older Canadian adults was estimated at CAD 5.6 billion, which was more than

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- In fiscal year 2023/24, the number of fall-related ED visits among older adults was 212 570, representing a crude rate of 58.9 per 1000 older adults in Ontario and Alberta combined. The age-standardized rate increased annually at 1.6% from 2010/11 to 2017/18. The 2020/21 rate showed a sharp decrease (16.8%) compared to the pre-COVID-19 year 2019/20. After 2020/21, the age-standardized rate greatly increased in 2021/22, 13.7% higher compared to 2020/21. The 2022/23 rate was 1.0% higher than that of 2021/22 and the 2023/24 rate was 2.1% higher than that of 2022/23.

twice the cost associated with falls among those aged 25 to 64 years.[3]

Older adults are projected to represent over a fifth of the Canadian population by 2068.[4] Therefore, it is essential to monitor trends in falls among this population and the associated burden on those injured, their families and the health care system, which is important for effective management and prevention. The objective of this study was to use the most recent data available to provide the temporal trends and characteristics of fall-related mortality, hospitalizations and emergency department (ED) visits among older adults in Canada.

Methods

Our data sources were the Canadian Vital Statistics–Death database[5] for deaths due to falls, the Discharge Abstract Database (DAD)[6] for FRHs and the National Ambulatory Care Reporting System (NACRS)[7] for fall-related ED visits.

We used ICD-10/ICD-10-CA[8,9] codes W00–W19 (unintentional fall) to identify fall cases. For deaths due to falls, we used the underlying cause, that is, the disease or external cause of injury that initiated the sequence of events leading directly to death, or the circumstances of the incident that produced the fatal injury. A fall-related hospitalization is defined as a hospitalization in acute care containing W00–W19 in the diagnosis fields (maximum of 25) in the DAD record.[2,10] The analysis was based on episodes of care. If a patient was transferred for care to

another health facility, all discharges were counted as a single case (or episode).[2,11,12] We merged DAD records with an exact match on (1) encrypted health card number; (2) health card issuing province; and (3) year of birth.[2,11,12] Fall-related ED visits were identified by any one of the diagnoses (maximum of 10) containing W00–W19 in the NACRS ED records.[2] A similar analysis based on episodes of care and linking methodology was also conducted for ED visits.

We used SAS Enterprise Guide version 7.1[13] to compile the pooled and stratified (by sex and age) counts. Population estimates from Statistics Canada[14] were used for rate calculation. We used the 2011 Canadian population for direct age standardization. To quantify temporal trends, we used Joinpoint software version 5.0.2[15] to compile annual percent changes (APCs) of age-standardized rates. Considering the interruption in hospitalizations and ED visits caused by the COVID-19 pandemic, as of fiscal year 2020/21, APC was calculated by the difference in hospitalization or ED visit rates between two continuous years divided by the first year. We checked the autocorrelation in the data and used the corresponding setting in Joinpoint to run the program. A *p* value threshold of 0.05 was used to determine statistical significance.

Results

Temporal trends in deaths, hospitalizations and ED visits

Figure 1 shows the temporal trends in deaths due to falls, and fall-related hospitalizations and ED visits over more than a decade. Annual numbers and crude and standardized rates are presented.

In Canada (all provinces and territories), the annual number of deaths due to falls rose between 2010 (3652) and 2014 (4383) with decreases in 2015 (4274) and 2016 (4252). From 2017 to 2022, in Canada (excluding Yukon), the annual number of deaths due to falls rose more steeply, reaching 7189 in 2022 (crude rate: 98.2/100 000 older adults). The age-standardized rate increased annually at 1.7% from 2010 to 2013, decreased annually at 2.8% from 2013 to 2016, and increased again annually at 6.8% from 2017 to 2019 and 4.1% from 2019 to 2022.

For FRHs (excluding Quebec), the annual numbers steadily rose from fiscal year 2010/11 (53 347) to 2023/24 (81 599) except in 2020/21 (68 759), the year of the early stage of the COVID-19 pandemic. The number of hospitalizations in 2023/24 was 53.0% higher than in 2010/11. The trend in crude rates for hospitalizations showed different results and was highest in 2013/14 (15.1/1000 older adults); the rate was 14.1 per 1000 older adults in 2023/24. The age-standardized rate increased annually at 1.4% from 2010/11 to 2013/14 and decreased annually at 0.4% from 2013/14 to 2019/20. The 2020/21 rate showed a decrease (7.0%) compared to the pre-COVID-19 year 2019/20. After 2020/21, the age-standardized rate increased: 4.0% higher in 2021/22 compared to 2020/21, 1.0% higher in 2022/23 compared to 2021/22 (not significant) and 2.1% higher in 2023/24 compared to 2022/23.
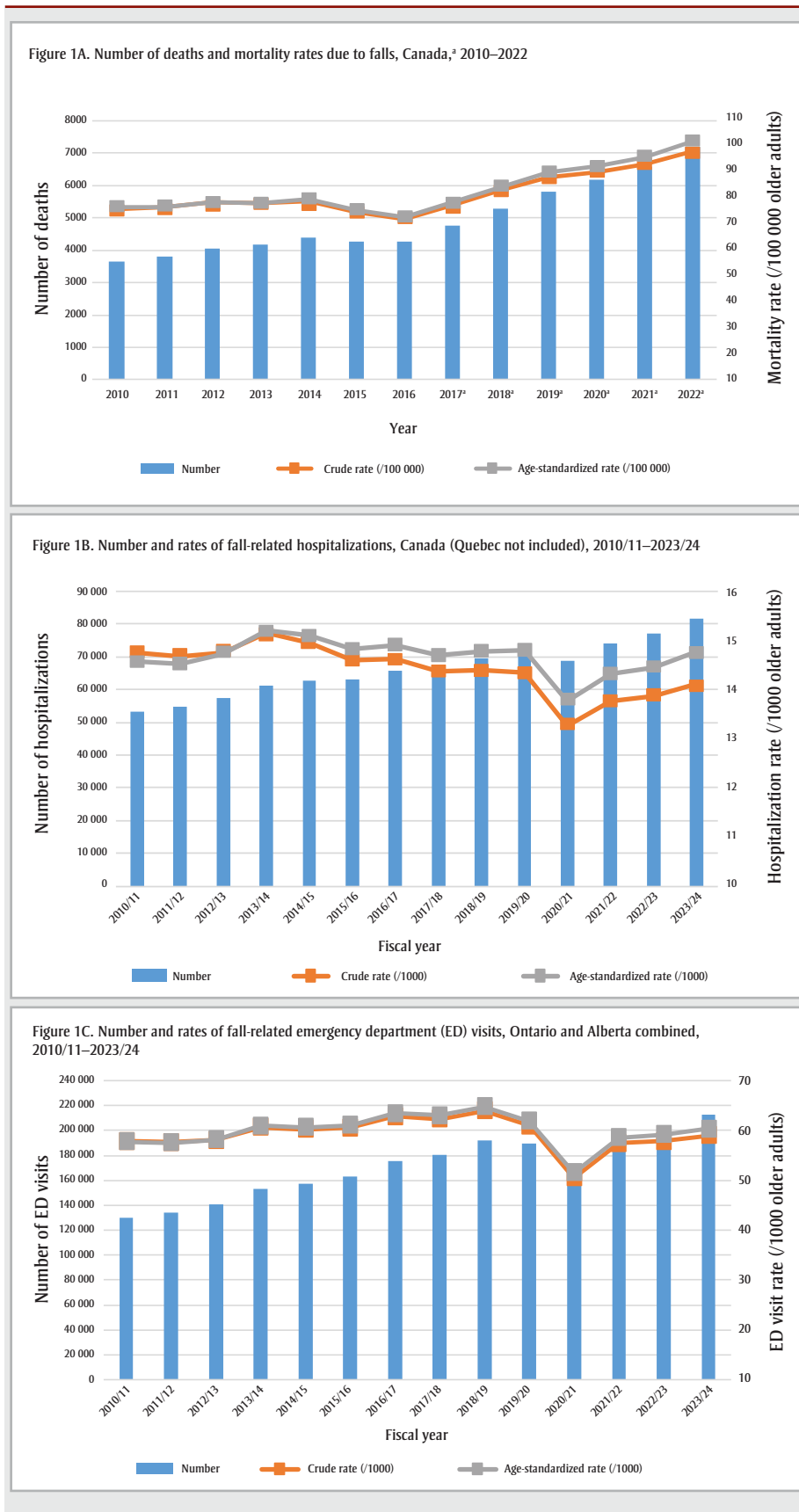
In Ontario and Alberta, two provinces where full data coverage is available, the annual number of fall-related ED visits continuously rose from fiscal year 2010/11 (129 825) to 2018/19 (191 689) with a slight decrease in 2019/20 (189 669). The number greatly decreased in 2020/21 (163 026) but rose again, above all the previous years, with 212 570 visits in 2023/24. The crude rate was 58.9 per 1000 older adults in 2023/24 and highest in 2018/19 (64.0/1000 older adults). The age-standardized rate increased annually at 1.6% from 2010/11 to 2017/18. The 2020/21 rate showed a sharp decrease (16.8%) compared to the pre-COVID-19 2019/20. After 2020/21, the age-standardized rate greatly increased in 2021/22, 13.7% higher compared to 2020/21. The 2022/23 rate was 1.0% higher than that of 2021/22 and the 2023/24 rate was 2.1% higher than that of 2022/23.

Age and sex characteristics

Figure 2 shows the age-specific number and rates by sex for 2022 for deaths and fiscal year 2023/24 for fall-related hospitalizations and ED visits.

In 2022, 7189 older adults (3063 men and 4126 women) died due to a fall in Canada (excluding Yukon). The age-specific mortality rates rose with advancing age for both men and women. Men had higher rates than women across all age groups even though more women than men died from falls.

Figure 1A. Number of deaths and mortality rates due to falls, Canada,ᵃ 2010–2022

Figure 1B. Number and rates of fall-related hospitalizations, Canada (Quebec not included), 2010/11–2023/24

Figure 1C. Number and rates of fall-related emergency department (ED) visits, Ontario and Alberta combined, 2010/11–2023/24
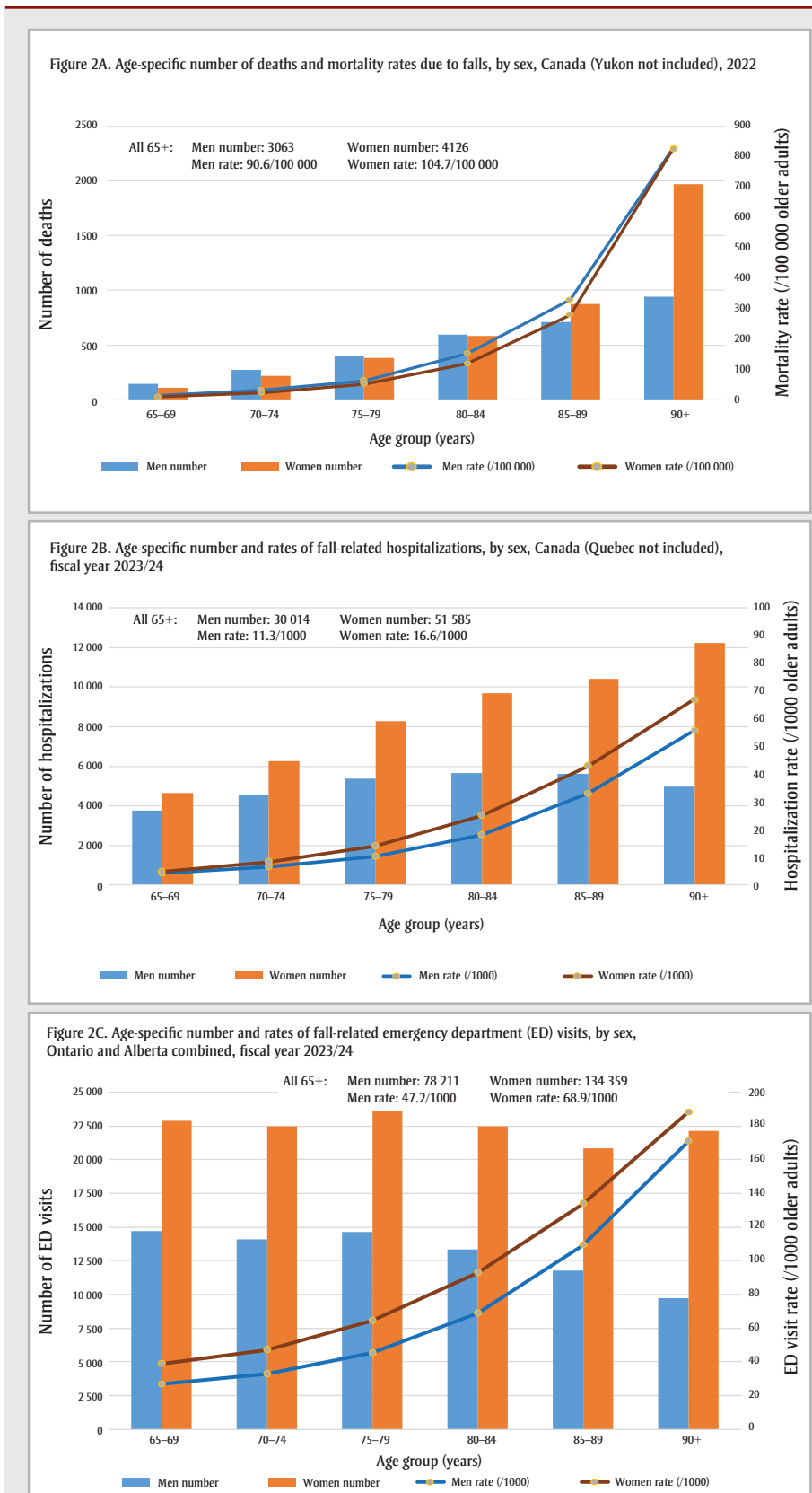
In fiscal year 2023/24, there were 81 599 FRHs (excluding Quebec) among older adults, almost two-thirds of which (51 585) occurred among women. The age-specific rates were higher at successively older ages, and numbers and rates for FRHs in women consistently exceeded those of men.

In fiscal year 2023/24, there were 212 570 fall-related ED visits in Ontario and Alberta among older adults, almost two-thirds of which (134 359) occurred among women. Similar to FRHs, the age-specific rates were higher at successively older ages, and the numbers and rates for women consistently exceeded those of men.

Discussion

We used the most up-to-date data to analyze the temporal trends and characteristics of deaths due to falls, and fall-related hospitalizations and ED visits for older adults in Canada, spanning over a decade. From 2010 to 2022, deaths due to falls for those aged 65 years and over generally increased in both numbers and rates. From fiscal year 2010/11 to 2023/24, even though the overall trend of the rates of fall-related hospitalizations and ED visits did not increase, the numbers generally rose year by year, except in 2020/21, the early stage of the COVID-19 pandemic. As for age and sex characteristics, the rates for deaths, hospitalizations and ED visits rose with advancing age for both men and women.

FIGURE 2
Age-specific number and rates of fall-related deaths, hospitalizations and emergency department visits, by sex, among older adults in Canada

Figure 2A. Age-specific number of deaths and mortality rates due to falls, by sex, Canada (Yukon not included), 2022

All 65+: Men number: 3063   Women number: 4126
          Men rate: 90.6/100 000   Women rate: 104.7/100 000

Figure 2B. Age-specific number and rates of fall-related hospitalizations, by sex, Canada (Quebec not included), fiscal year 2023/24

All 65+: Men number: 30 014   Women number: 51 585
          Men rate: 11.3/1000   Women rate: 16.6/1000

Figure 2C. Age-specific number and rates of fall-related emergency department (ED) visits, by sex, Ontario and Alberta combined, fiscal year 2023/24

All 65+: Men number: 78 211   Women number: 134 359
          Men rate: 47.2/1000   Women rate: 68.9/1000

Data source: Canadian Vital Statistics–Death database, Discharge Abstract Database, and National Ambulatory Care Reporting System.[5-7]

We observed a difference between the trends for mortality and morbidity. The overall trend of the rates of fall-related hospitalizations and ED visits has been relatively steady (except in 2020/21), with the numbers increasing. This indicates that the overall risk of going to the ED or being hospitalized because of a fall remains relatively stable, and that the rise in numbers is probably mostly due to the aging population. However, the mortality due to falls has increased in both rates and numbers. Further research is needed to explain this, such as the trend in the nature of injuries resulting from falls, and comorbidities.

The results of this paper demonstrate that falls among older adults remain an important public health concern in Canada despite prevention efforts. Risks associated with falls stem from a number of biological, behavioural, socioeconomic and environmental factors.[16] Older adults have a particularly high risk of falling compared to the younger population. This risk can be attributed to a number of factors, which can include decreased mobility and balance, muscle weakness, visual impairment and medication side effects.[16]

Fall prevention efforts generally entail a multifaceted approach. At the individual level, for instance, participating in balance and strength exercises and managing medications and their side effects are strategies that may reduce the risk of falls among older adults. At the community level, providing educational opportunities to older adults on fall prevention strategies (i.e. exercise programs, fall prevention skills and social connection), installing handrails and grab bars, and removing hazards such as snow and ice from public walkways are examples of broader-scale approaches.[17,18] Continued research to address knowledge gaps and assess promising practices will strengthen the evidence base, lessen the consequences of falls for older adults and promote healthy aging.

Strengths and limitations

The strengths of this study include the timeliness of data, the analysis of both mortality and morbidity related to falls among older adults and the quantification of the temporal trends over a decade.

Our results are subject to the limitations existing in the data sources we used. The

Canadian Vital Statistics–Death database does not include information from Yukon as of 2017; the mortality counts in years 2019 to 2022 are to be considered preliminary. With respect to hospitalizations, Quebec data were not included. Additionally, data for ED visits came from Ontario and Alberta only. All of these limitations pose a difficulty in presenting a complete national picture in Canada.

Conclusion

The health care burden of falls (deaths due to falls, fall-related hospitalizations and ED visits) among older adults in Canada increased from 2010 to 2022. The information presented in this paper is essential for understanding the temporal trends in falls and patient characteristics and evaluating fall prevention strategies among older adults in Canada. As Canada's population ages, continuous monitoring will be crucial.

Conflicts of interest

All authors declare no conflicts of interest.

Authors' contributions and statement

XY: conceptualization, formal analysis, methodology, writing—original draft.

AC: writing—review and editing.

SM: writing—review and editing.

WT: writing—review and editing, supervision.

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