Health Promotion and Chronic Disease Prevention in Canada

Research, Policy and Practice

Volume 46 · Number 1 · January 2026

Inside this issue

Indexed in Index Medicus/MEDLINE, DOAJ, SciSearch® and Journal Citation Reports/Science Edition

Public Health Agency of Canada | Agence de la santé publique du Canada

Canada

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Published by authority of the Minister of Health.

ISSN 2368-738X
Pub. 250257
HPCDP.journal-revue.PSPMC@phac-aspc.gc.ca

Également disponible en français sous le titre : *Promotion de la santé et prévention des maladies chroniques au Canada : Recherche, politiques et pratiques*

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https://doi.org/10.24095/hpcdp.46.1.01

Original qualitative research

Closing the knowledge gap: identifying research priorities for firearm-related injury and mortality in Canada

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This article has been peer reviewed.

Abstract

Introduction: Firearm-related injury and death are leading yet preventable causes of premature death in Canada. Our objective was to identify knowledge gaps and research priorities to inform a national research agenda to prevent firearm-related injury and death.

Methods: In a two-stage process, nominal group technique was used to encourage experts in firearm injury and death (N = 15) to generate ideas relevant to knowledge gaps in three areas: unintentional firearm injury, intimate partner violence (IPV)/femicide and other firearm-related assaults. Relevant parties (N = 43) subsequently voted on the identified gaps to determine top priorities for future research.

Results: In Stage 1, the experts identified 22 knowledge gaps in unintentional firearm injury, 16 in IPV-related firearm injury/femicide and 33 in other assault-related firearm injuries. Based on their importance and feasibility as research projects, they then selected five, three and seven, respectively, of these knowledge gaps. In Stage 2, the top priorities for future research emerged: the economic cost of firearm injuries to victims' families and communities and Canadian society; the impact of social policies and legislation aimed at reducing IPV/femicide-related firearm injuries and deaths; and a description of the available and required Canadian firearm-injury data.

Conclusions: The top priorities highlight the large and diverse gaps in knowledge about firearm injury and death in Canada. This marks the first step toward developing a national research agenda for firearm-related injuries. Next steps include operationalizing these gaps into research questions, identifying data sources and methodological approaches, and choosing knowledge translation strategies.

Keywords: *firearms, gun violence, injury prevention, public health, priority-setting*

Highlights

- Experts identified knowledge gaps to inform a research agenda that focuses on preventing firearm-related injury and death in Canada.
- There is a lack of accessible and usable data on unintentional and intentional firearm injuries in Canada.
- Researching the economic cost of firearm injuries to victims' families and communities and Canadian society was identified as the top priority.
- The barriers to collecting firearm-injury data and the impact of social policies and legislation to reduce intimate partner firearm injury and femicide were also identified as key priorities for research.

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Introduction

Firearm-related injury is a leading yet preventable cause of premature death in Canada.[1] Canada ranks third among the G7 countries in terms of age-adjusted firearm-related mortality.[2] Firearm-related violent crime increased by 55% between 2013 and 2022 (23.7 to 36.7 incidents per 100 000 population),[3] and the homicide rate in 2022 was 2.24 per 100 000 population, the highest in 30 years.[1] More than one in three homicides (41% in 2022) are firearm related, with the highest firearm-related homicide rates in Saskatchewan and Manitoba.[1,3]

Numerous individuals, including children and youth, present to hospital each year for unintentional firearm injuries.[4] Between 2002 and 2016, for every firearm death, three people were treated for nonfatal injuries in Ontario hospitals.[5]

After the 2020 mass shooting in Nova Scotia, the deadliest mass shooting in Canada, the Mass Casualty Commission called for a cultural shift to institute a public health approach to firearm safety.[6] A public health approach evaluates firearm access and the societal factors that contribute to or mitigate firearm violence. The Mass Casualty Commission emphasized that collaborating to address root causes such as the social determinants of health and deeply entrenched sociopolitical factors is essential for community safety.[6] The Commission highlighted that resource allocation should focus on policing and law enforcement and on prevention; made numerous recommendations for regulations aimed at risk reduction; and emphasized the need for gender analysis, recognizing the effect of toxic masculinity among gun owners and the police.[6]

The design, implementation and effectiveness of any new firearm-injury prevention program relies on access to linked high-quality health, firearm, social and criminal justice data. At the time of writing, Canada lacks such firearm-related data because of funding constraints, political sensitivities, privacy concerns and other factors. The literature often highlights the need for qualitative data on the social determinants of firearm-related injuries and deaths as well as quantitative data on vulnerable populations most affected by firearm violence.[4-6]

Addressing these gaps is crucial because effective injury prevention strategies need to be informed by the social contexts and disparities that shape firearm risks. Successful injury prevention programs must involve community groups, victims, researchers, health care professionals, law enforcement personnel, policy-makers and other involved parties to ensure a comprehensive and collaborative approach.

To frame the impact of firearms as a public health issue, Canada needs a coordinated national effort and robust research initiatives. In this article, we aim to lay the groundwork for a national research agenda by identifying knowledge gaps in firearm-related injury and death and research priorities.

We focused on three areas: unintentional firearm injuries; intimate partner violence (IPV) and femicide; and other assault-related firearm injuries. Unintentional firearm injuries are accidental and can be self-inflicted or inflicted by others.[7] These injuries are often due to the mishandling, improper storage or unintended discharge of firearms.[8] Assault-related firearm injuries, on the other hand, are intentional and violent.[8] Injuries as a result of IPV and femicide are a distinct form of assault related to gender-based violence. We examined IPV/femicide-related firearm injury separately to capture the unique dynamics of this issue as well as the specialized support services and nuanced policy responses required. We did not examine firearm-related self-harm because of the broad scope of this topic and the different prevention priorities.

Methods

We used nominal group technique, led by a certified professional facilitator, in two successive stages to achieve consensus on topics relevant to a national firearm research agenda (Table 1).

The Unity Health Toronto research ethics board confirmed that this project did not require ethics approval because it does not constitute human research or contain any identifiable personal information.

Participant recruitment

Engaging a variety of people with broad interests is critical for identifying current needs in firearm research and providing diverse perspectives and expertise. Purposive sampling methods were used to recruit participants for both stages. Email invitations were sent to 36 key professional contacts with expertise in firearm injury and death in Canada between 24 July and 14 September 2023. These included experts in clinical practice and research in firearm injury, advocates for and leaders in violence prevention, decision-makers, individuals with lived experience (either directly or through loved ones) and community representatives. Specific groups included the Danforth Families for Safe Communities, an organization of community members affected by the 2018 shooting on Danforth Avenue, Toronto, Ontario, and YouthLink, which works with youth and families to improve community well-being.

Stage 1: Identifying knowledge gaps

Fifteen participants (Table 2) met virtually on 20 September 2023 to generate ideas on current knowledge gaps. They were placed into preselected breakout groups to ensure multidisciplinary and varied geographical representation.

All the discussions were conducted in English.

With the end goal to identify knowledge gaps in firearm-related injury and death in Canada, the focus groups were asked the following questions, which had been preselected by the research team: (1) What

TABLE 1
Stages of research

Stage	Objective	Study sample	Data collection tool	Analysis
1.	To identify current research needs and gaps	Key experts (N = 15)	Jamboard (digital whiteboard)	Document analysis and deductive content analysis
2.	To rank knowledge gaps	Canadian Academy of Health Sciences forum attendees (N = 43)	Feedback Frames[9] (voting tool)	Quantitative analysis of scores after participant voting

are the current research needs and gaps in unintentional firearm injury? (2) What are the current research needs and gaps in assault-related firearm injury? (3) What are the current research needs and gaps in intimate partner firearm injury/femicide?

An interactive online whiteboard tool, Jamboard (Google, Mountain View, CA, US), was used to record responses.

The participants were then asked to pick those generated ideas that were most likely to lead to research projects based on two criteria, importance and feasibility. Importance refers to a project providing relevant and valuable insights; feasibility refers to the realistic implementation of a project using existing data or feasible novel data sources. The priority knowledge gaps were finalized after a facilitated group discussion that used nominal group technique to reach agreement.

After the first meeting, the recorded knowledge gaps were rewritten in more formal language for review in Stage 2 (Table 3).

Stage 2: Ranking knowledge gaps

Stage 2 took place at the Canadian Academy of Health Sciences forum, "Gun Violence is a Public Health Issue," in Toronto, Ontario. The forum was open to all interested individuals; attendees included practitioners in community settings, representatives of the legal community, social workers, representatives from victim and survivor groups, and researchers in academia. The Stage 2 exercise and instructions were explained to all the forum attendees (approximately 150), who were encouraged to participate during breaks between presentations. The exercise occurred on 27 and 28 September 2023. The meetings and materials were in English.

The aim of Stage 2 was to rank the knowledge gaps selected in Stage 1. Using Feedback Frames,[9] each of the 43 participants voted anonymously by dropping tokens assigned to different knowledge gaps into slots indicating "top priority," "high priority," "medium priority," "low priority," "disagree that it is a priority" and "not sure." Also provided was an area to write comments about each knowledge gap.

TABLE 2
Stage 1 participant characteristics (N = 15)

Characteristics	Size of sample, n
Female sex	12
Provinces represented	3
Professional role	
Professor	1
Advocacy group	5
Chief Firearms Officer	3
Epidemiologist	1
Physician	2
Other	3

Votes were counted and quantitatively analyzed by the facilitator. Final scores to determine ranking were calculated using weighted scores (top priority = 5 points; high priority = 4 points; medium priority = 3 points; low priority = 2 points; "not sure" = 1 point; and "disagree that it is a priority" = 0 points).

The following was used to calculate the numerical scores:

$$\frac{(5 \times \#\text{ of Top priority tokens}) + (4 \times \#\text{ of High priority tokens}) + (3 \times \#\text{ of Medium priority tokens}) + (2 \times \#\text{ of Low priority tokens}) + (1 \times \#\text{ of Not sure tokens}) + (0 \times \#\text{ of Disagree priority tokens})}{\text{Total number of tokens}}$$

TABLE 3
Summary of knowledge gaps selected at Stage 1

Knowledge gaps in unintentional firearm injury (n = 5)
1. The relationship between mental health history reported during firearm licence applications and mental health service utilization.
2. The differential health and community impact of firearm injuries and deaths in rural vs. urban areas.
3. The utilization and enforcement of child access protection laws after unintentional firearm injuries.
4. The mental health service utilization patterns of family members after firearm injuries.
5. The environment that led to unintentional firearm injuries: How was the firearm accessed? How were the firearm and ammunition stored? Did the injury happen at home?
Knowledge gaps in assault-related firearm injury (n = 7)
1. The risk factors that put people in situations that result in the injuries; proactively address/mitigate the risk to individuals.
2. The economic cost of firearm injuries to victims' families, community and Canadian society.
3. A description of the available and required Canadian firearm-injury data, including impediments to data collection and use.
4. The impact of assault-related firearm injuries on communities and the approaches to healing after such incidents.
5. Canada-specific definitions and language around the different types and intents of firearm injuries, as well as their consequences.
6. The relationship between social media and assault-related firearm injuries.
7. The available and required support for individuals and/or their families after a firearm-related injury or death.
Knowledge gaps in intimate partner firearm injury/femicide (n = 3)
1. The available and required support for individuals and/or their families after a firearm-related injury or death in situations of IPV or femicide.
2. The impact of social policies and legislation aimed at reducing IPV/femicide-related firearm injuries and death.
3. Early indicators of or risk factors for IPV or femicide before the involvement of a firearm.

Abbreviation: IPV, intimate partner violence.

These numerical scores were then placed in order from highest to lowest to assign rank. The rank difference between two priorities was calculated as the difference between their scores.

Results

Research idea generation

During Stage 1, the 15 participants generated 22, 16 and 33 free-text responses to the questions on the current research needs and gaps in unintentional firearm injury, intimate partner firearm injury/femicide and other assault-related firearm injuries, respectively (Figure 1).

During subsequent facilitated discussions, the participants agreed on which research projects would be the most feasible and important. Across the three focus questions, 16 topics were selected; two were eliminated as they referred to knowledge translation rather than a research need or gap. Another knowledge gap, "the available and required support for individuals and/or their families after a firearm-related injury or death," was generated and added during the facilitated group discussion. A total of 15 knowledge gaps were put forward for voting in Stage 2 (Table 3).

Knowledge gap ranking

The Stage 2 participants (N = 43) voted on the knowledge gaps using Feedback Frames. Participants did not vote on all 15 knowledge gaps; however, each station received votes from at least 38 individuals.

The highest-ranking knowledge gap, with a weighted average score of 4.1, was "the economic cost of firearm injuries to victims' families, community and Canadian society" (Table 4). The next two highest-ranking priorities were "the impact of social policies and legislation aimed at reducing IPV- or femicide-related firearm injuries and death," with a weighted average score of 4.0, followed by "a description of the available and required Canadian firearm-injury data, including impediments to data collection and use," with an average score of 3.8.

Of note, the second-ranked research priority, the impact of social policies and

FIGURE 1A
Free-text responses to Stage 1 focus question 1: What are the current research needs and gaps in unintentional firearm injury?

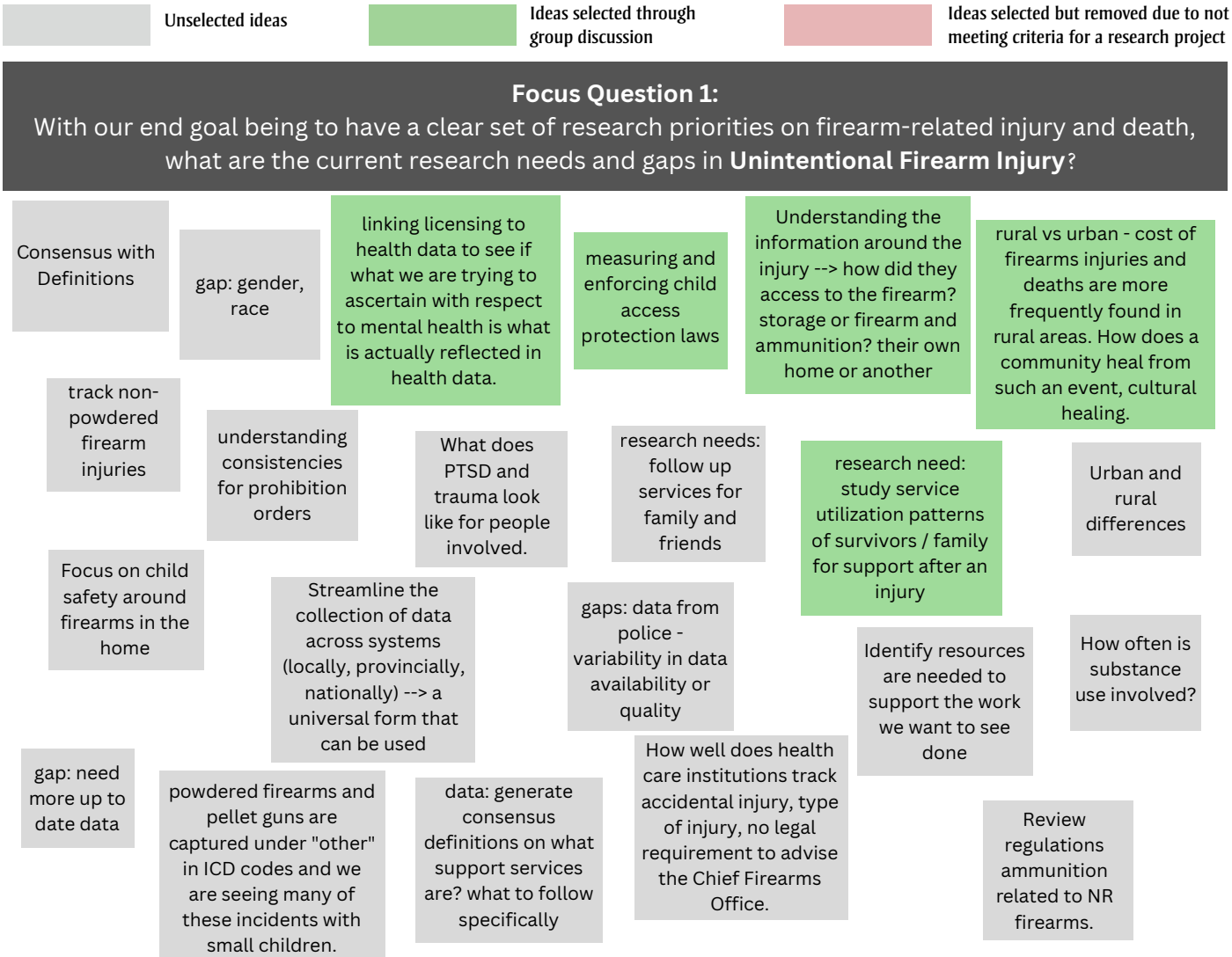
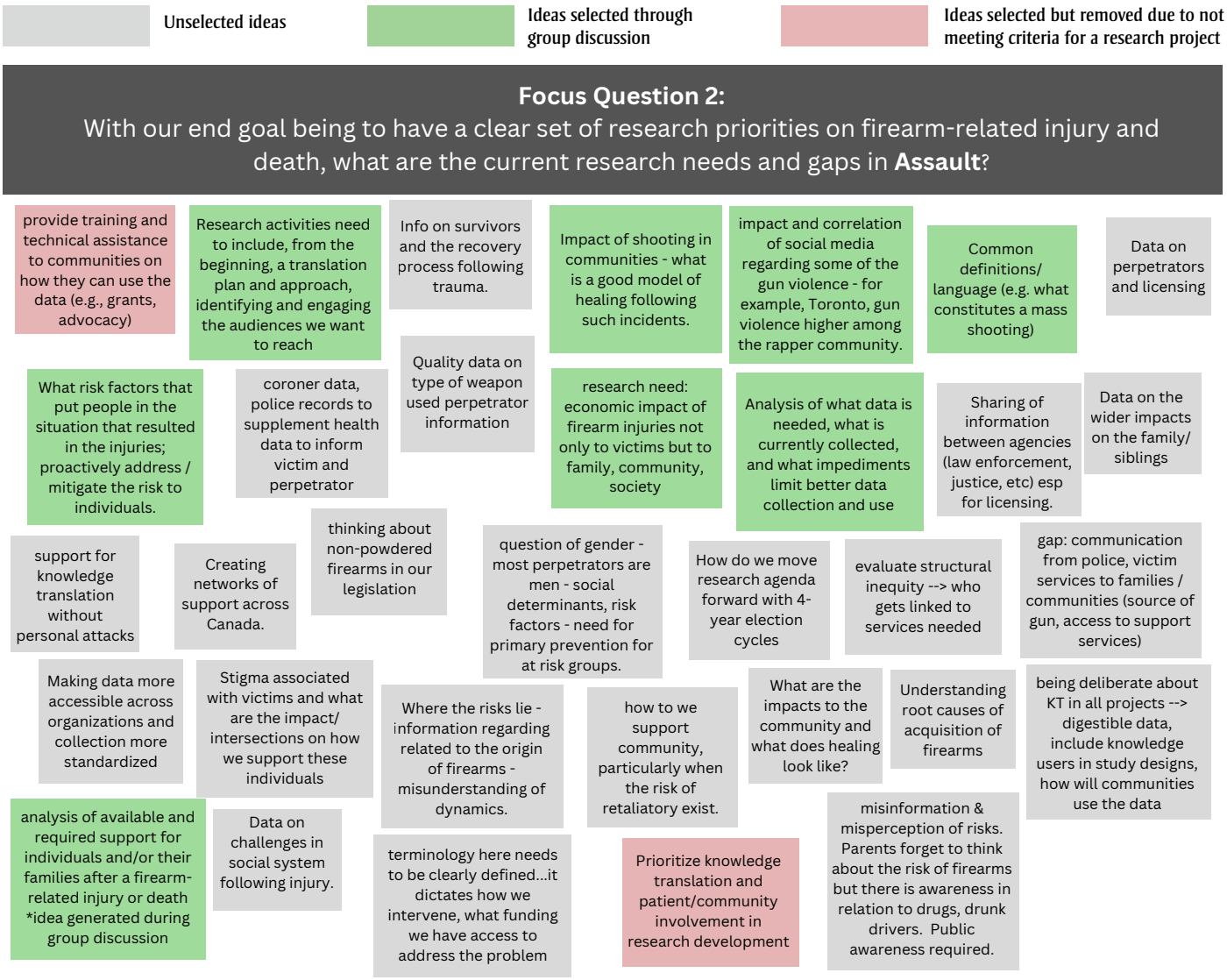


FIGURE 1B
Free-text responses to Stage 1 focus question 2: What are the current research needs and gaps in assault-related firearm injury?



legislation aimed at reducing IPV- and femicide-related firearm injuries and death, garnered the most top- and high-priority votes in total (n = 29), more than even the highest-ranked priority (n = 27), "the economic cost of firearm injuries to victims' families, community and Canadian society." Two research priorities that scored lower in the overall ranking also stood out because they received 25 or more votes categorizing them as a top or high priority: "risk factors that put people in the situations that result in the injuries; proactively address/mitigate the risk to individuals," which ranked sixth (with 7 top- and 20 high-priority votes) and "the mental health service utilization patterns of family members after firearm injuries," which ranked eighth (5 top- and 20 high-priority votes).

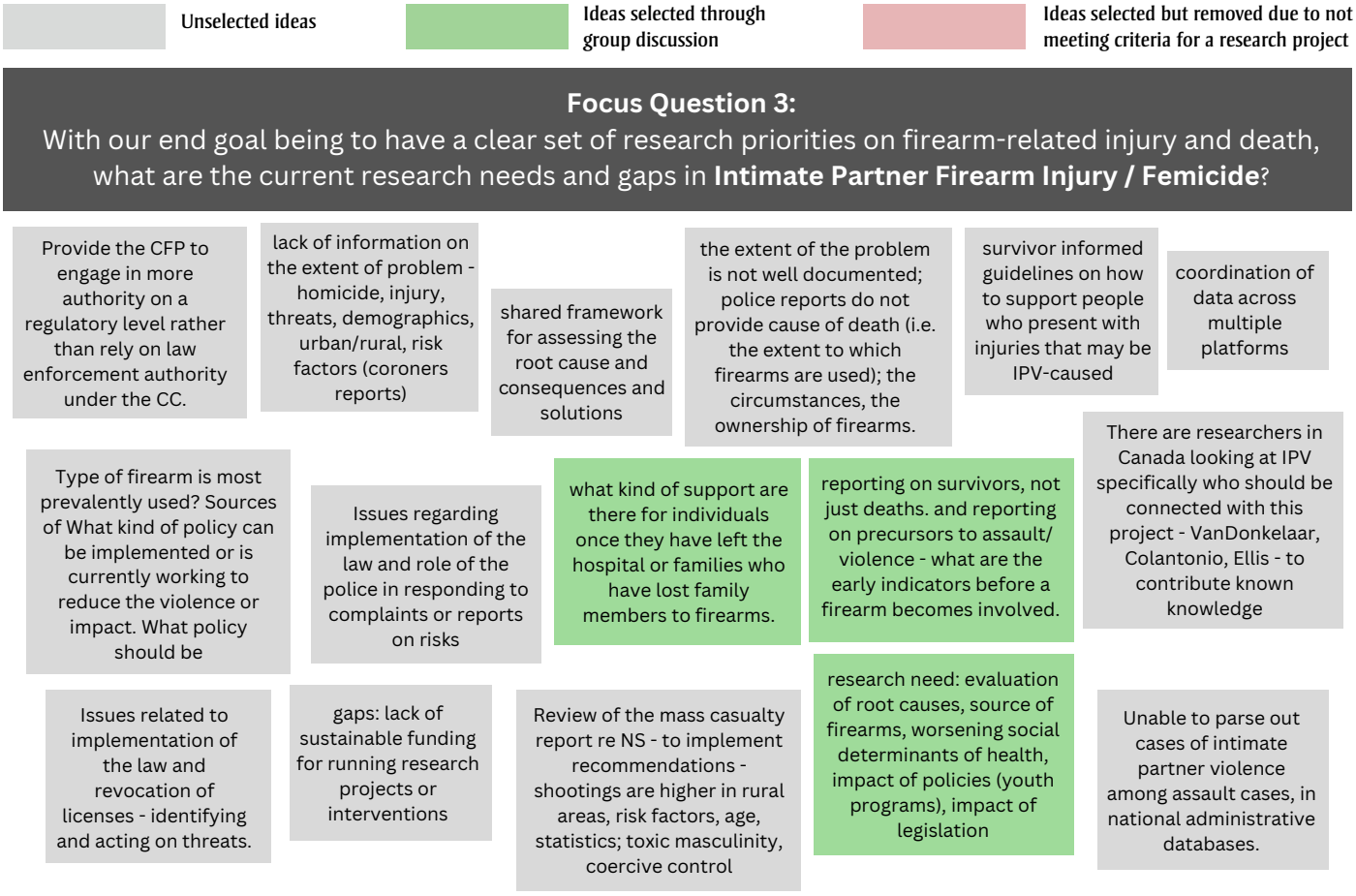
Although the facilitator organized the Feedback Frames for ranking in such a way as to avoid choice overload and vote-splitting effects, there were two instances where ballot stuffing may have occurred, as more vote tokens were counted than the number of participant signatures for that station. This may have occurred because participants forgot to sign in. Regardless, these two research priorities ranked twelfth and thirteenth out of 15.

Discussion

The 15 identified knowledge gaps offer valuable insights into areas on which to focus Canadian research efforts. Many of these priorities resemble the ones the National Research Council identified in 2013 in response to executive orders to learn about firearm violence in the United States.[10] We did not identify any priorities related to gun safety technology or assessment of prevention strategies, however, likely due to a lack of substantial research in firearm safety technology and a scarcity of long-standing Canadian prevention programs.[6]

We identified themes from across the three categories—unintentional firearm injury, assault-related firearm injury and intimate partner firearm injury/femicide—that emphasize broader gaps such as risk factors and the overall impact of firearm injuries and deaths in Canada. To better organize these gaps and align with public health frameworks, we used a social

FIGURE 1C
Free-text responses to Stage 1 focus question 3: What are the current research needs and gaps in intimate partner firearm injury/femicide?



Abbreviations: CC, criminal code; CFP, Canadian Firearms Program; ICD, International Classification of Diseases; IPV, intimate partner violence; KT, knowledge transfer; NR, not reported; NS, Nova Scotia; PTSD, posttraumatic stress disorder.

ecological model that highlights research priorities at different levels, clarifying where knowledge gaps exist (Figure 2).[11] We identified knowledge gaps at all levels of the model, emphasizing the need for comprehensive interventions that span individual, interpersonal, community and policy domains.

The knowledge gap selected as the top area to investigate was the economic cost of firearm injuries to victims' families, communities and Canadian society. Detailed analyses of the current economic burden of firearm injuries could influence legislative change and improve funding of prevention programs. The most recent report on the economic and social impacts of firearm-related crime in Canada, in 2008, estimated the costs at more than CAD 3.1 billion;[12] however, this was likely an underestimate as the consequences of suicide or unintentional firearm injuries and deaths were not taken into account.[12]

The second-ranked research priority was the impact of policies and legislation to reduce IPV- and femicide-related firearm injuries and death. Previous research on the effects of policies and laws on firearm injury and death rates had mixed results, with some studies suggesting that changes were significant and others reporting minimal effects.[13-15] Further evaluation of, for example, *An Act to amend certain Acts and to make certain consequential amendments (firearms)* (the former Bill C-21) could help assess the influence of such legislation on firearm-injury rates among IPV victims.[16]

The third-ranked research priority focuses on describing the firearm-injury data that are available and that are required. A 2019 scoping review of empirical research on firearms in Canada identified only 34 peer-reviewed publications over 18 years.[13] The available data are limited and fragmented, with siloed municipal, provincial/territorial, federal agencies and academic institutions collecting data according to their specific needs.[17] These datasets are often inaccessible to other agencies or researchers, even though firearm-related data collected by, for example, the Ontario Ministry of Children, Community and Social Services during client assessments, could provide other agencies with valuable insights.[17] Comparing data across regions is also hampered by inconsistent data collection methods and by the use of definitions that are neither standardized nor designed for diverse purposes.[17]

A summary of available data would help identify areas for standardization, facilitating future analyses of data from different agencies and institutions. For instance, firearms-related offences are more likely to involve multiple victims; however, some data systems input these as single incidents while others count these multiple times.[3]

TABLE 4
Ranking results for knowledge gaps (n = 15)

Rank	Knowledge gaps	Number of votes, n						Weighted average score
		Top priority	High priority	Medium priority	Low priority	Disagree[a]	Not sure	
1	The economic cost of firearm injuries to victims' families, community and Canadian society.	18	9	12	1	0	0	4.1
2	The impact of social policies and legislation aimed at reducing IPV/femicide-related firearm injuries and death.	13	16	9	2	0	0	4.0
3	A description of the available and required Canadian firearm-injury data, including impediments to data collection and use.	15	11	11	4	0	1	3.8
4	The available and required support for individuals and/or their families after a firearm-related injury or death.	8	13	17	1	0	0	3.7
5	Risk factors that put people in situations that result in injuries; proactively address/mitigate the risk to individuals.	7	20	10	4	0	1	3.7
6	The mental health service utilization patterns of family members after firearm injuries.	5	20	11	4	0	0	3.7
7	Early indicators of or risk factors for IPV or femicide before the involvement of a firearm.	9	12	18	3	0	1	3.6
8	The available and required support for individuals and/or their families after a firearm-related injury or death in situations of IPV or femicide.	6	16	17	3	0	0	3.6
9	The impact of assault-related firearm injuries on their communities and the approaches to healing after such incidents.	7	12	15	4	0	1	3.5
10	The relationship between social media and assault-related firearm injuries.	6	14	15	7	0	0	3.5
11	The differential health and community impact of firearm injuries and deaths in rural vs. urban areas.	6	14	12	7	0	0	3.5
12	The environment that led to unintentional firearm injuries: How was the firearm accessed? How were the firearm and ammunition stored? Did the injury happen at home?	7	10	10	9	1	1	3.3
13	The relationship between mental health history reported during firearm licence applications and mental health service utilization.	4	10	14	11	1	1	3.0
14	The utilization and enforcement of child access protection laws after unintentional firearm injuries.	5	5	16	8	1	3	2.9
15	Canada-specific definitions and language around the different types and intents of firearm injuries, as well as their consequences.	7	3	13	12	2	3	2.8

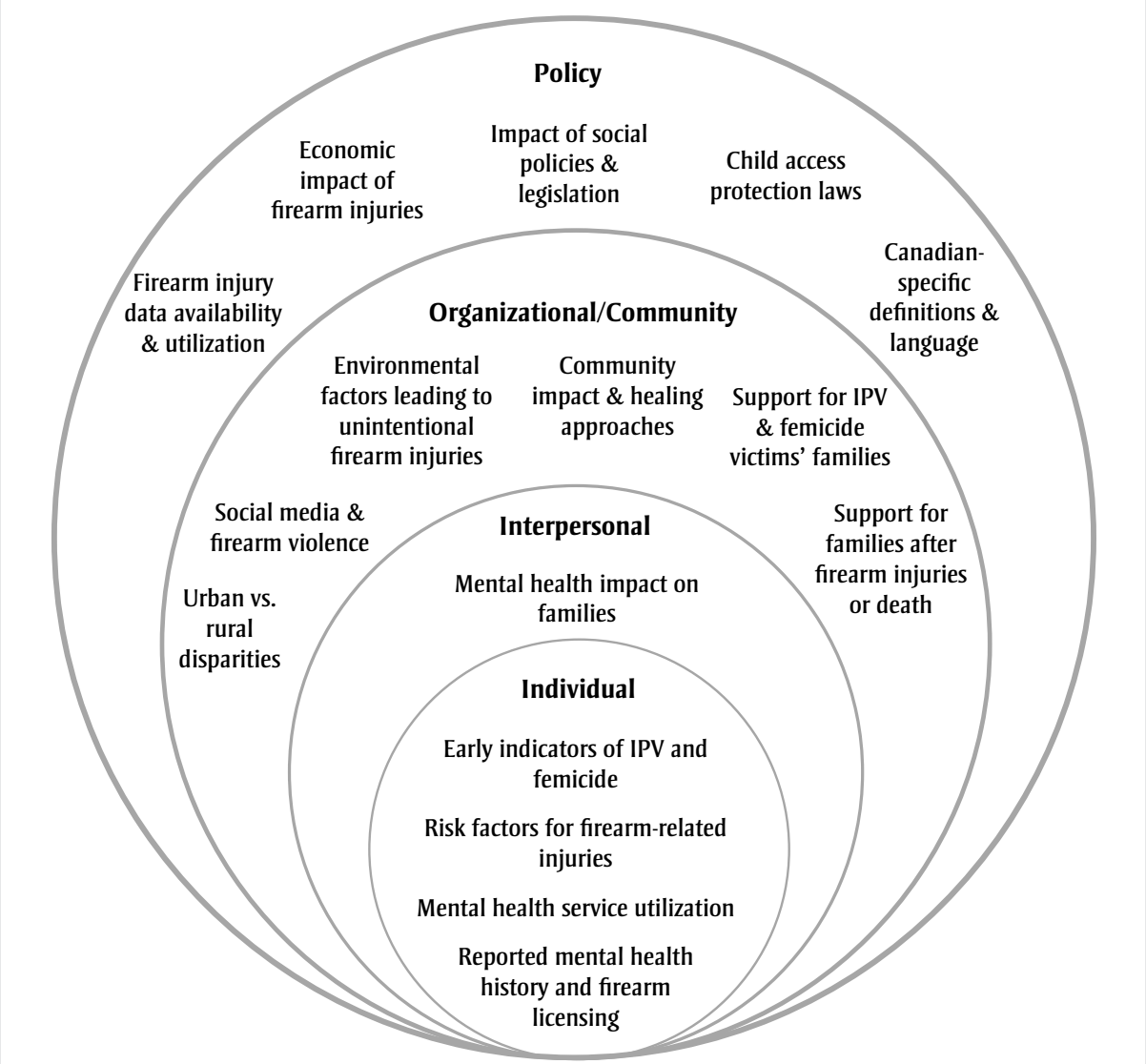
Abbreviation: IPV, intimate partner violence.

[a] "Disagree that this [knowledge gap] is a priority."

In the last 3 years, the Canadian Association of Chiefs of Police and the Canadian Centre for Justice and Community Safety Statistics have worked to improve the national Uniform Crime Reporting Survey, which is used to measure the incidence of crime in Canada.[18] Standard definitions of what constitutes a "shooting" and "crime gun" were added to the survey as recently as 2021.[18] However, data on demographic variables such as victim and offender characteristics are still lacking.[13,18] Collecting these data sensitively, by working with communities and with policing agencies, is critical to developing community-level public health interventions.[19] By developing a central database that compiles all available firearm data from various agencies, we can continue to identify gaps and improve data collection.

Participants' comments on lower-ranked research priorities included concerns about the feasibility of projects due to data privacy restrictions. For example, determining the relationship between mental health history reported during firearm licence applications and mental health service utilization was considered unfeasible due to a lack of linked data sources. Nevertheless, more than half of the participants considered risk factors in firearm events a top or high priority, and risk factor–related priorities ranked fifth and

FIGURE 2
Social ecological model of firearm injury knowledge gaps



Abbreviation: IPV, intimate partner violence.

seventh out of the 15 knowledge gaps. Others commented that for specific priorities, the issues lie in the gaps between knowledge and actionability, and not in a lack of data.

Future work will focus on turning the highest priority knowledge gaps into actionable research projects. We will continue to work with interested parties and multidisciplinary groups to discuss data sources, methodological approaches and strategies to mitigate limitations.

Limitations

The findings in this report are subject to several limitations.

Participants from only three provinces (Ontario, New Brunswick and Nova Scotia) took part in generated ideas during Stage 1. As such, their priorities may not reflect national or other provinces' priorities. To help mitigate this, we gathered a team of diverse and multidisciplinary experts familiar with the issue of firearm-related injury on a national scale to take part in a rich discussion on knowledge gaps that covered many topics.

The potential for an "echo chamber" effect nevertheless existed as not all relevant perspectives were included in discussions, potentially limiting the diversity of ideas generated. For example, the predominance of female participants in Stage 1 may have influenced the prioritization of certain topics, reflecting perspectives more commonly emphasized by this demographic. Also, while the participants had many different public health and advocacy roles, the viewpoints of people working in economics, law enforcement or politics were not represented. Including a greater number of perspectives was beyond the feasibility of this project but would be valuable in future work.

There was potential for expertise bias because idea generation took place in a group setting, which may have allowed more assertive participants to influence the group. We minimized this effect by having multiple breakout groups and

having a professional facilitator who elicited contributions from everyone.

We decided on three focus questions to stimulate the generation of idea, but having more questions may have uncovered additional topics.

Participants asked for clarifications and additional definitions regarding some of the priorities. Providing more detailed explanations about the knowledge gaps might have affected the way these participants ranked them.

Lastly, as participant involvement occurred during the breaks between presentations at the "Gun Violence is a Public Health Issue" forum, the high participant traffic at these times may have led to a bandwagon effect, either through participants overhearing open discussions or seeing other participants' actions despite efforts to make voting anonymous and conceal the results.

Conclusion

With this study, we identified knowledge gaps related to firearm-related injury and death and research priorities that could inform a national research agenda for Canada. The top priorities highlight the large and diverse research gaps around firearm-related injuries and deaths. Next steps include operationalization of these top knowledge gaps into research questions, identification of data sources and optimal methodological approaches, and decision-making regarding knowledge translation strategies. The results of this consultation process may serve as a catalyst to create impactful and much-needed firearm-related priority prevention research.

Acknowledgements

We thank Karyn Dumble of Monarch Park Group, Toronto, Ontario, for her critical role as a certified professional facilitator. We also thank the experts who contributed their invaluable knowledge during the various phases of this work.

Funding

This study was supported by a Canadian Institutes of Health Research (CIHR) Institute of Cancer Research (ICR) Planning and Dissemination Grant (Funding reference number PCS 183367).

Conflict of interests

None.

Authors' contributions and statement

LA: Formal analysis, writing—original draft.

AS, AY, CG, AB, CS, WC, IW, WT, ST, NB, BB, NS: Formal analysis, writing—review and editing.

DG: Conceptualization, methodology, investigation, project administration, supervision, formal analysis, writing—review and editing.

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

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https://doi.org/10.24095/hpcdp.46.1.02

Original quantitative research

Identifying social prescribing core outcomes using a Delphi approach: findings and future directions

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This article has been peer reviewed.

Abstract

Introduction: Although social prescribing is a growing global health and social movement, no Delphi studies have determined which outcomes are critical to assess. Our aim was to identify a core outcome set based on feedback from diverse user groups of people who could be affected by (e.g. adults ≥ 60 years) or who can affect (e.g. providers, researchers) social prescribing.

Methods: Following standard guidelines for Delphi studies, we developed a two-round online survey with a focus on Canadian perspectives. We asked participants to rate 21 outcomes as "critical" (7–9 on a 9-point scale), "important but not critical" (4–6 points) or "not important" (1–3 points). We provide a subgroup description of findings from older adult/family and friend perspectives.

Results: Round 1 was completed by 74 people from 10 user groups and Round 2 by 52 people from eight user groups (70% retention). Ratings between rounds were generally consistent. Seven outcomes met the "critical" threshold. No outcomes were excluded. Critical outcomes focused on mental health, physical and social functioning, and well-being. Participants commented on environmental (e.g. resources, care delivery) and equity factors.

Conclusion: This study identified seven critical outcomes to consider in evaluations of social prescribing research and interventions. Future investigations should investigate how contextual and personal factors might influence outcomes and identify specific instruments (e.g. questionnaires, performance-based tests) to assess each outcome. Identification of outcomes is a continuous process, requiring regular updates as results may change due the ongoing evolution of social prescribing and other factors.

Keywords: *determinants of health, outcomes research, public health, seniors*

Highlights

- Social prescribing is an emerging health and social care model, but a list of outcomes that are the most important to assess has not yet been published.
- Having a core outcome set would help maintain consistency between studies for subsequent synthesis and to support practice.
- We conducted a Delphi study with different user groups, including adults 60 years and older and their families or friends, to determine which outcomes were critical.
- After the second of two survey rounds, seven outcomes that focused on mental health, physical and social functioning, and well-being were selected as critical.
- This is the first iteration of a social prescribing core outcome set; this set may change over time and depend on where it is applied.

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Introduction

The social prescribing movement is a health and social model of care that is growing globally.[1,2] Social prescribing is described as a means of addressing people's unmet social needs by connecting them with resources.[3] Social prescribing can take a number of approaches, from a light touch that lets people know about community resources ("signposting") to a holistic social prescribing hub with a team-based approach that can include "prescriptions" to community-based activities and resources that address health-related social needs and involve link workers who support people as they engage with these resources.[4]

Although the available evidence indicates that social prescribing shows promise, previous research has been limited by small studies,[4] a lack of rigorous study designs[5] and incomplete information on program implementation.[4] Inconsistencies in the outcome measures used in studies of social prescribing impede the comparison of data across these studies.[6] A lack of standardized outcomes might also affect program implementation, making it difficult to evaluate, improve and sustain implemented programs.[7]

Having a core outcome set could improve the consistency of study designs and facilitate meta-analyses.[8] We were unable to identify any applicable core outcome sets that had been published despite that the most recent definition (based on the results of a Delphi study with experts in social prescribing from 26 countries) stated the need to use outcomes to evaluate the effects on the individual.[3] Examples of impacts included "nonmedical, health-related social needs, health and well-being (physical, mental, social), satisfaction, clinical and nonclinical supports and services (e.g. demand, costs) and the community."[3,p.8] Well-being was the most frequently cited outcome in studies with adults 18 years and older.[9]

Although social prescribing programs are available for all ages,[1] our focus is people as they age and, in particular, older adults—a large and growing demographic.[10] Our previous systematic reviews[4,9,11] focused on adults 40 years and older. Social prescribing may be especially important for older adults in the wake of reports of loneliness and social isolation during the pandemic.[12]

Recognizing the importance of engaging people with lived experience in the development of the core outcome sets,[13] we were especially interested in the perspectives of older people and their families. Moreover, people who are directly affected need to be involved in developing solutions to challenges in order to bring about change[14] in, for example, health and social care. It is also possible that excluding the recipients of an intervention such as social prescribing from a Delphi study could result in missing important outcomes.[13] Further, including multiple perspectives may help identify those outcomes that are best tailored to the needs of recipients of social prescribing interventions, the programs and the community.

The aim of this study was to identify a core outcome set for use in future social prescribing research trials with older adults, based on feedback from multiple diverse user groups.

Methods

Ethics approval

This study received ethics approval from the Behavioural Research Ethics Board at The University of British Columbia (H22-03569). We published our protocol[6] and registered it with the Core Outcome Measures in Effectiveness Trials (COMET) database (https://www.comet-initiative.org/Studies/Details/2364).

Delphi study

The aim of this prospective Delphi study[15-20] was to identify critical outcomes for use in social prescribing research trials with adults aged 60 years and older. We followed guidance from *The COMET Handbook*[8,21] to help identify and choose suitable measures for research trials to create "an agreed standardized collection of outcomes, known as a core outcome set … which should be measured and reported in all trials for a specific clinical area."[22,p.1]

We conducted two rounds of an online Delphi survey to rate 21 outcomes for use in social prescribing research trials. These outcomes were grouped into domains based on a published taxonomy[23] and our 2024 modified umbrella review.[9]

We delivered the 21-item list of outcomes to participants using DelphiManager (COMET Initiative, Liverpool, UK) in both rounds of the Delphi survey.

Participants

We invited people from diverse user groups—people who could affect or are affected by social prescribing[24]—to identify critical core outcomes to use in social prescribing. We focused our recruitment efforts within Canada to support national research and practice, but as social prescribing is relatively new to Canada, with the first evaluations commencing in 2018 in Ontario,[25] we also identified potential participants from, for example, the United Kingdom. In British Columbia, where many of our research team are located, social prescribing began as a demonstration project in early 2020 in approximately 20 sites across the province, and the program continues to expand.[26]

Although the optimal number of Delphi panel members has not been established, it has been suggested that 30 to 50 people may be appropriate for a group with similar perspectives.[27] We therefore tried to recruit an even larger number of participants in order to gather a variety of viewpoints. Diverse perspectives among panellists may also contribute to the coproduction process[28] especially for interventions that focus on well-being,[29] equity[30] and sustainability and that take into account the "community paradigm," which argues that "public services should work with the insight of people and communities to be effective and sustainable."[31,p.1]

Recruitment

We extended invitations to individuals in the "social prescribing" user groups identified in our published protocol[6] and based on our 2013 framework for older adults' mobility in the community.[32] These user groups included researchers (who could "test" social prescribing), health care providers (who could make referrals), community groups and social service providers (nonprofit or volunteer groups that could deliver social prescribing interventions), trainees (including students and fellows who could provide feedback and ensure the sustainability of social prescribing interventions), link workers ("community connectors" or "navigators"), data and implementation scientists, and ethicists as

well as managers, decision-makers and policy-makers.

We searched online for potential participants using terms such as "social prescribing" and keywords related to each user group and location (initially within Canada, and then wherever social prescribing was conducted), and identified publicly available email addresses. An author [MCA] sent email invitations to at least 10 (if possible) potential participants from each of the user groups, to a total of 131 email invitations (Table 1).

We recruited older adults (≥ 60 years) and their family members or friends because of the need to understand their perspectives,[13] in keeping with the coproduction approach in social prescribing.[1] To recruit individuals, we worked with a British Columbia–based research service to post our ethics-approved recruitment materials online. Participants aged between 60 and 110 years were eligible to take part. We also posted ethics-approved recruitment material on our research laboratory's social media account.

We did not provide a stipend to study participants.

Delphi survey rounds

Round 1 of the Delphi survey started on 22 May 2024 and closed on 8 July 2024 (7 weeks). Round 2 started on 25 September 2024 and closed on 7 November 2024 (6 weeks).

In our introductory emails to participants, we provided information on the study and access to DelphiManager, and assigned each participant a unique study number. We deliberately limited the materials sent to participants to prevent unintentional bias, providing them with the consent form (which included some background information) and instructions on how to participate in each round.

We asked participants to rate each of the 21 outcomes on a nine-point scale from one ("not important") to nine ("critical"). We categorized the responses into three groups: critical outcomes (7–9 points); important but not critical outcomes (4–6 points); and not important outcomes (1–3 points). Participants could also say that they were "unable to score" a response or to leave the question unanswered.

In Round 1, participants could also suggest and rate additional outcomes to include in the next survey round. Only the person who suggested an additional outcome was able to rate it. Two researchers [MCA, AC] reviewed and adjudicated the suggested outcomes.

Between rounds, participants were provided with a summary of their responses and results from their user group.

Delphi research team

Core members of the Delphi research team were from the following user groups: community groups, decision-makers, health care providers, researchers and trainees. The study lead for recruitment and data analysis [MCA] is a professor and physiotherapy researcher who practised in the community setting and is an older adult. All team members were invited to complete the surveys; the study lead [MCA] did not provide ratings.

Analysis

We used SPSS version 30.0 (IBM, Chicago, IL, US) and Excel (Microsoft Corp., Redmond, WA, US) to clean and descriptively analyze data. We used the Excel Crosstabs function to identify how participants rated outcomes, using the category labels "critical," "important but not critical" and "not important." We did not compare participants' ratings between rounds (e.g. to assess the stability of responses) as we only conducted surveys at two time points.[27] We also did not to ask participants or research team members to rank outcomes because previous research has found results to be similar when outcomes are rated versus ranked, but the process of ranking is more difficult.[33] We analyzed the ratings given by participants who self-identified in the older adults and family or friends/caregivers group separately from those of the other user groups, which we analyzed collectively.

Definition of consensus used in this study

We defined consensus in advance of this study. An outcome was included when at least 75% of participants rated it as critical (7–9 points) with less than 20% rating it as not important (1–3 points). Conversely, we excluded an outcome if more than 75% of participants deemed it not important with less than 20% of participants rating it as critical.[6]

Results

Between 22 May 2024 and 8 July 2024 (7 weeks), 83 participants logged on to the study website. Nine participants did not start the survey: older adults (n = 5); other (no additional information is available) (n = 2); data scientists (n = 1); and health care providers (n = 1) (Figure 1).

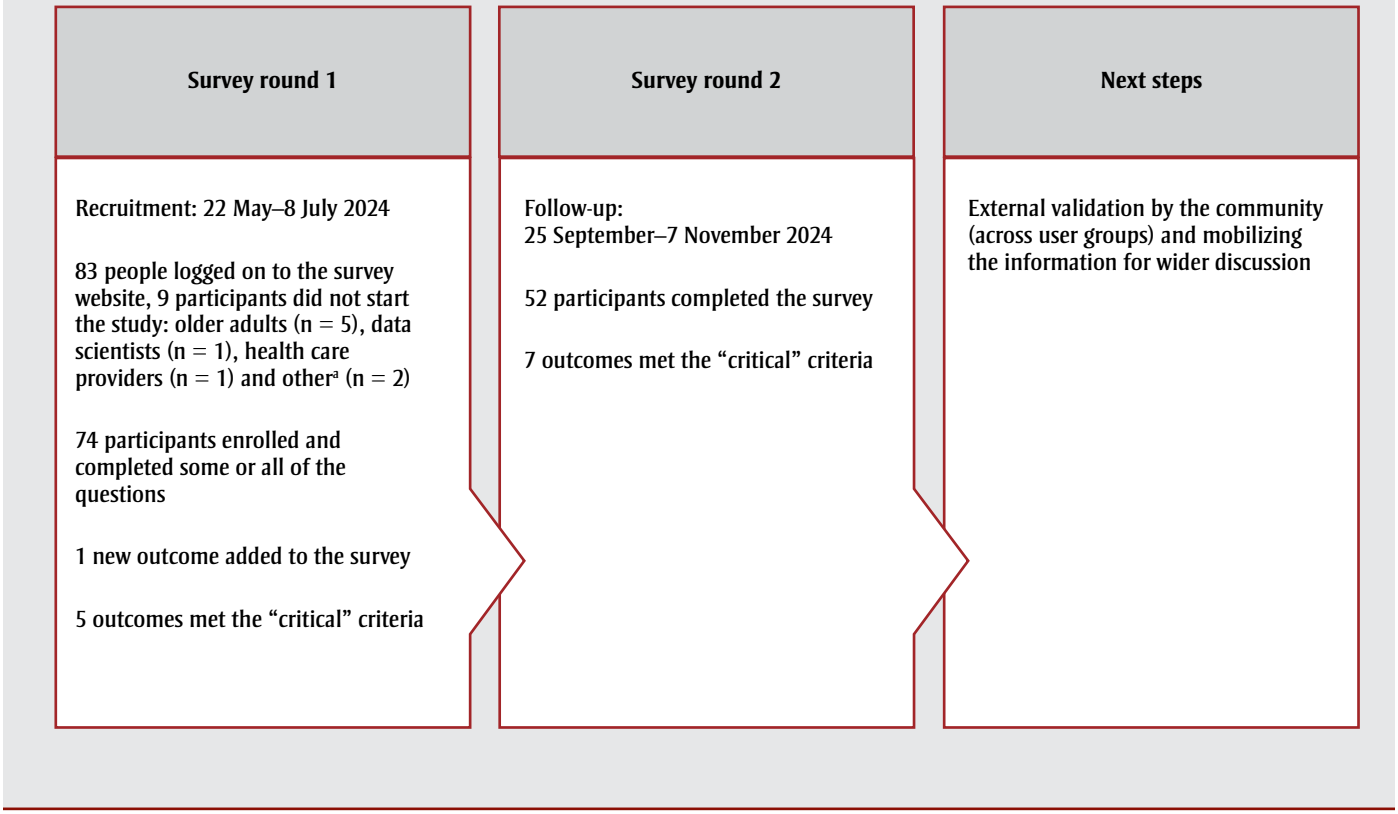
No data scientists or ethicists in Canada or elsewhere enrolled in the study or chose to use either of these user group designations, despite the invitations emailed to potential participants (n = 20). It is also possible that social support providers

TABLE 1
Number of individual emails sent to recruit participants to pre-identified social prescribing user groups[a]

	User group	Recruitment emails sent, n
1	Link workers	22
2	Researchers	20
3	Trainees[b]	16
4	Health care providers	15
5	Community groups[c] or social service providers	12
6	Data scientists	10
7	Ethicists	10
8	Implementation scientists	10
9	Policy-makers, managers, decision-makers	10
10	Family caregiver groups	6
	Total	131

[a] Identified in Esfandiari et al.[6] and based on Schiller et al.[32]
[b] Including students and fellows.
[c] Including nonprofit and volunteer groups.

FIGURE 1
Flow diagram of study methods



[a] No additional information is available.

(or any participant) identified themselves as belonging to a different user group.

A total of 73 participants completed and one person partly completed Round 1. These 74 participants represented 10 user groups, including the nine social prescribing user groups recruited via email plus the group of older adults and their families or friends recruited via the research platform (Table 2). In Round 1, 59 (80%) of the participants were from Canada, 9 (12%) from the United Kingdom and 6 (8%) from Australia, Ireland or the United States. When asked if they had delivered or received social prescribing, 52 (70%) participants said no, 19 (26%) said yes and three (4%) did not respond.

In Round 1, 19 (26%) participants suggested 44 new potential outcomes, rating 31 as critical. The participants suggested between 1 and 12 new items each (mean = 2). Only one of the 19 participants suggested more than four items.

Most of the suggestions were descriptive variables and not outcomes. For example, suggested community-level factors included "accessibility"; "community-level outcomes (beyond individual and caregiver)"; "neighbourhood area; power/resource shift to community (funding, paid roles, decision-making, etc.)"; and "social determinants of health." Other suggested items related to person-level outcomes were already in the taxonomy (e.g. belonging, mental well-being, etc.).

Seven items, proposed by four participants, related to equity: "access to health care; health outcomes; access to social determinants of health"; "cultural safety and inclusion"; "participatory governance; patient/participant voice; community voice"; "improved access to social determinants of health (housing, income, employment, social participation, etc.)"; "language services"; "that health equity be more of a global-level measurement than an individual level"; and "standardization of service applies to all categories."

Only one of the items proposed in Round 1 was added to the survey in Round 2: "community benefits (increase in availability/stability/access for community services/resources, physical space improvements, social cohesion, etc.)." The team members involved in the adjudication process [MCA, AC] decided that this outcome was not a descriptor and that it could be related to social prescribing interventions that aim to increase benefits for the community.

In Round 2, 52 participants from eight user groups completed the survey (70% retention) (Table 2). The median rating values between groups and rounds were overall consistent. For user groups with five or more participants, the median (interquartile range [IQR]) rating values for Round 1 were as follows: community groups, 7 (2); health care providers, 7 (2); older adults and family or friends/caregivers, 7 (3); researchers and implementation scientists, 7 (3); and trainees, 7 (3). For Round 2, the median (IQR) values were as follows: community groups, 7 (2); health care providers, 6 (2); older adults and family or friends/caregivers, 7 (3); researchers and implementation scientists, 7 (4); and trainees, 7 (3).

TABLE 2
Number and proportion of participants in user groups at Delphi survey Rounds 1 and 2

User group	n (%)	
	Round 1	Round 2
Older adults and family or friends/caregivers[a]	24 (32)	14 (27)
Researchers and implementation scientists[a]	19 (25)	14 (27)
Community groups[b] or social service providers	10 (14)	5 (10)
Trainees[c]	8 (11)	7 (13)
Health care providers	6 (8)	5 (10)
Link workers	3 (4)	3 (6)
Other[d]	2 (3)	2 (4)
Policy-makers, managers, decision-makers	2 (3)	2 (4)
Total	74	52

Note: Each participant self-selected their user group.

[a] Some of the pre-identified user groups (Table 1) were combined if enrolment was low, for reasons of confidentiality; the family caregiver group was combined with the older adults and family or friends group and the researchers group was combined with the implementation scientists group. No participants self-identified as data scientists or ethicists.

[b] Including nonprofit and volunteer groups.

[c] Including students and fellows.

[d] No additional information available.

None of the outcomes met the threshold for exclusion in either round of the Delphi survey and none were deleted. In Round 1, the mean percentage of people who rated an outcome as not important was 5.6% (standard deviation [SD]: 5.8%; range: 0–16.2%). In Round 2, the mean (SD) was 4.8% (SD: 6%; range: 0–21.2%). The "musculoskeletal and connective tissue" outcome was the only one considered "not important" (i.e. assigned a value of 1–3 points) by 20% of participants.

In December 2024, six team members [MCA, AC, ML, TP, KR, ST] met to discuss the findings, but no changes were made to the list of outcomes.

The list of outcomes, in order of the proportion of participants who rated them as critical in Round 2 of the Delphi survey, is shown in Table 3.

The outcomes that were rated as critical in both rounds of the Delphi survey by the older adults and family or friends/caregivers user group and by remaining user groups combined are shown in Table 4.

An overview of the operational and construct definitions for the final seven critical outcomes identified via the Delphi approach is shown in Table 5.

Discussion

Consistent and reliable outcome measures are paramount in research and practice,[22] especially in an emerging field like social prescribing. We used a Delphi approach to support future research trials in social prescribing[22] by determining seven critical outcomes alongside important contextual factors. Although this study was relatively small and focused on Canada, we conducted the research according to published guidelines[44-46] and included people from many different user groups.

Many of the critical outcomes were psychosocial factors—social (elements and/or processes) and psychological (perceptions and meanings)[47]—such as well-being. Participants also proposed outcomes beyond the person-level, a signal to consider the context of the applied nature of this model of care. Specifically, in addition to identifying critical outcomes for future social prescribing research trials,[8,22] this work acknowledges the environmental and personal contexts within which an intervention is tested given that social prescribing opportunities depend on contextual factors like availability, affordability, accessibility and others.

This work complements the definition of social prescribing (also developed using a Delphi approach) that looks beyond person-level factors.[3] This initial list of critical outcomes for evaluating social prescribing research trials and interventions' should be regularly updated within a comprehensive evaluation framework. This is especially salient as social prescribing continues to evolve.

Outcomes that matter most

Older participants were well-represented in this study, an important consideration when developing a core outcome set,[13] even though most participants lacked personal experience with social prescribing. In the subgroup analyses, the selections made by the older adults and family members or friends user group differed from those of the remaining user groups combined. Notably, older adults and their family members or friends rated cognition as a critical outcome in Round 1. This did not receive the same emphasis from the other six groups collectively; nor did it reach the 75% threshold in Round 2 (in which fewer older adults participated). Previous research suggests that older people may worry about cognitive loss,[48,49] which may account for these findings in the subgroup analysis in Round 1.

Other distinct outcomes for the older adults and family or friends/caregivers user group relates to implementation factors; these were rated lower by the other user groups combined. Specifically, this user group rated the outcomes "adherence/compliance," "resources needed for further intervention" and "adverse events" for inclusion. One plausible explanation for this disparity may be that the older adults took a broader perspective to evaluate social prescribing (based on their lived

TABLE 3
Proportion of participants who rated outcomes "critical"[a] in Round 2 of the Delphi survey

Outcome	Proportion of participants who rated the outcome "critical," %	
	Round 2 (n = 52)	Round 1 (n = 74)
Physiological/clinical – mental health (anxiety, depression, mood, etc.)	94	89
Life impact – physical functioning (frailty, physical activity, life activities)	92	84
Life impact – social functioning (belonging, friendship, social participation)	90	88
Life impact – emotional functioning/well-being (well-being, life satisfaction, loneliness, self-esteem, self-efficacy)	90	89
Physiological/clinical – general outcomes (disease burden, pain, number of chronic conditions)	82	77
Life impact – global QoL	80	74
Delivery of care – patient/carer satisfaction (person or family satisfaction with program, perceived benefits, expectations)	75	64
Resource use – economic (GP visits/calls/ health resource utilization/hospitalizations)	71	65
Life impact – personal circumstances (available resources [personal or community], needs)	67	66
Delivery of care – process, implementation and service outcomes (program acceptability, adoption, reach, maintenance, referral sources)	61	63
Resource use – need for further intervention (additional referrals based on identified needs, e.g. physiotherapy, occupational therapy, community programs, medications)	59	58
Delivery of care – adherence/compliance (adherence or completion of program)	59	50
Life impact – perceived health status	57	51
Adverse events (injuries or negative consequences resulting from engagement in programs)	55	54
Community benefits (increase in availability/stability/access for community services/resources, physical space improvements, social cohesion, etc.)[b]	54	—
Resource use – societal/carer burden (social support)	47	52
Mortality (all-cause and specific-cause survival/mortality and related outcomes)	39	36
Resource use – hospital visits	37	42
Life impact – cognitive functioning (cognition)	35	55
Life impact – role functioning (work)	24	26
Physiological/clinical – musculoskeletal and connective tissue (bone health, muscle strength)	21	27
Physiological/clinical – metabolism and nutrition (BMI, energy expenditure)	18	24

Abbreviations: BMI, body mass index; GP, general practitioner; QoL, quality of life.

[a] Predefined as ≥ 75% of Delphi survey participants rating the outcome as critical (7–9 points on a 9-point scale from 1 for "not important" to 9 for "critical") with < 20% of participants rating the item as not important (1–3 points).

[b] Suggested in Round 1 and added to the survey in Round 2.

experience), while the remaining user groups focused on outcomes relevant to research trials. Alternatively, this user group may have found it challenging to engage in the Delphi study (as suggested in other work[50]) and the research process[51] and may therefore have provided different rating scores.[52] However, examination of the median values of the user group scores do not align with this observation. Further, a systematic review noted that core outcome sets (for routine care) that did not include patients and similar users were less likely to include outcomes from a "life impact" domain.[53]

Finally, "personal circumstances" (e.g. available resources [personal or community], needs)" exceeded the threshold for a critical outcome for participants from the remaining user groups. Although outcomes in this domain may not always be considered primary, they may contain key contextual data that help to situate findings within the bigger picture and address equity-related factors. This domain shares similar features to the community-level items proposed by participants in Round 1. Thus, although we identified critical outcomes that "matter," these serve as a reminder to collect and consider other factors, especially those that promote equity within social prescribing. Collectively, participant ratings in this study provide insights into what may be important from their perspective and are valuable for an overall evaluation plan.

Equity factors

There is a need for routinely collected data on the social determinants of health,[54] particularly as they relate to health equity.[55] Recent research on social prescribing in Canada highlights the need to take health equity into account in future work,[56] as part of grounding social prescribing within the Quintuple Aim.[57] There are also examples of recent Canadian social prescribing initiatives that focused on health equity.[25,58,59] There are numerous definitions for health equity, with many encompassing "the aim of achieving the highest level of health for all people, providing the opportunity to do so, and ensuring the absence of disparities."[60,p.572] However, information related to equity is

TABLE 4
Outcomes rated critical[a] in Rounds 2 and 1 of the Delphi survey, by all participants and by subgroups

Round 2: all participants (n = 52)	Round 2: remaining user groups combined[b] (n = 38)	Round 2: older adults + family/friends/caregivers user group (n = 14)
Physiological/clinical – mental health	Life impact – social functioning	Life impact – physical functioning
Life impact – physical functioning	Physiological/clinical – mental health	Physiological/clinical – general outcomes
Life impact – emotional functioning/well-being	Life impact – emotional functioning/well-being	Delivery of care – adherence/compliance[c]
Life impact – social functioning	Life impact – physical functioning	Resource use – GP visits/hospitalizations[c]
Physiological/clinical – general outcomes	Life impact – global QoL	Resource use – need for further intervention[c]
Life impact – global QoL	Life impact – personal circumstances[c]	Physiological/clinical – mental health
Delivery of care – patient/carer satisfaction	Physiological/clinical – general outcomes	Adverse events[c]
—	—	Delivery of care – patient/carer satisfaction
—	—	Life impact – emotional functioning/well-being
Round 1: all participants (n = 74)	**Round 1: remaining groups participants[b] (n = 50)**	**Round 1: older adults + family/friends group (n = 24)**
Life impact – emotional functioning/well-being	Life impact – emotional functioning/well-being	Physiological/clinical – general outcomes
Physiological/clinical – mental health	Physiological/clinical – mental health	Life impact – physical functioning
Life impact – social functioning	Life impact – social functioning	Physiological/clinical – mental health
Life impact – physical functioning	Life impact – physical functioning	Life impact – cognitive functioning[c]
Physiological/clinical – general outcomes	Life impact – global QoL[c]	Life impact – emotional functioning/well-being
—	—	Resource use – need for further intervention[c]
—	—	Life impact – social functioning
—	—	Resource use – GP visits/hospitalizations[c]

Abbreviations: GP, general practitioner; QoL, quality of life.

[a] Predefined as ≥ 75% of Delphi survey participants rating the outcome as critical (7–9 points on a 9-point scale from 1 for "not important" to 9 for "critical") with < 20% of participants rating the item as not important (1–3 points).

[b] Participants who self-selected from one of the following user groups: community groups or social service providers; health care providers; link workers; policy-makers, managers, decision-makers; researchers and implementation scientists; trainees (including students and fellows); other (no additional information available).

[c] Consensus on these outcomes was only reached in these subgroups.

not always consistently collected or considered within social prescribing.[61] Specifically, evidence published to date has been more general and not disaggregated by personal characteristics,[61] and equity-related factors are often missing in publications.[62]

Guiding literature and innovations are available to support identifying and collecting personal factors that describe study participants and their environments with the aim of improving equity or minimizing inequities. Examples include PROGRESS-Plus,[63,64] the Screening for Poverty and Related Social Determinants to Improve Knowledge of and Links to Resources (SPARK) tool[54] and the Diversity Minimal Item Set (DiMIS).[65] These innovations, if adopted within research, may be a way to improve the inclusion and collection of data to inform the evaluation of social prescribing.

The big picture

The aim of our work was to identify outcomes considered critical to measure in social prescribing research based on an established Delphi process.[22] No outcomes were excluded (i.e. deemed unimportant), and other descriptive factors were also proposed, particularly ones related to equity. These outcomes should also be incorporated within a larger evaluation framework.

Our findings share similarities with existing frameworks, such as the International Classification of Functioning, Disability and Health, which situates health and disability within a larger context to account for environmental and personal factors.[66] Still, social prescribing is not a single complex intervention[67] but a series of relationships and interventions[67,68] that take into account factors beyond person-level outcomes, for example, context. In particular, social prescribing aims to tackle health inequities,[69] which may underpin the need for social prescribing in the first place.[9] Health inequities are the "differences in health status or in the distribution of health resources between different population groups, arising from the social conditions in which people are born, grow, live, work and age."[70,p.1]

In its current form, social prescribing is more focused on person-level outcomes (aligned with the critical outcomes identified in this study) and interventions. Several studies have described the challenges of using person-level interventions to address health disparities.[69,71,72] Therefore, as social prescribing evolves, there is a need to regularly reconsider the evolving (and growing) social prescribing movement and, in particular, the practice and the people who use its services. There is also a need to articulate a conceptual understanding of social prescribing, including defining its potential mechanism(s) of action and core functions.

Integrating the principles of the Quintuple Aim[57] and the Ottawa Charter[56] with those of social prescribing should also be considered. The focus of the Quintuple Aim, initially introduced by the Institute for

TABLE 5
Definitions for outcomes rated critical[a] by all user groups in Round 2 of the Delphi survey

Outcome	Operational definition in the survey	Explanation of construct
Emotional functioning/ well-being	Well-being, life satisfaction, loneliness, self-esteem, self-efficacy	"…an umbrella term for psychological concepts such as life satisfaction, life purpose and positive emotions, all of which are shown to be associated with decreased mortality and improved physical and mental functioning."[34,p.136]
Global QoL	QoL	"… individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns."[35,p.551]
Mental health	Anxiety, depression, mood, etc.	"A state of mental well-being that enables people to cope with the stresses of life, to realize their abilities, to learn well and work well, and to contribute to their communities."[36,p.8]
Social functioning	Belonging, friendship, social participation	"Social functioning is defined as how a person operates in their unique social environment (i.e. engagement in activities, connectedness with others and contributions to social roles)."[37,p.1989]
General outcomes	Disease burden, pain, number of chronic conditions	"Disease burden is an important indicator of the state of health of a population. It can be measured as the frequency (e.g. incidence and prevalence) of a condition or its effects including fatal and nonfatal health loss from disease (e.g. disability-adjusted life years) as well as the financial costs (e.g. direct health care costs and indirect health care expenditures related to lost income because of premature death)."[38,p.2031]
Physical functioning	Frailty, physical activity, life activities	"Physical functioning is recognized as the ability of an individual to carry out activities that require physical capability; these may range from basic self-care to more intense activities."[39,p.2757]
Patient/carer satisfaction	Person or family satisfaction with program, perceived benefits, expectations	Identifying a universally accepted definition of patient satisfaction is problematic,[40] as is deciding which elements (e.g. providers, health care system, etc.) to include.[41] Patient satisfaction is thought to be a measure of people's perceptions and expectations of care, processes and environment,[42] and it is distinct from patient experience.[43]

Abbreviation: QoL, quality of life.

[a] Predefined as ≥ 75% of Delphi survey participants rating the outcome as critical (7–9 points on a 9-point scale from 1 for "not important" to 9 for "critical") with < 20% of participants rating the item as not important (1–3 points).

Healthcare Improvement in 2007 as the Triple Aim, was on enhancing patient experiences and outcomes while reducing costs; it was later updated to include clinician well-being and health equity.[73] The Ottawa Charter has five action items for health: public policies, supportive environments, community action, personal skills and health system changes.[74] Together, these guiding frameworks focus on both the person and the wider community or society through understanding and addressing social determinants of health, for example.[56] They aim to support people and address the environments within "which people are born, grow, live, work and age."[70,p.1] Thus, although this present study is a starting place for identifying a core outcome set, larger evaluation frameworks for social prescribing should be considered. Some are in development (for example, Elliott et al.,[75] Calderón-Larrañaga et al.[76]), while others already exist (for example, NHS England's *Social Prescribing and Community-based Support: Summary Guide*[77]).

Strengths and limitations

We identified seven critical outcomes to consider in evaluations of social prescribing research and interventions and to understand, at least in part, what may be important to recipients such as the older adults and caregivers who participated in this study.

However, the systematic review and Delphi processes have inherent limitations. For example, the 21 outcomes rated in this Delphi study were extracted from previous research studies by our 2024 evidence review.[9] This list may reflect the early adoption and implementation of social prescribing interventions. As the social prescribing movement continues to grow, the core functions of social prescribing may evolve and other outcomes may be considered critical should the consensus process be repeated.

In addition, as we did not ask participants to provide detailed sociodemographic data, we do not know how representative our sample was of the overall population of Canadian adults in this age group (≥ 60 years). We also recognize most participants did not have specific experience delivering or receiving social prescribing or a Canadian perspective; together, these factors may limit the generalizability of the work.

Social prescribing is not a single complex intervention,[67] but a collection of multiple complex interventions.[67,68] Consequently, it may be challenging to identify critical outcomes that are relevant to all aspects of social prescribing, that go beyond person-level outcomes, and that include community-level outcomes (e.g. access to resources) and research-related outcomes (e.g. adverse events). Nonetheless, our findings may be beneficial for researchers and practitioners planning social prescribing research trials, which was the primary objective of our study. Consistency in the use of outcome measures may support evaluating the effectiveness of social prescribing interventions, enhance the synthesis of data in future evidence reviews and possibly support the practice of social prescribing.

We also recognize that social prescribing is growing and evolving, and that there may be differences in what matters to people receiving and those delivering social prescribing. This is not a new phenomenon,[13,78] and everyone involved has a duty to continue exploring how to best measure and evaluate what is important to a wider group of interested parties.

Next steps

This and our previous study[9] should be viewed as the start of developing acceptable

and meaningful outcomes and evaluations for and by people affected by and who can affect social prescribing. In order to do this at a systems level, it is important to first develop a list of the core functions in social prescribing, similar to the four core primary care functions (the "4Cs of PC") proposed for public health[79] that address "better quality services, lower costs, less inequality in health care and better population health."[79,p.1] As such, our work should be seen as a "living document" that is regularly updated in different contexts over time. In addition, building on our umbrella review,[9] more work is needed to define specific instruments (e.g. questionnaires, performance-based tests) to assess each outcome.

We will release findings (via emails, presentations, surveys, websites, etc.) to receive feedback and external validation as part of our preplanned knowledge mobilization strategies.[6]

Conclusion

Here we provide an initial list of critical and important outcomes to consider for social prescribing research; participants further provided feedback on environmental and personal (contextual) information, which should be considered within evaluation frameworks (the bigger picture). This first iteration of a core outcome set for social prescribing will require regular updates, as results are likely to vary as a result of numerous factors, including the ongoing evolution of social prescribing.

Acknowledgements

We thank all the study participants for their contributions to this work.

MCA and TP gratefully acknowledge the support of the Canada Research Chairs Program. AMC acknowledges the support of the Canadian Institutes of Health Research through the Patient-Oriented Research Awards – Transition to Leadership Stream, Phase 2 Award (reference number 188352). ST acknowledges the support of the Research Trainee Award from Michael Smith Health Research BC.

Funding

Social Sciences and Humanities Research Council of Canada and the UBC Health Innovation Funding Investment (HIFI) Awards.

Conflicts of interest

None.

Authors' contributions and statement

MCA: Conceptualization, methodology, analysis, supervision, visualization, writing—original draft, writing—review and editing.

AMC, KM: Conceptualization, methodology, analysis, writing—review and editing.

ML, TI, GSN, WBM, TP, RP, KLR, BS, ST: writing—review and editing.

All authors agreed to the published version of the manuscript.

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

Data availability statement

Data cannot be shared publicly because we did not ask permission from participants.

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Original quantitative research

Associations between adherence to public health measures and changes in alcohol consumption among middle-aged and older adults during the COVID-19 pandemic: the Canadian Longitudinal Study on Aging (CLSA)

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This article has been peer reviewed.

Abstract

Introduction: The COVID-19 pandemic and associated public health measures (PHMs) potentially affected alcohol consumption. Our objectives were to evaluate if adherence to PHMs was associated with changes in alcohol consumption and binge drinking during the COVID-19 pandemic.

Methods: A prospective cohort study was conducted with participants (50–96 years) in the Canadian Longitudinal Study on Aging (N = 23 615). Adjusted odds ratios (aORs) were estimated from multinomial logistic regression models for associations between PHM adherence (self-quarantine, attending public gatherings, leaving home, mask wearing and handwashing) and self-reported changes in alcohol consumption during the first year of the pandemic and prospectively measured changes in alcohol consumption frequency and frequency of binge-drinking events from 2015–2018 to 2020.

Results: During the first year of the pandemic, 13% (n = 2733) of participants self-reported increased alcohol consumption, while 13% (n = 2921) self-reported decreased consumption. Prospective measures suggested 19.1% (n = 4421) increased and 34.5% (n = 7971) decreased consumption frequency, while 12.9% (n = 1427) increased and 17.6% (n = 1953) decreased frequency of binge-drinking events. High PHM adherence, compared to low, was associated with higher odds of decreased alcohol consumption frequency (aOR = 1.17; 95% confidence interval [CI]: 1.06–1.30). No associations were observed between PHM adherence and self-reported change in alcohol consumption or frequency of binge-drinking events. Associations were consistent across socioeconomic groups.

Conclusion: PHM adherence was associated with decreased, and not increased, frequency of alcohol consumption by adults aged 50–96 years in the first year of the COVID-19 pandemic.

Keywords: *CLSA, COVID-19, alcohol use change, public health measure, adherence, alcohol consumption*

Highlights

- We examined the association between adherence to the public health measures initiated to limit COVID-19 spread and self-reported and prospective changes in frequency of alcohol consumption and binge drinking by adults aged 50 to 96 years.
- Up to 20% reported increasing their alcohol consumption and frequency of binge drinking or of alcohol consumption.
- Up to 35% reported decreasing frequency of their alcohol consumption.
- Greater adherence to public health measures appeared to be associated with higher odds of decreasing frequency of alcohol consumption.
- Adherence to the public health measures did not result in increased alcohol consumption by middle-aged and older adults.

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Introduction

At the onset of the COVID-19 pandemic, border closures, school closures, business operation restrictions, quarantine and stay-at-home orders, and other public health measures (PHMs) were implemented to limit non-essential social interactions and minimize COVID-19 transmission, deaths and strain on health care systems.[1-3] While PHMs were essential for slowing down SARS-CoV-2 transmission, the restrictions resulted in job losses and reduced incomes, introduced uncertainty and increased stress levels.[1,2]

Despite limited social activities, alcohol consumption and sales increased in Canada after the onset of the pandemic.[4,5] Given that research has identified links between alcohol use and coping strategies,[6] an increase in consumption may have been a reflection of increased stress.[4,7] Research investigating the effects of disasters[8] and quarantine[9] have found strong associations between psychological stress and increased substance use. Job and income loss can also increase stress levels, which can, in turn, lead to increased alcohol consumption and related health concerns.[10] The pandemic may have also disproportionately impacted Canadians aged 65 years and older as they experienced most of the excess deaths and may have been at greater risk for social isolation.[11]

Changes in alcohol consumption during the pandemic were most frequently observed among male participants.[7] Higher rates of increased alcohol consumption were also observed among individuals in higher-income groups, those who were divorced, separated or widowed, those who were unhoused and those aged 60 years and older.[12,13] One report found that 13% of the older adults sampled increased their alcohol consumption during the pandemic, which is a concern due to their heightened sensitivity to alcohol and alcohol-related effects.[14,15]

Given the effects of the pandemic on older Canadians[11] and the adverse health outcomes associated with excess alcohol consumption,[16] examining alcohol intake in this population is crucial to understanding the impact of the pandemic and pandemic responses, including adherence to PHMs, on changes in alcohol intake.

Despite the disproportionate effect of the pandemic on equity-deserving groups in Canada, research examining health equity factors on pandemic-related outcomes such as alcohol consumption has shown inconsistent results.[1]

Most of the Canadian studies that reported increased alcohol consumption during the pandemic were cross-sectional and based on self-reported recall of changes in consumption.[4,7,17] While some studies evaluated determinants of longitudinal changes in self-reported alcohol consumption among middle-aged and older adults during the pandemic,[15] none have assessed associations between PHM adherence and changes in alcohol consumption. Further, as individual responses to pandemic-related stress may influence PHM adherence, adherence may affect alcohol consumption.[18] Because implemented PHMs varied across the provinces, there may also be differences in alcohol consumption changes across Canada.[19]

The objectives of our study were to evaluate the association between longitudinal measures of PHM adherence and self-reported change in alcohol consumption and longitudinal changes (pre-pandemic to early pandemic) in alcohol consumption among adults aged 50 to 96 years, while identifying sociodemographic modifiers of these associations. We hypothesize that increased PHM adherence during the COVID-19 pandemic was associated with increased alcohol consumption as a way to manage the stress associated with increased social isolation and loneliness.

Methods

Study design and setting

We conducted a longitudinal cohort study with middle-aged and older adults (aged 50–96 years) residing in the 10 Canadian provinces. We report our results in keeping with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[20]

Data source

We used data collected via the Canadian Longitudinal Study on Aging (CLSA) in this study. The CLSA enrolled participants (45–85 years at the time of recruitment) from the Canadian provinces.[21] The CLSA includes a Tracking Cohort and a Comprehensive Cohort. Tracking Cohort participants are selected randomly from all 10 provinces and are interviewed via the Internet or over the telephone.[21,22] Comprehensive Cohort participants are selected randomly from within a 20 to 50 km radius of one of 11 data collection sites in seven provinces and are interviewed in person.[21] Similar information is collected from both cohorts, but Comprehensive Cohort participants undergo a thorough physical assessment.[21] All eligible participants are cognitively able to independently complete questionnaires in English or French.[21]

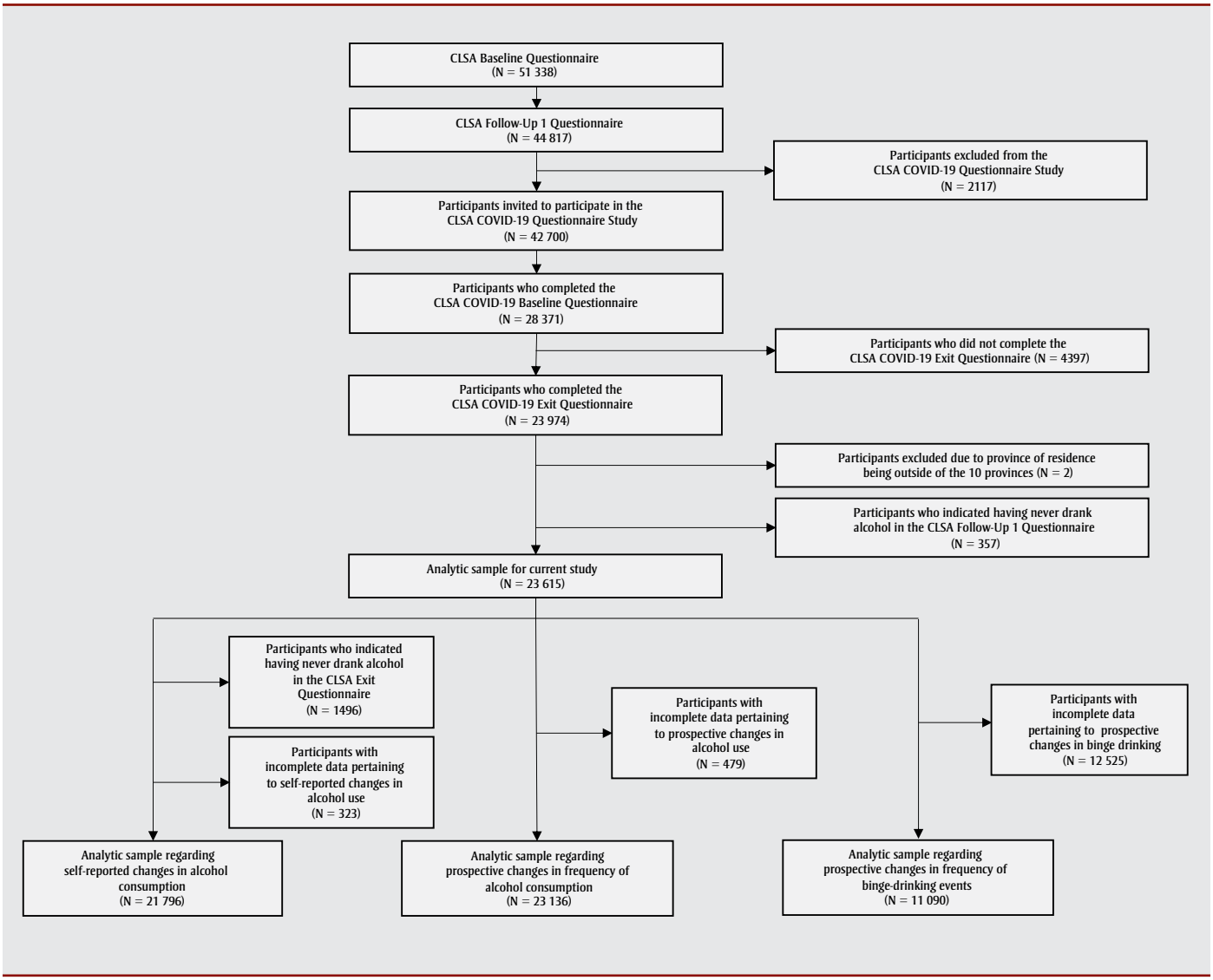
At the time of baseline data collections, people living in the territories, on First Nations reserves or in other First Nations settlements, and in institutions as well as full-time members of the Canadian Armed Forces were excluded, in alignment with the Canadian Community Health Survey's inclusion criteria.[21,23]

Data are collected every 3 years and participants are followed for 20 years (until 2033) or until death or loss to follow-up.[21] Baseline data were collected between 2011 and 2015, and Follow-Up 1 (FUP1) was conducted between 2015 and 2018.[21] Of the 51 338 participants at baseline, 44 817 completed the FUP1 Questionnaire (Figure 1).[21]

The COVID-19 Questionnaire Study assessing the impact of the pandemic was initiated in April 2020.[22] The study included five questionnaires: the COVID-19 Baseline Questionnaire (conducted between 15 April 2020 and 30 May 2020, and completed by 28 559 participants[24]); three questionnaires conducted monthly in July, August and September 2020; and the COVID-19 Exit Questionnaire (conducted between 29 September and 29 December 2020 and completed by 23 974 participants).[25]

To ensure accuracy of the analyses on prospective changes in alcohol consumption frequency, self-reported changes in alcohol consumption and prospective changes in frequency of binge-drinking events from FUP1 to completion of the COVID-19 Exit Questionnaire, 357 individuals who indicated that they had never drank alcohol (assessed at FUP1) were excluded from the study as were two respondents who did not reside in the provinces (Figure 1). The final analytic sample included 23 615 participants aged 50 to 96 years at the time of taking the CLSA COVID-19 Baseline Questionnaire.

FIGURE 1
Numbers of participants completing the CLSA Baseline Questionnaire (2011–2015), the Follow-Up 1 Questionnaire (2015–2018) and the COVID-19 Questionnaire Study (2020), Canada



Abbreviation: CLSA, Canadian Longitudinal Study on Aging.

Ethics approval

Ethics approval for this study was received from the Hamilton Integrated Research Ethics Board (HiREB #14090).

Outcome: Measuring alcohol consumption

We analyzed three outcome measures among respondents who reported ever drinking at FUP1. The first outcome, self-reported changes in alcohol consumption, was measured using the COVID-19 Exit Questionnaire (September to December 2020). Participants who responded "no" to the prompt "Have you ever drank alcohol?" (n = 1496) were excluded from this analysis because they were not asked if their alcohol consumption changed (Figure 1). All participants who responded "yes" were asked, "Since March 1st, 2020, has your alcohol consumption increased, decreased or stayed the same?"

The second outcome, prospective change in the frequency of alcohol consumption, was measured via responses to questions on self-reported alcohol consumption asked pre-pandemic, using the FUP1 Questionnaire (2015–2018), and during the pandemic, using the COVID-19 Exit Questionnaire (September to December 2020). The FUP1 Questionnaire asked about alcohol consumption in the past 12 months, while the COVID-19 Exit Questionnaire asked about alcohol consumption since 1 March 2020. The response options were as follows: "never," "about once a month," "2 to 3 times a month," "once a week," "2 to 3 times a week," "4 to 5 times a week" and "almost every day." COVID-19 Exit Questionnaire respondents who indicated that they never drank alcohol were categorized as having no alcohol consumption since 1 March 2020. Based on changes in responses from the FUP1 to the COVID-19 Exit Questionnaires, participants were classified as having increased, decreased or not changed their alcohol consumption.

The third outcome, prospective change in frequency of binge-drinking events, was measured via responses to questions on self-reported number of binge-drinking

events (four or more drinks at the same sitting or occasion for females and five or more drinks at the same sitting or occasion for males) pre-pandemic using the FUP1 Questionnaire and during the pandemic using the COVID-19 Exit Questionnaire.

The questions about alcohol consumption were adapted from the Ontario Health Study.[26] Agreement between self-reported changes in alcohol consumption and prospective changes in frequency of alcohol consumption was quantified using the kappa statistic.

Exposure: Measurement of PHM adherence score

Data on PHM adherence were collected via the COVID-19 Baseline Questionnaire (April–May 2020) and the three monthly questionnaires. The COVID-19 Baseline Questionnaire and each monthly questionnaire asked participants whether, in the past month, they had been under self-quarantine, attended a large public gathering or left their home for essential reasons (e.g. going to work, buying food, going to a pharmacy or hospital, taking care of dependents) or non-essential reasons (e.g. because they were tired of being inside); on average how many times a day in the past month they had washed their hands; and how often in the past month they had worn a mask when leaving the home (see Supplementary Table 1).[27]

For each PHM, a score between 0 (low adherence) and 1 (high adherence) was assigned. The average individual PHM adherence score at each time point (i.e. at the time of the COVID-19 Baseline Questionnaire and each subsequent monthly questionnaires) for each participant was calculated. An overall PHM adherence score was then calculated for each participant by averaging the scores from each time point. Each PHM was weighted equally across all time points. The overall PHM adherence score was then categorized as low (first quartile of the averaged scores), medium (second and third quartile of the averaged scores) and high (fourth quartile of the averaged scores). This was our primary exposure for regression models. Quartiles were based on the complete COVID-19 baseline sample and applied to the current sample, which excludes nondrinkers and those without COVID-19 Exit Questionnaire data.

Measurement of sociodemographic characteristics

Information on participants' sex, immigrant status, educational attainment and racial background were obtained via the CLSA Baseline Questionnaire; marital status and total household income were obtained via the CLSA FUP1 Questionnaire; and age, region of residence, anxiety symptoms and depression symptoms were obtained via the COVID-19 Baseline Questionnaire. Participants with a score of 10 or more on the 10-item Center for Epidemiologic Studies Depression Scale or the Generalized Anxiety Disorder 7-item screening tool were considered to have symptoms of depression or anxiety, respectively.[28,29]

Models were adjusted for the following potential confounders: sex, age at baseline, racial background, marital status, immigrant status, educational attainment, region of residence and total household income. These confounders were selected a priori, as they have been previously associated with the outcome and exposure but not the causal pathway (Supplementary Figure 1).[1,12,30-38] In addition, sex, age at baseline, marital status, immigrant status and racial background were assessed as equity stratifiers of associations.

Statistical analysis

Analysis was completed using statistical package SAS version 9.4 (SAS Institute Inc., Cary, NC, US). For our first objective, we evaluated the association between PHM adherence score and self-reported change in alcohol consumption, prospective changes in frequency of alcohol consumption and prospective changes in frequency of binge-drinking events. We report the percent change in each category (increased, decreased, no change) for each operationalization of the outcome. We used multinomial logistic regression to estimate associations, addressing potential underestimation of standard errors by applying nonparametric bootstrapping with replacements (n = 1000). Unadjusted and adjusted odds ratios (ORs) with associated 95% confidence intervals (CIs) are reported. Variance inflation factors for adjusted models were estimated using a linear regression model to assess multicollinearity. All these factors were less than 5, suggesting multicollinearity was not severe.[39]

For our second objective, we evaluated statistical interactions between overall PHM adherence score and sex, age, marital status, immigrant status and racial background. Stratified results were presented for characteristics with statistically significant interaction terms based on bootstrapped likelihood ratio test p values ($p < 0.05$) as well as by age and sex. Sampling weights were not available for the COVID-19 Study Questionnaire, so the results are unweighted. Because few data were missing, we conducted a complete case analysis.

Results

Of the 42 700 participants invited to participate in the COVID-19 Questionnaire Study, 23 615 were eligible for analysis (response = 55%; Figure 1). Table 1 shows participant sociodemographic characteristics and level of PMH adherence. Participant mean (standard deviation) age at the COVID-19 Baseline Questionnaire was 69.1 (9.5) years.

Self-reported changes in alcohol consumption and prospective changes in frequency of alcohol consumption and of binge-drinking events

Of the 21 796 participants included in the analysis of self-reported changes in alcohol consumption, 74% (n = 16 142) self-reported no change in consumption, while 13% (n = 2921) self-reported decreased consumption and 13% (n = 2733) self-reported increased consumption (Figure 2). Prospective changes in alcohol consumption frequency showed that 46.4% (n = 10 744) of 23 136 participants had no change in alcohol consumption, while 34.5% (n = 7971) decreased consumption and 19.1% (n = 4421) increased consumption. In addition, 69.5% (n = 7710) of 11 090 participants showed no change in frequency of binge-drinking events, while 17.6% (n = 1953) showed a decrease and 12.9% (n = 1427) an increase (Figure 2).

The agreement between self-reported and prospective changes in frequency of alcohol consumption was low ($\kappa = 0.15$), possibly because different measurement periods were used. Self-reported changes were assessed from the beginning of the pandemic (1 March 2020); prospective changes were assessed from before the pandemic (2015–2018) (Table 2). We also cannot rule out the possibility that self-reported recall of changes in alcohol may be less valid than prospective measurement.

TABLE 1
Sociodemographic characteristics of the total sample completing the CLSA COVID-19 Exit Questionnaire (N = 23 615), Canada

Characteristics	n	%
Sex[a]		
Female	12 514	52.99
Male	11 101	47.01
Missing	0	—
Age, years[b]		
45–54	1075	4.55
55–64	7171	30.37
65–74	8628	36.54
≥ 75	6741	28.55
Missing	0	—
Immigrant status[a]		
Yes	3708	15.70
No	19 907	84.30
Missing	0	—
Total household income, CAD[c]		
< 50 000	5596	25.08
50 000–100 000	8455	37.89
100 000–150 000	4545	20.37
≥ 150 000	3721	16.67
Missing	1298	—
Marital status[c]		
Single/never married	1972	8.36
Married/common law	16 587	70.28
Widowed	2280	9.66
Divorced/separated	2761	11.70
Missing	15	—
Educational attainment[a]		
Secondary school graduation or less	3388	14.37
Some postsecondary education	1692	7.18
Postsecondary degree/diploma	18 493	78.45
Missing	42	—
Racial background[a]		
White	22 967	97.36
Racialized	623	2.64
Missing	25	—
Anxiety status[b,e]		
Positive	1346	5.93
Negative	21 347	94.07
Missing	922	—
Depression status[b,f]		
Positive	4765	20.54
Negative	18 438	79.46
Missing	412	—

Continued on the next page

Associations between PHM adherence and self-reported and prospective changes in frequency of alcohol consumption and binge-drinking events

Similar to the unadjusted models, the adjusted results suggest that medium adherence, compared to low, was not associated with lower odds of self-reported decreased alcohol consumption (aOR = 0.97; 95% CI: 0.88–1.07) or with higher odds of self-reported increased alcohol consumption (aOR = 1.00; 95% CI: 0.92–1.11) compared to no change in alcohol consumption. Nor was medium adherence, compared to low, associated with lower odds of decreased frequency of binge-drinking events (aOR = 0.94; 95% CI: 0.83–1.07) or with higher odds of increased frequency of binge-drinking events (aOR = 1.02; 95% CI: 0.89–1.17) (Table 3). However, medium adherence was associated with higher odds of prospectively measured decrease in alcohol consumption frequency (aOR = 1.10; 95% CI: 1.02–1.18) compared to those who reported no change (Table 3). Likewise, high adherence was associated with higher odds of prospectively measured decrease in alcohol consumption frequency (aOR = 1.17; 95% CI: 1.06–1.30) compared to low adherence (Table 3). Wider CIs in high adherence groups may reflect response variability and small sample sizes for prospectively measured changes in frequency of binge-drinking events.

PHM adherence levels

The proportion of participants with a high PMH adherence was highest at baseline and decreased with time (Supplementary Table 2). Most of the missing observations (6.6% of the included CLSA sample of 23 615) were at the first monthly COVID-19 Questionnaire, in July 2020, and fewest of the missing observations were at baseline (0.9% of the CLSA sample of 23 615). Missing observations at the second and third COVID-19 monthly questionnaires accounted for 5.6% and 6.2% of the included CLSA sample, respectively.

Higher proportions of female participants and of participants aged 75 years and older exhibited higher PHM adherence levels (Supplementary Table 3). Higher proportions of individuals at lower household income status exhibited higher adherence levels, while higher proportions of

TABLE 1 (continued)
Sociodemographic characteristics of the total sample completing the CLSA COVID-19 Exit Questionnaire (N = 23 615), Canada

Characteristics	n	%
PMH adherence level[g]		
Low	6038	25.58
Medium	14 413	61.06
High	3155	13.37
Missing	9	—

Abbreviations: CAD, Canadian dollars; CLSA, Canadian Longitudinal Study on Aging; PHM, public health measure.

[a] Measured via the CLSA Baseline Questionnaire, conducted in 2011–2015.

[b] Measured via the CLSA COVID-19 Baseline Questionnaire, conducted in 15 April 2020–30 May 2020.

[c] Measured via the CLSA Follow-Up 1 Questionnaire, conducted in 2015–2018.

[d] Measured via the CLSA COVID-19 Exit Questionnaire, conducted in September–December 2020.

[e] Participants with a score of ≥ 10 on the Generalized Anxiety Disorder 7-item screening tool[29] were considered to have symptoms of anxiety.

[f] Participants with a score of ≥ 10 on the 10-item Center for Epidemiologic Studies Depression Scale[28] were considered to have symptoms of depression.

[g] Levels of PMH adherence were created based on the first quartile (low), second and third quartiles (medium) and fourth quartile (high) of the mean of the average PMH adherence score at each time point (i.e. at the time of the COVID-19 Baseline Questionnaire, conducted between 15 April 2020 and 30 May 2020, and each of the three subsequent monthly questionnaires, conducted in July, August and September 2020).

those with higher educational attainment had lower adherence levels. (For distributions of sociodemographic characteristics by self-reported and by prospectively measured changes in frequency of alcohol consumption and by prospectively measured changes in frequency of binge-drinking events, see Supplementary Tables 4, 5 and 6, respectively.)

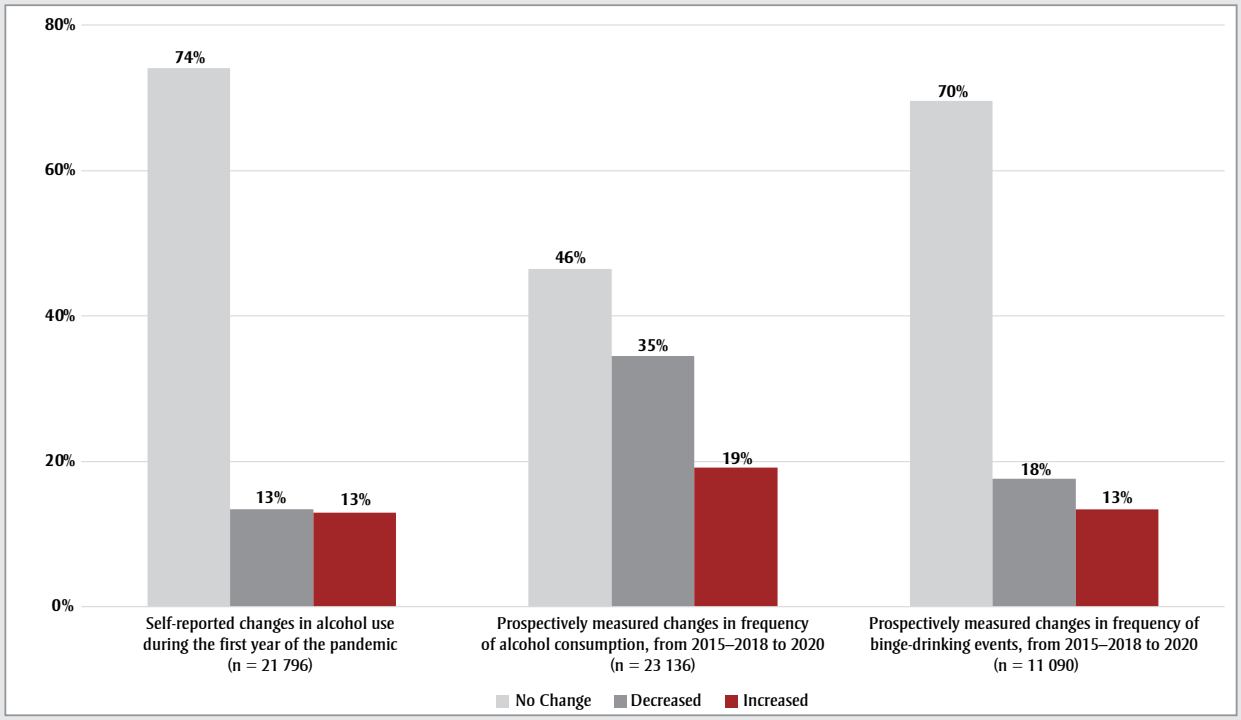
Effect modification

Statistically significant interaction terms were not observed between PHM adherence and age, sex, marital status, immigrant status or household income for outcomes of self-reported change in alcohol consumption (Supplementary Tables 7). Age-stratified results showing the associations between PHM adherence and self-reported changes in alcohol consumption by age group are presented in Table 4. Stratified results suggest associations between high PHM adherence and decreased self-reported change in alcohol consumption were significant and stronger among male participants (Supplementary Table 7). In addition, the association between medium and high, compared to low PHM adherence, and prospective changes in alcohol consumption frequency were significant and stronger for females compared to males (Supplementary Table 9). However, no statistically significant interactions with sex were observed.

Discussion

During the first 9 months of the COVID-19 pandemic, from March to December 2020, 74% of 21 796 CLSA participants self-reported no change in alcohol consumption, while equal proportions (13%) self-reported a decrease and an increase. Similarly, prospective measures found that most

FIGURE 2
Self-reported changes in alcohol consumption and prospective changes in frequency of alcohol consumption and of binge-drinking events during the COVID-19 pandemic, Canada



Note: Data in this figure have been rounded for presentation purposes.

TABLE 2
Cross-tabulation representing the number of participants categorized under self-reported changes in alcohol consumption[a] by prospective measures of change in the frequency of alcohol consumption,[b] Canada

Prospective measure of change in the frequency of alcohol consumption	Self-reported changes in alcohol consumption in 2020, n (%)		
	Decreased (n = 2908)	No change (n = 16 057)	Increased (n = 2731)
Decreased	1708 (59)	5244 (33)	299 (11)
No change	885 (30)	7914 (49)	1250 (46)
Increased	315 (11)	2899 (18)	1182 (43)

Abbreviation: CLSA, Canadian Longitudinal Study on Aging.

Note: $\kappa = 0.15$.

[a] Changes were assessed from the beginning of the pandemic (1 March 2020) to late 2020 (September–December 2020) based on responses to the CLSA COVID-19 Exit Questionnaire.

[b] Changes were assessed based on responses to the CLSA Follow-Up 1 Questionnaire (2015–2018) and the CLSA COVID-19 Exit Questionnaire (September–December 2020).

participants did not change their alcohol consumption or frequency of binge drinking, and only a small proportion increased either their consumption or binge drinking. Our results also show that medium and high adherence to PHM, in comparison to low adherence, was associated with higher odds of decreased prospective changes in alcohol consumption frequency. Modifiers of associations between PHM adherence and changes in alcohol consumption were not observed.

While several sources have suggested that alcohol sales and consumption increased across Canada since the start of the pandemic,[4,5,7,17] our study found that less than 20% of participants increased their consumption, regardless of how changes were measured. This inconsistency may be because we evaluated changes in frequencies of alcohol consumption, rather than changes in quantity of alcohol consumed. Increases in alcohol consumption in Canada have been identified across multiple age groups, including younger adults,[17,40] while our study was conducted with adults aged 50 years and older.

Medium and high PHM adherence were associated with higher odds of prospective decreased frequency of alcohol consumption. However, no associations were observed between medium or high PHM adherence and self-reported decreased alcohol consumption or prospective decreased frequency of binge-drinking events. While not consistent with our initial hypothesis, this is consistent with the findings of several studies that reported associations between higher PHM adherence and fewer occasions of alcohol consumption and heavy drinking.[41-43] Consumption may have also decreased because the imposed PHM restrictions limited access to alcohol, reduced opportunities to socialize and increased health prioritization.[4]

Statistics Canada reported that Canadians aged 65 years and older, who accounted for most of the excess deaths and COVID-19-related deaths between April 2020 and mid-May 2021, were more likely to express health concerns.[11] This supports research suggesting that older people were less likely to adopt negative health behaviours such as alcohol consumption, early in the pandemic.[44]

Trust in public health communications also affected adherence behaviours,[45] but future studies are needed to understand how such communications affected alcohol consumption in Canada. Overall, the impact of the pandemic on alcohol consumption is not straightforward, and while some did not increase their alcohol intake, a more nuanced consideration is necessary.

While we initially hypothesized that associations between PHM adherence and changes in alcohol consumption may differ by sex, such differences were not observed. This is consistent with mixed results in the literature. Some studies suggest that males had higher alcohol consumption since the start of the pandemic while others reported that females were more likely to increase consumption consumption.[7,46,47] Studies also suggest that young and middle-aged adults in the United States increased their alcohol consumption due to boredom and to relieve stress during the pandemic.[40]

While many studies identified differences in changes in alcohol consumption across age groups, they primarily focused on differences between middle-aged and younger people.[40] Our study comprised middle-aged and older Canadians. As such, differences within this age range may not be noticeable. In addition, we may not have observed any differences between racial backgrounds, as the proportion of White respondents was significantly larger than the proportion of racialized respondents. Similarly, the proportion of non-immigrant participants in our study was much larger than that of immigrant participants, potentially explaining why any differences in immigrant status were not observed. Overall, changes in alcohol consumption and the association with PHM adherence seem to be consistent within this study sample, as we found it to be independent of sex, age, marital status, immigrant status and region of residence.

Nevertheless, because older individuals are more sensitive to the effects of increased alcohol consumption, including increased risk of chronic conditions,[16] our results highlight the importance of enhancing substance use services, especially because of the relaxation of alcohol sales and consumption regulations since the onset of the pandemic.[48]

Strengths and limitations

Data beyond December 2020 were not available, so our assessment only applies to the first 10 months of the pandemic. Unweighted analyses were conducted as sampling weights were unavailable. While nonparametric bootstrapping was used to improve robustness of standard error estimates, generalizability of study results to the broader Canadian population is limited.

While agreement between self-reported and prospectively measured changes in alcohol consumption was low, differences

TABLE 3
Associations between PMH adherence and self-reported changes in alcohol consumption[a] and prospective changes in frequency of alcohol consumption and of binge-drinking events,[b] Canada

PMH adherence	Self-reported changes in alcohol consumption[a]						Prospective changes in frequency of alcohol consumption[b]						Prospective changes in frequency of binge-drinking events[b]					
	OR (95% CI) (n = 21 867)			aOR (95% CI)[c] (n = 20 583)			OR (95% CI) (n = 23 127)			aOR (95% CI)[c] (n = 21 809)			OR (95% CI) (n = 11 085)			aOR (95% CI)[c] (n = 10 527)		
	No change	Decrease	Increase	No change	Decrease	Increase	No change	Decrease	Increase	No change	Decrease	Increase	No change	Decrease	Increase	No change	Decrease	Increase
Low	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Medium	Ref.	0.99 (0.90–1.10)	0.89 (0.81–0.97)	Ref.	0.97 (0.88–1.07)	1.00 (0.92–1.11)	Ref.	1.14 (1.06–1.22)	0.92 (0.84–1.00)	Ref.	1.10 (1.02–1.18)	0.96 (0.88–1.04)	Ref.	0.96 (0.86–1.08)	0.96 (0.84–1.09)	Ref.	0.94 (0.83–1.07)	1.02 (0.89–1.17)
High	Ref.	1.09 (0.96–1.25)	0.71 (0.61–0.82)	Ref.	1.10 (0.96–1.26)	0.95 (0.81–1.11)	Ref.	1.26 (1.14–1.39)	0.88 (0.78–0.99)	Ref.	1.17 (1.06–1.30)	0.98 (0.87–1.12)	Ref.	0.88 (0.74–1.05)	0.78 (0.64–0.94)	Ref.	0.89 (0.73–1.07)	0.85 (0.68–1.03)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; CLSA, Canadian Longitudinal Study on Aging; OR, odds ratio; PHM, public health measure; ref., reference.

[a] During the first year of the COVID-19 pandemic. Self-reported changes were assessed from the beginning of the pandemic (1 March 2020) to late 2020 (September–December 2020) using the CLSA COVID-19 Exit Questionnaire.

[b] From 2015–2018 to 2020. Prospective changes were assessed based on responses to the CLSA Follow-Up 1 Questionnaire (2015–2018) and the CLSA COVID-19 Exit Questionnaire (September–December 2020).

[c] Adjusted for sex, age at baseline, household income, marital status, educational attainment, racial background, region of residence and immigrant status.

TABLE 4
Adjusted multinomial logistic regression models for self-reported changes in alcohol consumption, stratified by age group, Canada

PMH adherence	45–54 years (n = 975)			55–64 years (n = 6519)			65–74 years (n = 7632)			≥ 75 years (n = 5457)		
	aOR (95% CI)[a]			aOR (95% CI)[a]			aOR (95% CI)[a]			aOR (95% CI)[a]		
	No change	Decreased	Increased	No change	Decreased	Increased	No change	Decreased	Increased	No change	Decreased	Increased
Low	Ref.			Ref.			Ref.			Ref.		
Medium	Ref.	1.00 (0.65–1.56)	1.18 (0.87–1.7)	Ref.	0.92 (0.79–1.11)	0.91 (0.79–1.06)	Ref.	1.11 (0.94–1.32)	1.03 (0.88–1.21)	Ref.	0.86 (0.71–1.04)	1.12 (0.8–1.59)
High	Ref.	0.40 (0.07–0.95)	0.54 (0.21–1.1)	Ref.	1.35 (1.01–1.73)	1.04 (0.81–1.35)	Ref.	1.14 (0.9–1.46)	0.84 (0.63–1.06)	Ref.	0.97 (0.75–1.26)	1.22 (0.78–1.84)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; CLSA, Canadian Longitudinal Study on Aging; PHM, public health measure; ref., reference.

Note: Interaction term *p* value = 0.85.

[a] Adjusted for sex, total household income, marital status, educational attainment, racial background, region of residence and immigrant status.

in measurement periods limited our ability to validate self-reported recall of changes in consumption. While the risk of underreporting is well-recognized, self-reported alcohol consumption and self-reported changes in consumption are widely used in research[4,7,17,49] while other measures are still being explored. We did not apply correction factors to the self-reported data because there is no consensus on correction methods for adults in Canada aged 55 years and older. Further, since existing literature largely examines self-reported alcohol consumption changes based on recall while assuming it reflects true changes, we were able to examine prospective measures of changes in alcohol consumption frequency using the longitudinal data available. The results of this study suggest that self-reported changes may not reflect true changes in alcohol consumption.

Pre-pandemic frequencies of alcohol consumption and binge drinking were obtained from the CLSA FUP1 Questionnaire, conducted between 2015 and 2018, which may not reflect alcohol consumption behaviours immediately before the pandemic. While changes in frequencies of alcohol consumption were examined, information on quantities of alcohol consumed was not collected. Further, since our analysis included only individuals who reported consuming alcohol before the pandemic, our findings do not apply to the participants who reported never consuming alcohol before the pandemic. As such, findings are not generalizable to individuals who initiated alcohol consumption during the pandemic.

The PHM adherence score developed by De Rubeis et al.[27] facilitated analysis of adherence over the first 10 months of the pandemic. However, responses to the questionnaire prompts would be subject to recall bias and social desirability bias,[50] and scores may not reflect true adherence levels.

While depression and anxiety may affect alcohol consumption, detailed analysis was beyond the scope of this study.

Lastly, the study sample included few racialized participants and excluded people who were institutionalized, living in the territories, on First Nations reserves and other First Nations settlements, or who were not fluent in either English or French, limiting generalizability to broader, linguistically diverse and Indigenous populations who were differentially impacted by the pandemic.[1]

Conclusion

We examined associations between PHM adherence and self-reported changes in alcohol consumption and prospective changes in frequencies of alcohol consumption and binge-drinking events from before the start of the COVID-19 pandemic to the end of the first year of the pandemic in Canada. Our findings suggest that high PHM adherence was associated with higher odds of prospective decrease in frequency of alcohol consumption but not with decreased frequency of binge-drinking events or self-reported decreased alcohol consumption. We found no evidence of associations between PHM adherence and increased alcohol consumption early in the pandemic, potentially reflecting health prioritization, healthier behaviours, barriers to purchasing alcohol and less socializing by older Canadians. Because alcohol consumption is an important public health risk factor, more research is needed to understand the impact of public health crises and related measures on alcohol consumption by middle-aged and older adults in Canada.

Acknowledgements

This research was conducted using the CLSA Baseline Tracking Dataset version 4.0, Baseline Comprehensive Dataset version 7.0, Follow-Up 1 Tracking Dataset version 2.3, Follow-Up 1 Comprehensive Dataset version 3.2, COVID 19 Questionnaire Dataset version 1.0 under Application 2201020. The CLSA is led by Drs. Parminder Raina, Christina Wolfson and Susan Kirkland.

Funding

Funding for this study was obtained from the Public Health Agency of Canada (PHAC) and the Canadian Institutes for Health Research (CIHR) (grant: CIHR PJT-178394). This research was made possible through the Operating Grants Funding Program, Grant 840241 from the Cancer Research Society in partnership with the Canadian Institutes of Health Research – Institute of Cancer Research (CIHR-ICR; Grant CRP-178672) awarded to L. Anderson. Funding for support of the CLSA COVID-19 questionnaire-based study is provided by the Juravinski Research Institute, Faculty of Health Sciences, McMaster University, the Provost Fund from McMaster University, the McMaster Institute for Research on Aging, PHAC/CIHR (grant reference CMO 174125) and the Government of Nova Scotia.

This research was made possible using the data/biospecimens collected by the CLSA. Funding for the CLSA is provided by the Government of Canada through the CIHR under grant reference LSA 94473, the Canada Foundation for Innovation and the provinces of British Columbia, Alberta, Manitoba, Ontario, Quebec, Nova Scotia, and Newfoundland and Labrador.

Conflicts of interest

MdG is a former Associate Editor-in-Chief of the HPCDP Journal, but recused herself from the review process and editorial decision-making for this article.

The authors declare that they have no competing interests.

Authors' contributions and statement

KP: Conceptualization, analysis, writing—original draft, writing—review and editing.

LEG: Writing—review and editing.

AJ: Writing—review and editing.

VDR: Writing—review and editing.

JK: Writing—review and editing.

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The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Canadian Longitudinal Study on Aging or the Government of Canada.

Data availability statement

Data are available from the CLSA (www.clsa-elcv.ca) for researchers who meet the criteria for access to de-identified CLSA data.

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At-a-glance

The association between Google Trends suicide-related Internet searches and self-harm hospitalizations and suicide mortality in Canada

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This article has been peer reviewed.

Abstract

In this ecological study we examined associations between Google Trends (GT) suicide-related Internet searches and intentional self-harm hospitalizations and suicide mortality in Canada from 31 December 2017 to 31 March 2022. Hospitalizations and mortality data were from the Discharge Abstract Database and Vital Statistics - Death database. Cross-correlations identified lead periods, adjusted for in negative binomial regressions. GT of the search term "how to kill yourself" showed weak positive associations with self-harm hospitalizations. GT of the search terms "commit suicide," "how to commit suicide" and "how to kill yourself" showed weak positive associations with suicide mortality. Additional research is needed to determine the usefulness of GT in monitoring self-harm and suicide.

Keywords: *suicide, intentional self-harm, Canada, surveillance, Google Trends*

Highlights

- We explored associations between Google Trends suicide-related searches and intentional self-harm hospitalizations and suicide mortality in Canada.
- Google Trends search terms included "suicide," "commit suicide," "how to commit suicide" and "how to kill yourself."
- The search terms "commit suicide," "how to commit suicide" and "how to kill yourself" were weakly but positively associated with suicide mortality.
- "How to kill yourself" was weakly but positively associated with self-harm hospitalizations.

Introduction

Approximately 4500 suicide deaths occur annually in Canada,[1] and 61 individuals per 100 000 are hospitalized due to self-harm,[2] representing a significant public health issue. Hospital records are typically delayed by 6 to 12 months while mortality records can take up to 2 years because of lengthy coroner investigations.[3-5] Lack of timely data is a barrier to the health surveillance needed to inform rapid resource allocation and public health response.

Google Trends (GT) is a publicly available and deidentified repository of trends and patterns for the search terms used in the Google Search engine (Google, Mountain View, CA, US). These data are available in near real-time (i.e. within the hour), and their use has been proposed as a way to supplement surveillance efforts. Studies published since 2009 have found GT search volumes to be positively associated with infectious disease occurrences like influenza,[6] HIV,[7] Lyme disease,[8] syphilis[9] and measles.[10] The potential of GT has also drawn the attention of mental health researchers; a study conducted in the USA that linked suicide mortality to Internet search terms such as "commit suicide," "how to suicide" and "suicide prevention" suggested that GT could be used to determine heightened suicide risk.[11] Suicide mortality was found to be positively associated with the GT of the search term "suicide" and negatively with the GT of the search term "depression" in England between 2004 and 2013.[12]

Not all research has demonstrated significant findings.[13] A Japanese study concluded that the terms "suicide" and "suicide method" were not associated with suicide mortality.[14] A study conducted in Austria, Germany, Switzerland and the USA reported some temporal associations between GT and suicide rates, but cautioned that the findings were highly variable across and within countries, underscoring the low validity of GT for forecasting national suicide mortality rates.[15]

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The objective of our study was to report the associations between suicide-related Internet searches and intentional self-harm hospitalizations and suicide mortality in Canada from December 2017 to March 2022.

Methods

Google Trends

Suicide-related Internet search volume in Canada was gathered using GT, a publicly available online tool that provides deidentified search volumes for a specific topic, at a specified time and location (i.e. provinces and some larger cities).[16] Instead of showing absolute search numbers, GT calculates a query share for search terms, normalizing the data.[16] In other words, the number of searches for a term is calculated as a proportion of the total number of searches at a specific time and location. The data are then standardized and scaled by assigning values from 0 to 100,[17] with higher values indicating greater popularity. A score of 0 reflects low or no search volume.[16]

We investigated which suicide-related terms or phrases had been used in previous studies. After removing terms with missing GT (index score 0),[18] we decided on four English terms: "suicide," "commit suicide," "how to commit suicide" and "how to kill yourself." Data for these terms from 31 December 2017 to 31 March 2022 were extracted from GT using the *gtrendsR* package.[19] This period was selected to match available suicide-related outcome data.

Intentional self-harm hospitalizations

We used the Canadian Institute for Health Information's Discharge Abstract Database (DAD) to obtain daily intentional self-harm hospitalizations among individuals aged 10 years or older from all the provinces and territories except Quebec. The DAD records administrative, clinical and demographic hospital release details and classifies diagnostic outcomes, symptoms and procedures during hospitalization[20] using *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada* (ICD-10-CA) codes. Intentional self-harm events from 31 December 2017 to 31 March 2022 were identified using codes X60–X84 and Y87.0.[21] These data were aggregated to generate weekly counts.

Suicide mortality

We obtained suicide mortality data for individuals aged 10 years and older from the provisional monthly updated Canadian Vital Statistics - Death database (CVSD), which collects demographic and medical cause of death data from every provincial and territorial vital statistics registry (except Yukon).[22] Weekly suicide counts from 31 December 2017 to 31 March 2022, rounded to base 5 to avoid identifying individuals, were extracted using ICD-10 codes X60–X84 and Y87.0.

Statistical analysis

For each query, GT generates a new random sample at unspecified time intervals; we therefore used a bootstrap method to account for the variability in GT query results. We extracted 100 distinct draws by adding random alphanumeric strings to each term (e.g. "suicide 2vpq8aw50e") to get new results without altering search data.[12] Using 100 draws per term, we calculated average weekly GT, which allowed us to produce more reliable weekly time series, thereby minimizing the impact of GT's sampling variability.

Cross-correlation analyses identified significant time-leads that indicate that shifts in GT precede shifts in suicide-related events. We interpreted the Pearson correlation coefficients as weak ($r \leq 0.3$), moderate ($r = 0.4 - 0.6$) and strong ($r \geq 0.7$) effect sizes.[23]

Time-leads with the strongest association were incorporated into negative binomial regressions, estimating incidence rate ratios (IRRs). The dependent variables were suicide-related hospitalizations and mortality counts, while the independent variable was GT search volume of each suicide-related term. This quantified the change in the rate of suicide-related events associated with a unit increase in GT search volume. An IRR greater than 1.00 indicates an increased suicide-related events rate, an IRR of less than 1.00 suggests a decrease, while an IRR of 1.00 implies no effect. Statistical significance was determined ($\alpha = 0.05$).

Analyses were conducted in R version 4.2.2 (R Foundation for Statistical Computing, Vienna, AT) and SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary, NC, US).

Results

Intentional self-harm hospitalizations

Between 31 December 2017 and 31 March 2022, there were 57 336 intentional self-harm hospitalizations across Canada (except Quebec). Of these patients, 28.9% were 10 to 19 years old, 30.1% were 20 to 34 years old, 33.6% were 35 to 64 years old and 7.4% were 65 years or older. Approximately 64.8% of those hospitalized for intentional self-harm were female.

Increases in the GT of "how to kill yourself" was weakly and positively correlated with intentional self-harm hospitalizations ($r = 0.20$). The search terms "suicide," "commit suicide" and "how to commit suicide" were not significantly correlated with the outcomes (Table 1).

The negative binomial regression revealed that each one-unit increase in GT of "how to kill yourself" was significantly associated with a 0.16% increase in the self-harm hospitalization rate (IRR = 1.0016; 95% CI: 1.0006–1.0027) (Table 2).

Suicide mortality

There were 17 670 suicide deaths between 31 December 2017 and 31 March 2022. GT search volumes of "commit suicide" at a 3-month lead period ($r = 0.23$), "how to commit suicide" at a 1-month lead period ($r = 0.21$) and "how to kill yourself" at a 2-month lead period ($r = 0.18$) were weakly and positively correlated with suicide mortality (Table 1). All GT suicide-related searches, with the exception of "suicide," demonstrated positive associations with suicide mortality (Table 2). A one-unit increase in the GT search volume of "commit suicide" was significantly associated with a 0.48% increase in the suicide mortality rate (IRR = 1.0048; 95% CI: 1.0020–1.0075). We also found significant associations for "how to commit suicide" and "how to kill yourself."

Discussion

Our study results indicate that the GT of the search term "how to kill yourself" was positively but weakly associated with same-month intentional self-harm hospitalizations. We also found that GT of the search terms "how to kill yourself," "commit suicide" and "how to commit suicide" showed weak positive associations with suicide mortality at time-leads of 2, 3 and

TABLE 1
Cross-correlation model results of the associations[a] between GT[b] suicide-related search term volumes and intentional self-harm hospitalizations and suicide mortality data, Canada, December 2017–March 2022

	Search term	Time-lead in months			
		−3	−2	−1	0
Hospitalizations[c]	Suicide	0.10	0.10	−0.01	0.10[e]
	Commit suicide	−0.10	0.07	0.06	0.12[e]
	How to commit suicide	0.00	0.08[e]	0.04	0.05
	How to kill yourself	−0.02	−0.03	−0.08	0.20[e*]
Deaths[d]	Suicide	−0.01	0.08	0.05	0.10[e]
	Commit suicide	0.23[e*]	0.20[*]	0.19[*]	0.19[*]
	How to commit suicide	0.12	0.19[*]	0.21[e*]	0.19[*]
	How to kill yourself	0.13	0.18[e*]	0.05	0.08

Abbreviation: GT, Google Trends.

[a] Shown as Pearson correlation coefficients, *r*.

[b] The search volume of GT data as a proportion of the total number of searches at a specific time and location standardized and scaled from 0 to 100.

[c] Self-harm hospitalization data do not include Quebec data.

[d] Death data do not include Yukon data.

[e] These indicate the maximum lead pattern of the cross-correlation coefficient for that search term, where lead pattern is the time at which GT changes before suicide-related events.

[*] Statistically significant at $\alpha = 0.05$.

1 months, respectively, suggesting that increases in these GT are associated with increases in suicide mortality 1 to 3 months later. Studies in Japan, Taiwan and the USA found positive associations between suicide mortality and the search terms "suicide," "commit suicide," "how to suicide," "suicide prevention" and "depression."[11,14,24] Our correlation coefficients were lower than those in previous studies,[11,13,14] suggesting weaker relationships.

Although weak, the consistent strength and the direction of associations highlight nuanced relationships between GT and suicide-related outcomes. Like previous studies,[14] our research revealed that not all search terms demonstrate equal utility, regardless of the outcome in terms of suicide-related mortality or hospitalizations. Search terms may reflect differences in intent; broad terms such as "suicide" may encompass searches related to prevention or information, whereas explicit phrases such as "how to kill yourself" likely indicate stronger intent towards self-harm or suicidal behaviour.

We found significant lead patterns, where increasing search volumes preceded increases in suicide-related events. Such consistent temporal associations, and the availability of past-hour GT data, may demonstrate GT's potential as an indicator of suicide-related outcomes.[11,24] Several international studies have suggested that observing changes in GT could help mobilize suicide prevention and mental health services.[3,11,12] When paired with responsive policies—public service announcements about suicide prevention resources[11] or the deployment of rapid response teams, for example—GT data could carry policy implications by helping to prevent suicides.

However, with the weak associations observed and the lack of Canadian research, further work is needed to assess the relevance of GT for informing suicide prevention efforts in Canada,[3,11] especially at a more local level.

Limitations

Study limitations include the lack of transparency by Google on how GT are

TABLE 2
Negative binomial model results of the associations between GT[a] suicide-related search term volumes and intentional self-harm hospitalizations and suicide mortality data, Canada, December 2017–March 2022

Hospitalizations[b]			Deaths[c]		
Search term (time-lead in months)	IRR	95% CI	Search term (time-lead in months)	IRR	95% CI
Suicide (0)	1.0011	0.9996–1.0026	Suicide (0)	1.0020	0.9994–1.0046
Commit suicide (0)	1.0014	0.9999–1.0030	Commit suicide (3)	1.0048[*]	1.0020–1.0075
How to commit suicide (2)	1.0006	0.9996–1.0017	How to commit suicide (1)	1.0029[*]	1.0011–1.0047
How to kill yourself (0)	1.0016[*]	1.0006–1.0027	How to kill yourself (2)	1.0025[*]	1.0007–1.0044

Abbreviations: CI, confidence interval; GT, Google Trends; IRR, incidence rate ratio.

[a] The search volume of GT data as a proportion of the total number of searches at a specific time and location standardized and scaled from 0 to 100.

[b] Self-harm hospitalization data do not include Quebec data.

[c] Death data do not include Yukon data.

[*] Statistically significant at $\alpha = 0.05$.

computed (i.e. indexed and normalized). In addition, the age and sex distributions of Google Search users were unavailable, preventing stratified analyses. This absence of sex- or gender-specific data in GT may limit the applicability of our findings, given that in Canada men are at higher risk of dying by suicide while women are more likely to engage in self-harm.[1] Estimates of mortality data may change as coroner investigations are finalized.

We may also have failed to capture nuanced information from Quebec by excluding French terms, limiting generalizability. We also did not have access to Quebec's hospitalization and Yukon's mortality data, which may have lowered national estimates for the outcomes and potentially attenuated associations.

Finally, GT records of suicide-related searches may not have reflected the search behaviours of those with suicidal thoughts. Instead, unconnected occurrences, for example, suicides of celebrities or releases of movies such as "Suicide Squad," may have boosted Internet searches, reducing associations.

Future studies could examine GT in Canadian provinces and larger cities, particularly in Quebec. Future research could also examine GT with suicide clusters and lag times (i.e. where increases in GT follow increases in suicide-related events).

Conclusion

We investigated associations between four suicide-related Internet search terms and intentional self-harm hospitalizations as well as suicide mortality in Canada. We found weak, but statistically significant associations between the GT of the search term "how to kill yourself" and hospitalizations. Associations between GT and mortality were also weak but slightly stronger and more consistent across terms than the hospitalization findings. These findings provide preliminary support for the utility of GT in suicide surveillance and research.

Funding

None.

Conflicts of interest

Justin J. Lang is an Associate Editor-in-Chief and an Associate Scientific Editor of the HPCDP Journal, but recused himself from the review process for this article. The authors have no conflicts of interest to declare.

Authors' contributions and statement

PK: Conceptualization, methodology, data curation, formal analysis, investigation, project administration, validation, writing—original draft, writing—review and editing.

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All authors have read and agreed to the published version of the manuscript.

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

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At-a-glance

Profiling cases of button battery ingestion using Canadian and British Columbia poison centre data

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This article has been peer reviewed.

Abstract

Ingestion of button batteries poses an acute life-threatening injury risk, particularly for small children. The Canadian Surveillance System for Poison Information reported 1021 single-substance button-battery ingestion cases from 2020 to 2023, and the British Columbia Drug and Poison Information Centre (DPIC) managed 548 unintentional ingestion cases from 2013 to 2023. Nearly all the DPIC cases required hospital admission for X-ray imaging, and seven patients required surgical removal of the battery from the esophagus. Our findings support developing product warning labels and enforcing child-resistant battery packaging and compartments on consumer products.

Keywords: *chemical burns, accident prevention, surveillance, poison control centers*

Highlights

- 62% of Canadian Surveillance System for Poison Information (CSSPI) cases and 69% of British Columbia Drug and Poison Information Centre (DPIC) cases of ingested button batteries occurred among children younger than 6 years.
- 13% of CSSPI cases and 15% of DPIC cases were among adults older than 59 years. In nearly all these DPIC cases, hearing aid batteries were ingested.
- 91% of DPIC cases were referred to hospital or were already there at the time of the call to DPIC.
- The battery had to be surgically removed from the esophagus of 7 individuals.

Introduction

Button batteries, also known as coin or disk batteries, are single-cell batteries commonly found in small electronic products. They are shaped like a flat cylinder and are typically 5 to 25 mm in diameter and 1 to 6 mm in height. Given their small size, these batteries can be easily ingested, including by infants and small children. The battery can pass uneventfully through the digestive tract, but there is a risk that it lodges in the esophagus, which can cause a pressure wound or alkaline chemical burn. Severe injury can start within 2 hours of ingestion and can include esophageal perforations, fistulas and related complications.[1,2] In short, ingesting button batteries poses an acute life-threatening injury risk and requires emergency imaging and endoscopic removal if the battery is lodged.

Surveillance of button battery–related injuries in Canada is limited. The United States *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) has a code for these events (W44A.A1), but the Canadian modification, ICD-10-CA, has no similar code.[3] The Consumer Product Safety Program collates health and safety incidents that companies are mandated to report and incidents that consumers and other involved parties elect to report. The Program reported that two children, one in 2021 and the other in 2022, died after ingesting a button battery.[4] From 2006 to 2020, the Canadian Hospitals Injury Reporting and Prevention Program reported an increase in the number of button battery–related visits to emergency departments at their sentinel hospital sites.[5,6] A 2022 Canadian Paediatric Surveillance Program (CPSP) survey of 1067 pediatric physicians found that they cumulatively managed 815 button battery ingestions in the previous 12 months, with 77 patients requiring endoscopic removal of the batteries.[7]

Poison centres are a valuable data source for battery-related injuries but, to our understanding, these cases have not been reported. In this article, we describe cases of button battery ingestions managed by the British Columbia Drug and Poison Information Centre (DPIC) or reported by the Canadian Surveillance System for Poison Information (CSSPI).

Methods

Poison centres are 24-7 telephone services that provide toxicological and clinical guidance to health care professionals and

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the public. Clinicians at poison centres follow cases as necessary to acute resolution, compile relevant clinical information and document the event in free-text chart notes and data fields standardized by America's Poison Centers (APC). CSSPI collates data from the five poison centres that serve all of Canada, including those from DPIC, whose jurisdiction covers British Columbia and Yukon.[8]

In this study, we examined ingestion cases with a button battery–related APC substance code. There are eight in total, each related to a different formulation (e.g. lithium) and identified by a 265 prefix. DPIC cases were available from 2013 to 2023. CSSPI cases were limited to single-substance cases and available from 2020 to 2023.

Given our access to DPIC chart notes through Environmental Health Services at the BC Centre for Disease Control, we could include DPIC cases without a button battery APC code but with a related free-text description. We reviewed the chart notes of all DPIC cases to confirm inclusion and also extracted information on the exposure and treatment course and the battery size, type and source. We conducted a descriptive analysis of the standardized data fields and the information extracted from the chart notes. We used population estimates to compute annual per capita case rates, 2021 census population values to compute person-year rates and all DPIC or CSSPI exposure case counts to compute crude rates of all exposure cases.[9,10]

We completed all analyses in R version 4.3.2 (R Foundation for Statistical Computing, Vienna, AT).[11]

This project is exempt from research ethics board review because the BC Centre for Disease Control, where DPIC is housed, is mandated to conduct surveillance analyses and report deidentified data by the British Columbia *Public Health Act*.[12]

Results

From 2013 to 2023, DPIC managed 571 cases of button battery ingestion. Of these, 566 (99%) involved ingestion of only a battery (i.e. a single-substance case) and five pediatric cases involved simultaneous ingestion of medications (n = 2), magnets (n = 2) and a household cleaning product (n = 1). From 2020 to 2023, CSSPI reported 1021 single-substance button battery ingestion cases.

About two-thirds of cases—394 (69%) of DPIC cases and 634 (62%) of CSSPI cases—were among children younger than 6 years (Table 1). Of the DPIC cases, 311 were infants and toddlers younger than 3 years. Among cases in individuals older than 5 years, the highest per capita case rate was among adults older than 59 years. There were more males than females overall. Among DPIC cases, this sex difference is seen in children and youth aged younger than 20 years.

Nearly all DPIC cases were unintentional (n = 548; 96%). There were 21 intentional ingestion cases and two with unknown intentionality. Most calls to DPIC (n = 432; 76%) were from family members or friends of the person who ingested the battery (referred to as "the patient"), 78 (14%) were from health care professionals and 44 (8%) were from the patients themselves; in 28 cases (5%), the callers were unknown (data not shown).

Other than a decrease in 2018, the annual trend of DPIC cases was stable from 2013

TABLE 1
Age- and sex-stratified counts and rates of cases of button battery ingestion[a]

Age, years	Total case count, n	Total case rate		Case count by sex, n		Case rate by sex per 100 000 person-years	
		Per 10 000 all exposure cases	Per 100 000 person-years	Females	Males	Females	Males
DPIC cases[b]							
All ages	571	18.49	1.03	271	296	0.96	1.09
< 6 years	394	33.76	13.4	181	211	12.63	14.00
6–19 years	52	13.13	0.66	18	33	0.48	0.81
20–59 years	14	1.89	0.05	9	5	0.06	0.03
> 59 years	88	33.55	0.58	47	41	0.58	0.57
Unknown	23	4.41	n/a	16	6	n/a	n/a
CSSPI cases[c]							
All ages	1021	13.52	0.69	481	536	0.64	0.74
< 6 years	634	26.09	7.10	n/a	n/a	n/a	n/a
6–19 years	152	12.69	0.66	n/a	n/a	n/a	n/a
20–59 years	73	2.83	0.09	n/a	n/a	n/a	n/a
> 59 years	135	16.61	0.35	n/a	n/a	n/a	n/a
Unknown	27	5.06	n/a	n/a	n/a	n/a	n/a

Abbreviations: CSSPI, Canadian Surveillance System for Poison Information; DPIC, British Columbia Drug and Poison Information Centre; n/a, not available.

[a] Four DPIC and four CSSPI cases with unknown sex are not included in sex-stratified counts and rates.

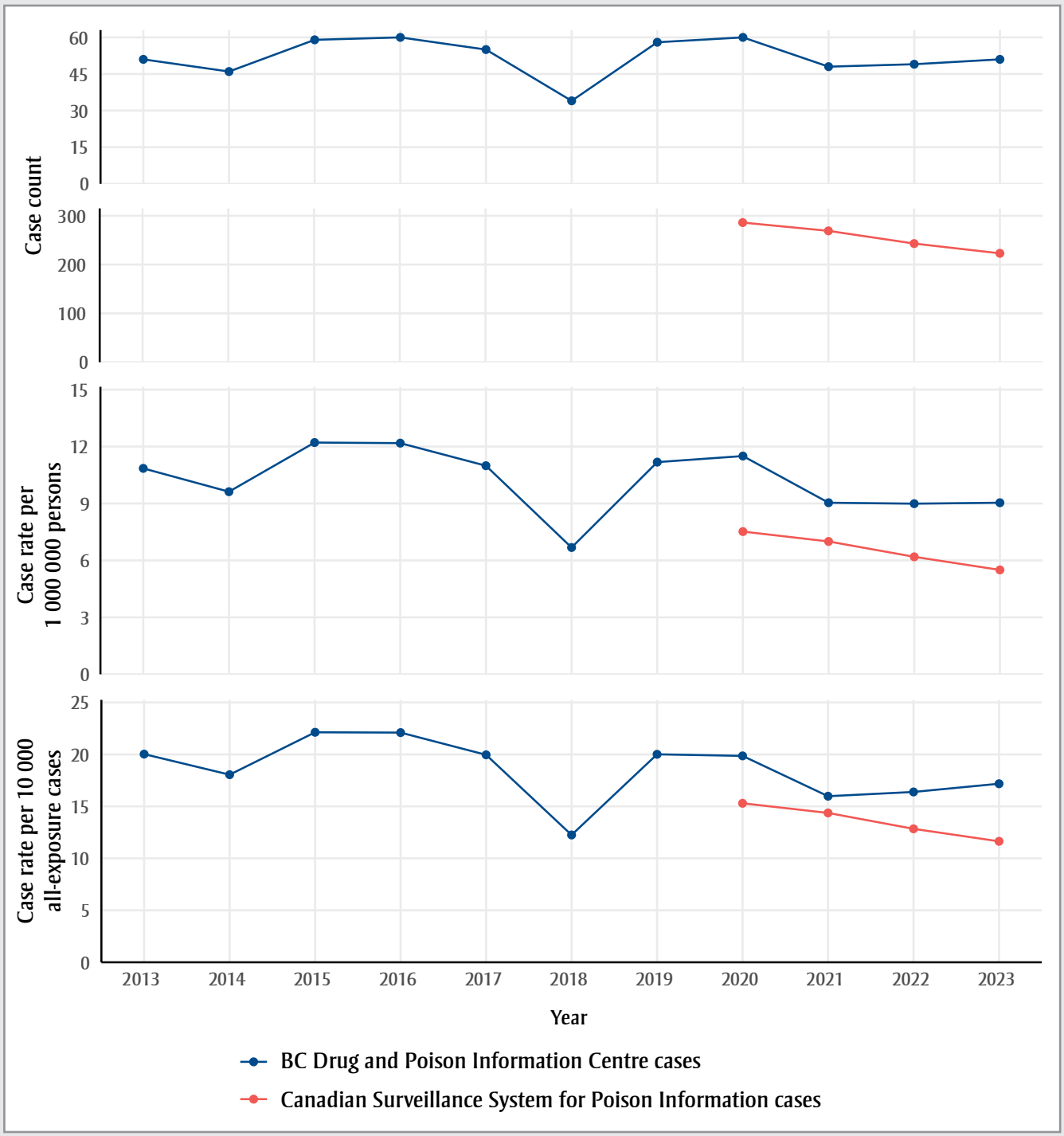
[b] Managed at the DPIC from 2013 to 2023.

[c] Reported to CSSPI from 2020 to 2023. CSSPI age- and sex-stratified counts are unknown.

to 2020 (Figure 1). The counts and rates decreased slightly in 2021 and remained stable through 2023. There was a consistent annual decrease in counts and rates of cases reported to CSSPI.

We found no information on the battery source (n = 281; 49%), type (n = 464; 81%) or size (n = 504; 88%) in most cases. When such information was available, we found that most of the batteries were from hearing aids (n = 131), toys (n = 52), watches (n = 47), flashlights (n = 23) and miscellaneous household items (n = 37). In 79 of 88 cases of adults older than 59 years, the battery was from

FIGURE 1
Annual counts and rates of cases of button battery ingestion[a]



[a] Cases managed at the British Columbia Drug and Poison Information Centre (DPIC) from 2013 to 2023 and single-substance button-battery ingestion cases collated by the Canadian Surveillance System for Poison Information (CSSPI) from 2020 to 2023.

a hearing aid. The patient mistook the battery for a pill in 31 cases. A medical condition such as dementia was implicated in 13 cases.

A total of 176 CSSPI cases (17%) and 49 DPIC cases (9%) were not referred to hospital. In 42 of the DPIC cases, the battery was excreted via stool, spat out or found (confirming noningestion) at the time of call. In seven cases of adults older than 59 years who had ingested smaller batteries, the individual was advised to monitor their stool and symptoms at home.

At the time of the call, 810 CSSPI cases (79%) were referred to hospital, were already there or were on their way. The patient flow was unknown in 35 CSSPI cases (3%). In total, 495 DPIC cases (87%) were referred to hospital and 27 patients had already been seen in hospital when DPIC was called. The specific outcome was unknown in 363 cases.

X-ray imaging showed the battery to be past the esophagus in 65 cases; it was not found by X-ray in 78 cases and passed via stool, vomited or found (confirming noningestion) in nine cases. The battery needed to be surgically removed from the esophagus in seven cases. In two cases of the battery being excreted or vomited, the patient was left with an ulceration or notable abrasion of their esophagus.

Discussion

This analysis of calls to poison centres contributes to the limited understanding of button battery–related injuries in Canada. Compiling data from the five Canadian poison centres, CSSPI reported 0.69 single-substance button-battery ingestion cases per 100 000 person-years from 2020 to 2023. DPIC, the poison centre that serves British Columbia and Yukon, had a higher rate of cases, 1.03 per 100 000 person-years from 2013 to 2023. This difference should be corroborated with other data sources. Although surgical removal of the battery was not common (n = 7), nearly all imposed a health system burden. DPIC did not follow 363 cases after referral to hospital or 65 cases after the battery was found in the esophagus. As such, it is likely that serious outcomes were undercounted.

There are limitations with these data. Poison centres do not manage all battery-related injuries and the reported statistics do not represent true population incidence. For example, physicians surveyed by the CPSP in 2022 reported 815 button battery ingestions in just one year,[7] whereas CSSPI reported between 223 and 286 cases each year from 2020 to 2023.

Poison centres provide acute clinical guidance and do not capture long-term complications, even after surgical removal of batteries.[13] Battery type and size are largely unknown, which precludes analyses with these product factors. The device source was also unknown in approximately half the cases. When this was known, nearly all cases in adults older than 59 years involved hearing aid batteries. This suggests an opportunity for targeted education.

Conclusion

The *Canada Consumer Product Safety Act* regulates consumer products in a post-market regulatory regimen.[14] At the time of writing, products containing button batteries have been identified as a "hazard of concern" under this statute, meaning that Health Canada is considering further risk management actions. Our findings support following the regulatory path in Australia, many European nations and the United States in enforcing child-resistant packaging of button batteries, child-resistant compartments on consumer products that use button batteries and product warning labels and establishing recall provisions.[15-17] Given that industry must follow other countries' regulations in a global marketplace, it is reasonable to implement and enforce the same consumer product regulations in Canada.

We also recommend that the ICD-10-CA adopt and promote the use of the button battery ingestion/insertion code to support surveillance efforts with hospitalization and mortality records.

Acknowledgements

The authors would like to thank the clinical staff at the British Columbia DPIC and all other Canadian poison centres for considering the surveillance and analytic outputs of their work beyond their clinical service; the members of the provincial and national working group for guiding this work; and CSSPI, led by Health Canada, and Canadian poison centres, for collating and providing pan-Canadian poison centre data.

Funding

None.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

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

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