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Original quantitative research

Cardiovascular diseases in Quebec health administrative databases: missing diagnoses and underestimation of the number of cases in a 28-year prospective cohort

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Abstract

Introduction: Cardiovascular disease (CVD) surveillance in Quebec and the rest of Canada is carried out using health administrative databases, which in Quebec includes the physician claims database. The presence of billing claims without diagnoses can lead to the number of CVD cases being underestimated. The purpose of this study is to estimate the proportion of CVD diagnoses and CVD cases that may be missing from these databases.

Methods: The study was conducted using a prospective cohort of 8781 participants living in the Québec City area. Access to health administrative databases was granted for the entire 28-year follow-up period. First, we performed frequency analyses to estimate the proportion of missing CVD diagnoses. Then we used validated algorithms to identify CVD cases and estimate the proportion of CVD cases that were potentially not captured over the 28-year period.

Results: About one-fifth (22.1%) of the diagnoses in the physician claims database were missing. The proportion of missing CVD cases was estimated at 12.7% for 1991–2018, although this varied with the period covered (1991–1996: 15.5%; 1997–2013: 10.7%; and 2014–2018: 16.3%).

Conclusion: Approximately 1 in 10 CVD cases are not identified due to a missing diagnosis. This underestimation of CVD cases is a potential limitation that should be considered when using Quebec health administrative databases to identify CVD cases for surveillance work and epidemiological studies.

***Keywords:** cardiovascular disease, surveillance, epidemiology, cohort study, missing diagnoses, coronary heart disease, stroke, Canada*

Highlights

- Health administrative databases are an important source of data on cardiovascular diseases (CVDs) in Quebec and elsewhere in Canada.
- We estimated the number of CVD cases that are potentially missed as a result of diagnoses not captured in Quebec health administrative databases.
- Using the health administrative data of 8781 participants who were followed for 28 years, we estimated that 12.7% of CVD cases may be overlooked because of missing diagnoses.
- Underestimating CVD cases is a limitation that should be considered in surveillance work and epidemiological studies that use health administrative databases.

Introduction

Cardiovascular diseases (CVDs) are the leading cause of death worldwide and the second most common cause of death in Canada, after cancer.[1,2] Approximately 2.4 million Canadians live with heart disease, which is the leading cause of years of life lost.[3] The economic burden of CVDs is significant because of the associated direct and indirect costs.[4]

Valid estimates of the prevalence and incidence of CVDs are required for monitoring and research purposes. Such estimates are also necessary for supporting the development and evaluation of the effectiveness of preventive strategies aimed at reducing the burden of CVDs in the population.[5,6] In a universal health care system like the one in Canada, health administrative databases are a valuable source of data on

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health conditions because they are accessible and inexpensive and provide near-universal coverage of the population over extensive periods of time.

The Quebec Integrated Chronic Disease Surveillance System (QICDSS) conducts CVD surveillance in Quebec. The prevalence and incidence of CVDs are identified using health administrative databases, including the hospitalization database (MED-ÉCHO), the physician claims database and the vital statistics death database.[7] In order to derive a valid estimate of the prevalence and incidence of CVDs, it is vital that these health administrative databases contain high quality data. The completeness of diagnoses is an essential element of the quality of such data;[8] a high proportion of missing data can undermine both the validity and accuracy of resulting estimates.

In Quebec, the completeness of diagnoses varies with the health administrative database.[8] The completeness of diagnoses was 100% in hospital records and between 88% and 93%, depending on the type of services, in physician claims databases.[8] Wilchesky et al.[9] found that approximately 30% of physician billing claims had missing or invalid diagnoses in the physician claims database. Although these studies suggest that a large proportion of diagnoses are missing in the physician claims database, no studies have documented the proportion of diagnoses missing for CVD nor the potential underestimation of CVD cases resulting from missing diagnoses.

The objective of this study was to estimate the proportion of missing diagnoses for CVD in the Quebec health administrative databases as well as the resulting impact on the number of identified CVD cases in a prospective cohort of 8781 women and men followed for 28 years. Specifically, we estimated the proportion of missing diagnoses that are potential diagnoses of CVD and the impact of these missing diagnoses on the estimate of the number of CVD cases.

Methods

Ethics approval

This study was approved by the ethics committee of the Centre de recherche du CHU de Québec—Université Laval (reference number 12-1674).

Description of cohort

The PROspective Québec (PROQ) Study on Work and Health is a prospective cohort that initially comprised 9188 white-collar workers (49.9% female and 50.1% male) from 19 public and quasi-public organizations in the Québec City area.[10] Average age was 40.2 years. Cohort participants were employed in management (10.4%), professional/teaching (34.0%) and technical/other (55.6%) positions. Education levels varied: 42.1% of participants had a university degree, 28.1% had a college diploma and 29.8% had neither. Annual family income at recruitment ranged from less than $30 000 (14.9%) to $70 000 or more (28.0%).

Population

At recruitment, the participation rate was 75%. Of the initial cohort (n = 9188), 380 refused access to their health administrative data, 14 gave their consent but could not be matched to the Régie de l'assurance maladie du Québec (RAMQ; the health insurance board of the province of Quebec) and 13 had missing nominative data, preventing matching to RAMQ; the 8781 participants thus represented 96% of the initial cohort. Access to health administrative data was secured for the 28 years of follow-up, until 31 December 2018.

All participants gave their informed written consent.

Extraction from health administrative databases

Diagnostic codes from the *International Classification of Diseases, Ninth Revision* (ICD-9) and *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD-10) and intervention codes from the *Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures* (CCP) and the *Canadian Classification of Health Interventions* (CCI) were extracted from the Quebec physician claims database and the Quebec hospitalization database (MED-ÉCHO) for the 1991–2018 period. The dates, medical procedure codes, service locations and types of services associated with these codes were also extracted from these databases.

Definition of CVD cases

CVDs considered in this study were coronary heart disease and stroke.[11,12] Participants with myocardial infarction, angina pectoris, and acute and chronic coronary syndromes or who had undergone percutaneous coronary intervention, coronary bypass or angioplasty were identified using the following codes: ICD-9 410–414; ICD-10 I20–I25; CCP 48.02, 48.03, 48.09 and 48.1; and CCI 1.IJ.50, 1.IJ.57.GQ and 1.IJ.76.[13] Strokes, including transient ischemic attacks, were identified with ICD-9 codes 362.3, 430–432 and 434–436 and with ICD-10 codes I60, I61, I63.X (except I63.6), I64, H34.0, H34.2 and G45.X (except G45.4).[14]

Participants were classified as CVD cases if health administrative records indicated a hospitalization with a diagnosis or procedural code for coronary heart disease or stroke; two medical claims with a diagnosis of coronary heart disease or stroke in the physician claims database within a one-year period; or coronary heart disease or stroke as the primary cause of death in the death records.

The event occurrence date was defined as the first date when one of these three criteria was met.

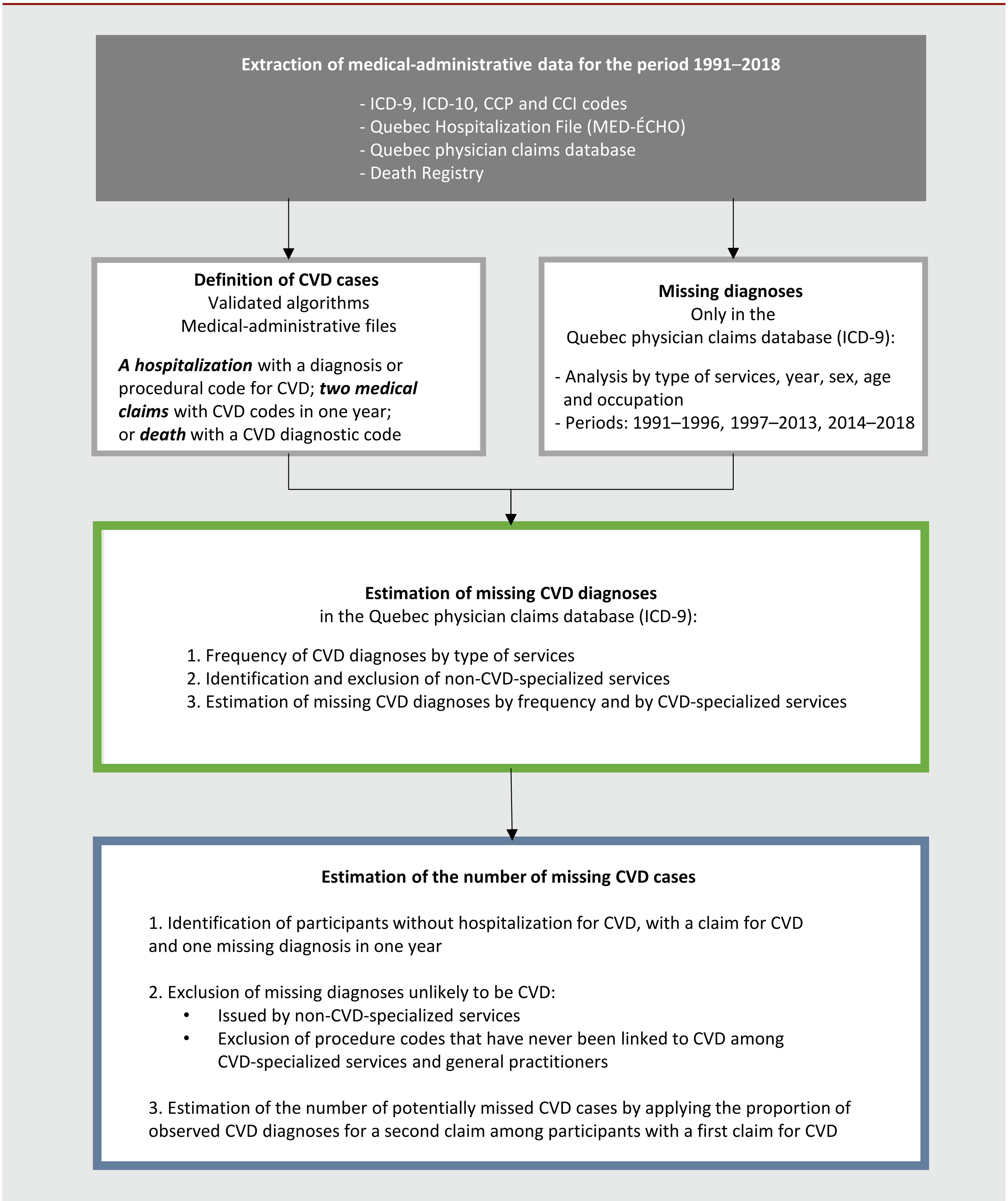
These algorithms are used for case definitions by the Institut national de santé publique du Québec (INSPQ).[15] Similar algorithms, except for death records, are used by the Canadian Chronic Disease Surveillance System (CCDSS).[3] These algorithms have been validated in Ontario for coronary heart diseases (sensitivity: 77.0%; specificity: 97.5%)[13] and stroke (sensitivity: 60.2%; specificity: 99.2%).[14]

Missing diagnoses

Only the physician claims database had missing diagnoses. In this database, the breakdown of missing diagnoses, identified by the codes "V999" and "0000" or a blank entry, was examined according to type of services, year and patient characteristics, namely sex, age group (< 35 years, 35–44 years, ≥45 years) and occupational category (management, professional/teaching and technical/other). Based on the overall trends observed over the entire follow-up period, the periods for which the proportion of missing diagnoses varied were identified (1991–1996, 1997–2013 and 2014–2018).

Figure 1 shows a flow chart of the process of estimating CVD diagnoses and cases

FIGURE 1
Flow chart showing the process for estimating CVD diagnoses missing from health administrative databases and resulting missing cases



Abbreviations: CCI, *Canadian Classification of Health Interventions*; CCP, *Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures*; CVD, cardiovascular disease; ICD-9, *International Classification of Diseases, Ninth Revision*; ICD-10, *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*.

missing from health administrative databases for the period 1991 to 2018.

Estimating missing CVD diagnoses

First, CVD diagnoses were identified using ICD-9 codes (362.3, 410–414, 430–432, 434–436), the only classification used in the physician claims database. We then calculated the frequency of types of services associated with those CVD diagnoses. The types of services with at least 18 CVD diagnosis codes were classified as “CVD-specialized services.” This threshold of 18 CVD diagnosis codes (for cardiology, diagnostic radiology or ultrasonography, neurology, internal medicine, cardiovascular and thoracic surgery, nuclear medicine, neurosurgery, physical medicine and rehabilitation, anesthesiology, emergency medicine, ophthalmology, general surgery, geriatrics, nephrology, respirology and thoracic surgery) was used because it encompassed 99.9% of all CVD diagnoses, that is, almost complete coverage. Other types of services (e.g. medical microbiology and infectious diseases, diagnostic radiology, hematology, orthopedic surgery, psychiatry, plastic surgery, otolaryngology / neck and face surgery, and public health or occupational preventive medicine) presented very few or no CVD diagnoses and were classified as “non-CVD-specialized services.” Missing diagnoses from these types of services were not included in this analysis given the low probability of these being CVD diagnoses.

We estimated the proportion of missing diagnoses that are potential CVD diagnoses by applying the percentages obtained for CVD diagnoses to the missing diagnoses. Specifically, for each combination of CVD-specialized services and medical procedure codes for a given period, we used frequency analysis to calculate the proportion of the total number of diagnoses that were CVD diagnoses. The resulting percentages were multiplied by the number of associated missing diagnoses to obtain an estimate of the number of potential CVD diagnoses among the missing diagnoses for each combination. Lastly, the number of potential CVD diagnoses were summed to obtain an estimate for the entire period.

Estimating the number of CVD cases

We estimated the number of potential CVD cases associated with missing diagnoses using an individual-based approach, according to validated algorithms.

We determined the number of participants without a CVD event (and therefore not hospitalized for CVD) who had a single claim for CVD and at least one other claim with a missing diagnosis within 365 days before or after the claim for CVD. Missing diagnoses with a low probability of being CVD diagnoses were excluded. Thus, all missing diagnoses associated with non-CVD-specialized services were excluded. Likewise, for all CVD-specialized services and general practitioners, we also excluded all missing diagnoses associated with codes for physician claims for which there was no CVD diagnosis during this period and for a given type of service. The resulting estimation is based on the assumption that all remaining missing diagnoses are CVD diagnoses. The estimated proportion of remaining CVD diagnoses was defined as the proportion of second CVD-related claims among participants with a first claim for CVD and a second claim with no missing diagnosis 365 days before or after the claim for CVD.

Results

Of the 8781 participants in our study, 8780 had at least one medical claim recorded in the physician claims database between 1991 and 2018, representing 2 121 856 claims. Only one participant did not have any medical claim during the entire study period. Diagnoses were complete in 77.9% of the claims (1 652 104 /2 121 856). The non-missing diagnoses included 49 999 unique claims with a CVD code. Therefore, CVD diagnoses accounted for 3.0% of all the non-missing diagnoses (49 999/1 652 104). The majority (76.4%; 38 194/49 999) were associated with CVD-specialized services, while general practitioners diagnosed 23.5% (11 736/49 999); only 0.1% (69/49 999) were associated with non-CVD-specialized services.

About one-fifth of the claims (22.1%; 469 752/2 121 856) presented a missing diagnosis. CVD-specialized services generated 19.9% of these missing diagnoses (93 435/469 752), while general practitioners generated 27.3% (128 391/469 752). Thus, the majority (52.8%) of the missing diagnoses were associated with non-CVD-specialized services (Table 1).

Proportions of missing diagnoses

The proportion of missing diagnoses varied by type of services and depended on the period studied. Since the vast majority of CVD diagnoses (99.9%; 49 930/49 999)

TABLE 1
Number and proportion of claims by diagnosis and type of services, Quebec, Canada, 1991–2018

	Single claim with a CVD diagnosis, n (%)	Single claim with another diagnosis, n (%)	Single claim with missing diagnoses, n (%)	Total, n (%)
	Non-missing diagnoses		Missing diagnoses	
CVD-specialized services[a]	38 194 (76.4)	328 752 (20.5)	93 435 (19.9)	460 381 (21.7)
General practitioners	11 736 (23.5)	819 300 (51.1)	128 391 (27.3)	959 427 (45.2)
Subtotal	49 930 (99.9)	1 148 052 (71.7)	221 826 (47.2)	1 419 808 (66.9)
Non-CVD-specialized services[b]	69 (0.1)	454 053 (28.3)	247 926 (52.8)	702 048 (33.1)
Total	49 999 (2.4)	1 602 105 (75.5)	469 752 (22.1)	2 121 856 (100)

Abbreviations: CVD, cardiovascular disease; ICD-9, International Classification of Diseases, Ninth Revision.

Notes: CVD diagnoses include the following ICD-9 codes: 362.3, 410–414, 430–432, 434–436.

[a] CVD-specialized services: cardiology, ultrasonography, neurology, internal medicine, cardiovascular and thoracic surgery, nuclear medicine, neurosurgery, physical medicine and rehabilitation, anesthesiology, emergency medicine, ophthalmology, general surgery, geriatrics, nephrology, respirology and thoracic surgery.

[b] Non-CVD-specialized services: medical microbiology and infectious diseases, diagnostic radiology, hematology, orthopedic surgery, psychiatry, plastic surgery, otolaryngology / neck and face surgery, and public health / occupational preventive medicine.

were associated with CVD-specialized services and general practitioners, frequency analyses were conducted based solely on claims from these services. Between 1991 and 1996, 34.0% of diagnoses were missing; between 1997 and 2013, 9.0% were missing; and between 2014 and 2018, 20.4% were missing, with an overall rate of 15.6% for the entire follow-up period. The proportions of missing diagnoses were comparable in terms of sex, age and occupational category (Figure 2).

Number of missing CVD diagnoses

The number of potentially missing CVD diagnoses was estimated by period and by type of services. The number of CVD diagnoses in the total number of missing diagnoses was estimated based on the claims associated with CVD-specialized services and general practitioners. For example, for a specific procedural code (09162: Primary Visit [Short-term Hospital Care, Outpatient]) performed by cardiologists between 2014 and 2018, 47.4% of the non-missing codes were CVD diagnoses and 355 diagnoses were missing. Based on these proportions (i.e. 355 × 47.4%), there were about 168 potentially missing CVD diagnoses among all the missing diagnoses for this specific combination. Adding up all the potentially missing CVD diagnoses across all types of services and for all periods equals 7389 potentially missing CVD diagnoses (Table 2), which represents a proportion of 12.9% (7389/57 388) of potentially missing diagnoses among all estimated CVD diagnoses.

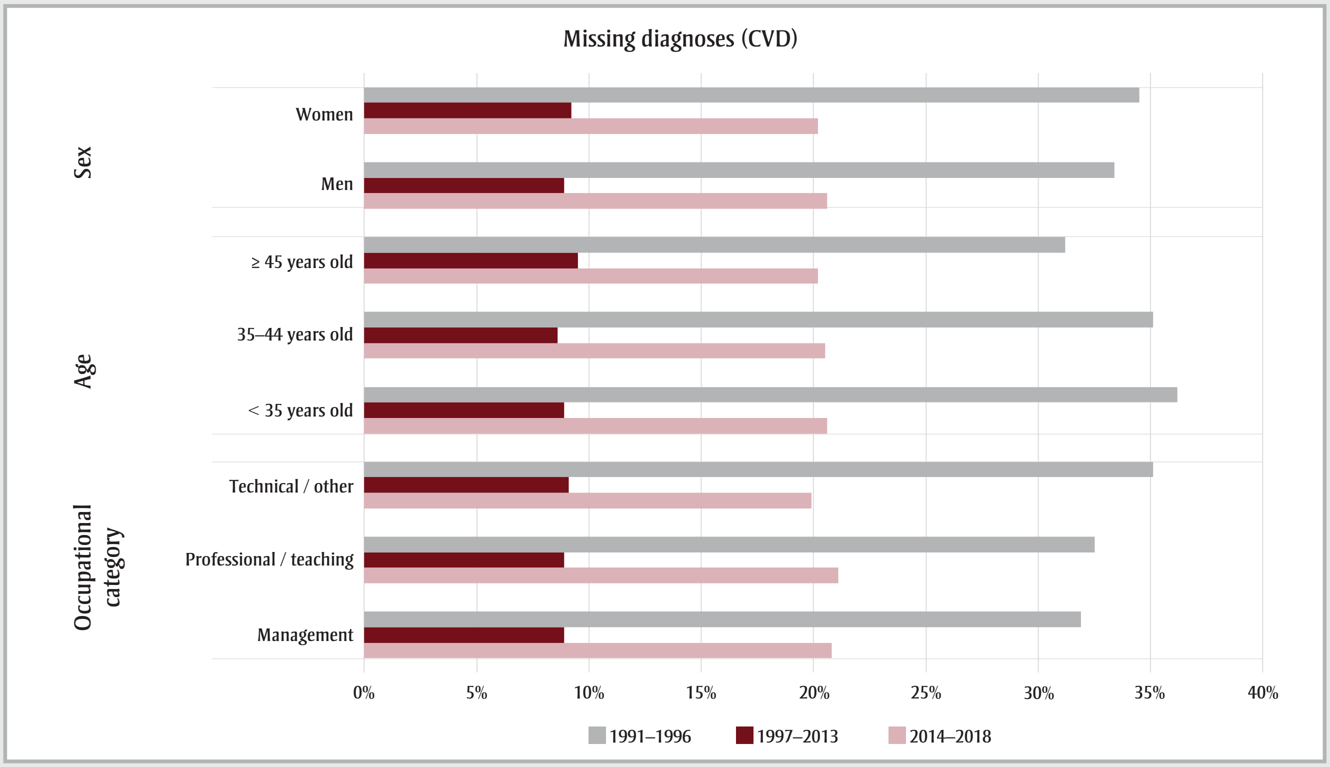
The proportion of missing diagnoses varied by the period studied: 17.1% of CVD diagnoses were potentially missing in 1991–1996, 8.7% in 1997–2013 and 21.2% in 2014–2018. A post hoc analysis conducted to determine if the proportion of missing CVD diagnoses varied between coronary heart disease and stroke determined that 12.8% of diagnoses for coronary heart disease and 13.3% of diagnoses for stroke would be missing, suggesting that there would be no difference for the two types of CVD (data not shown).

Number of CVD cases

A total of 1955 CVD events were observed among the 8781 participants in our study, for an annual average of 70 cases (over 28 years). The majority of CVD cases identified using the algorithms came solely from the physician claims database (i.e. 1203 non-hospitalized CVD cases out of a total of 1955 CVD cases, or 61.5%).

Of the participants without CVD according to the algorithms (n = 6826/8781), 1073 non-hospitalized for CVD had only one claim for CVD and at least one other claim with a missing diagnosis within 365 days before or after the claim for CVD. After excluding the missing diagnoses with a low probability of being CVD diagnoses, 576 participants had at least one other claim with a missing diagnosis within the 365-day interval that was associated with CVD-specialized services or a general practitioner. Of the participants without missing diagnoses, the proportion of CVD diagnoses in another claim, within a 365-day interval before or after a CVD claim, was 49.5%. Thus, 285 CVD cases could have been potentially missed (576 × 49.5%), representing an overall proportion of 12.7% of missing CVD cases (Figure 3). The proportion of missing CVD cases varied by period: 15.5% in 1991–1996, 10.7%

FIGURE 2
Proportion of missing diagnoses for CVD per period, by sex, age and occupational category, Quebec, Canada, 1991–2018



Abbreviation: CVD, cardiovascular disease.

TABLE 2
Diagnoses and cases of known and potentially missing CVD, by study period, Quebec, Canada, 1991–2018

	Number of known, n	Estimated missing, n	Total, n	Proportion of known, %	Proportion of missing, %
Number of CVD diagnoses					
1991–1996	5025	1036	6061	82.9	17.1
1997–2013	33 126	3176	36 299	91.3	8.7
2014–2018	11 848	3180	15 028	78.8	21.2
1991–2018	49 999	7389	57 388	87.1	12.9
Number of CVD cases					
1991–1996	279	51	330	84.6	15.5
1997–2013	1225	146	1371	89.4	10.7
2014–2018	451	88	539	83.7	16.3
1991–2018	1955	285	2240	87.3	12.7

Abbreviation: CVD, cardiovascular disease.

in 1997–2013 and 16.3% in 2014–2018 period (Table 2).

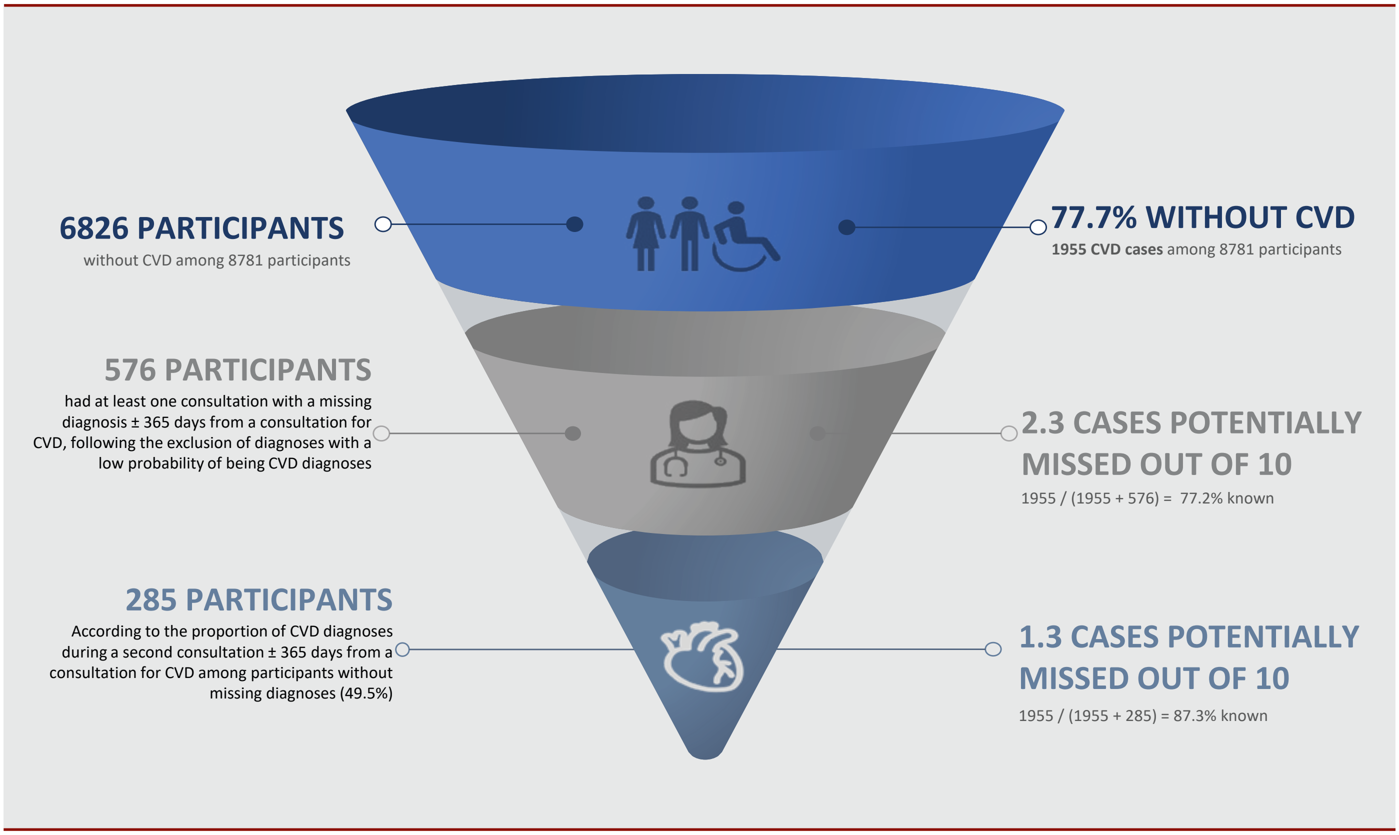
Discussion

To our knowledge, this is the first study to examine the impact of missing diagnoses on the estimated number of CVD cases in Quebec health administrative databases. The study was conducted using a large prospective cohort of 9188 males and females who were followed over 28 years.

The results of this study suggest that the proportion of underestimated CVD diagnoses and number of CVD cases are comparable, at approximately 13%. This proportion varied depending on the period covered, with a larger underestimate at the beginning (1991–1996) and end (2014–2018) of the follow-up period.

The total proportion of missing diagnoses in the physician claims databases was 22%. This is higher than the rate observed in an earlier Quebec study, which reported that missing diagnoses varied between 7% and 12%, depending on the reference

FIGURE 3
Number of potentially missing CVD cases



Abbreviation: CVD, cardiovascular disease.

year.[8] This difference can be explained by the 28-year follow-up of the current study, of which the more recent period (2014–2018) included a higher proportion of missing diagnoses. Similar to the Gagnon et al.[8] study, the completeness of the diagnoses in our study varied by type of services. Gagnon et al.[8] suggested that different compensation methods for physicians could help to explain the incompleteness of the diagnostic information in the medical services database. More specifically, fee-based compensation is more likely to affect completeness. Specialist physicians are entitled to a lump-sum payment for some medical activities, along with a supplemental fee. This mixed remuneration system could be contributing to the increase in the proportion of claims for which a diagnosis is missing.[8] However, we also found a large number of missing diagnoses among general practitioner claims (27%), which suggests that other factors might be at play.

This study suggests that the algorithm for identifying CVD cases used for surveillance in Quebec and the rest of Canada underestimates the prevalence, incidence and burden of CVDs at the population level. Based on CCDSS administrative health data, the prevalence (standardized according to age) of ischemic heart disease was relatively stable between 2000 and 2013, while the number of people living with ischemic heart disease increased significantly, from 1.5 million to 2.4 million individuals.[16] According to the INSPQ, the prevalence and incidence of CVDs decreased between 2005–2006 and 2015–2016, while the death rate remained relatively stable.[15] For example, the incidence of ischemic heart disease decreased from 9.1 to 6.0 per 1000 population between 2005–2006 and 2015–2016.[15] Our study findings show that the proportion of missing CVD cases varied in different periods, with the number of underestimated CVD cases seemingly higher more recently, between 2014 and 2018. The missing diagnoses in health administrative databases is thus likely to have influenced the estimation of these temporal trends.

Strengths and limitations

One of the strengths of this study is the long follow-up period because this allowed us to identify periods during the 28 years when the proportion of missing CVD cases was particularly high. We used INSPQ surveillance algorithms to identify CVD cases, fostering the potential to improve surveillance in Quebec.

This study has limitations. The cohort consisted only of white-collar workers, and thus is not fully representative of the Quebec population. However, several factors favour generalizing our results. First, at 52.7%, white-collar workers constitute the largest segment of the workforce in Canada.[16] Moreover, our results suggest that the proportion of missing diagnoses does not vary according to occupational category, which is an indicator of socioeconomic status. In addition, the prevalence of exposure to known CVD risk factors, including smoking (21%) and insufficient leisure-time physical activity (21%) in this cohort is comparable to that observed in a representative sample of the Quebec population.[17] Finally, the prevalence of CVD at recruitment, at 8%, is also comparable with the cohort observed in Canadian and American population-based surveys with a comparable age structure.[18,19]

It is also important to note that the algorithms used to identify CVD cases present an imperfect sensitivity (between 60% and 77%). In addition, these were validated in a different province (Ontario), using data from the Ontario Health Insurance Plan database of physician billings, which boasts virtually no missing diagnoses and near-perfect (99%) coverage.[20] Thus, the presence of these missing diagnoses in the Quebec context is a source of underestimation in addition to that resulting from the imperfect sensitivity of the algorithms.

Conclusion

Approximately one out of 10 CVD diagnoses is missing in the Quebec physician claims database. These missing diagnoses may have resulted in the number of CVD cases being underestimated by approximately 13% between 1991 and 2018. Underestimating CVD cases is a limitation worth considering in the context of surveillance work and epidemiological studies that use health administrative databases to identify CVD cases. Strategies aimed at improving the completeness of diagnoses in the physician claims database could be implemented and their effectiveness rigorously evaluated.

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Conflicts of interest

None.

Authors' contributions and statement

MLR: Writing – original draft, writing – review & editing

ETD: Writing – review & editing

ML: Writing – original draft, writing – review & editing

CB: Data collection, formal analysis, supervision

AM: Data curation, formal analysis

CaB: Data curation, formal analysis, interpretation

DT: Formal analysis and interpretation

XT: Supervision

All authors reviewed and approved the final draft of this manuscript.

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Original quantitative research

Assessing the impact of the COVID-19 pandemic on the mental health–related hospitalization rate of youth in Canada: an interrupted time series analysis

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Abstract

Introduction: This study evaluated the effect of the COVID-19 pandemic on temporal trends in mental health and addiction–related inpatient hospitalization rates among youth (aged 10–17 years) in Canadian provinces and territories (excluding Quebec) from 1 April 2018 to 5 March 2022.

Methods: We conducted an interrupted time series analysis across three periods: T0 (pre-pandemic: 1 April 2018 to 15 March 2020); T1 (early pandemic: 15 March 2020 to 5 July 2020); and T2 (later pandemic: 6 July 2020 to 5 March 2022).

Results: Pre-pandemic mental health and addiction–related hospitalization rates had significant regional variability, with weekly rates from 6.27 to 85.59 events per 100 000 persons in Manitoba and the territories combined, respectively. During T1, the national (excluding Quebec) weekly hospitalization rate decreased from a pre-pandemic level of 12.82 (95% CI: 12.14 to 13.50) to 5.11 (95% CI: 3.80 to 6.41) events per 100 000 persons. There was no statistically significant change in the mental health and addiction–related hospitalization rate across provinces and territories in T2 compared to T0. However, there was a significant increase in the rate of self-harm–related hospitalizations among females Canada-wide and in most provinces during this period.

Conclusion: Although several Canadian studies have reported increases in mental health and addiction–related outpatient and emergency department visits among youth during the COVID-19 pandemic, this did not correspond to an increase in the inpatient hospital burden, with the notable exception of self-harm among young females.

Keywords: *mental health, self-harm, substance use–related disorders, youth, adolescents, time series, COVID-19, Canada*

Highlights

- Before the COVID-19 pandemic, hospitalization rates related to mental health and addiction among youth aged 10 to 17 years varied significantly across Canada, with weekly rates from 6.27 events per 100 000 people in Manitoba to 85.59 events per 100 000 people in the territories.
- The national weekly hospitalization rate (excluding Quebec) decreased from a pre-pandemic level of 12.82 (95% CI: 12.14 to 13.50) to 5.11 (95% CI: 3.80 to 6.41) events per 100 000 persons during the early pandemic period (15 March 2020 to 5 July 2020).
- No significant change in mental health and addiction–related hospitalization rates was noted in the later pandemic period compared to pre-pandemic levels.
- Notably, there was a concerning rise in hospitalization rates for self-harm among female youth across Canada and in most provinces later during the pandemic period.

Introduction

Social isolation as a result of lockdowns and other societal changes during the COVID-19 pandemic led to a significant increase in mental health disorders such as anxiety, depression and post-traumatic stress disorder, resulting in higher outpatient and emergency department mental health–related visits for youths (< 18 years).[1-6]

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Loneliness, anxiety and depression have been on the rise in this population, especially among young females.[7-9] In 2020, females aged 15 to 17 years were twice as likely to be hospitalized for mental health–related disorders than their male counterparts.[10]

Studies focusing on changes in mental health–related emergency department visits and health service utilization among Canadian youths have been conducted in British Columbia, Ontario and Montréal (Quebec).[2,6,11-15] However, there is a lack of research on national and provincial/territorial trends in mental health–related inpatient hospitalizations. With different provincial and territorial public health responses to the pandemic, there may be differences in magnitudes, trends and associations in regional mental health–related hospitalization rates.

Our aim was to assess inpatient hospitalization rates for mental health and addiction diagnoses among Canadian youth across three distinct periods: pre-pandemic (T0), early pandemic (T1) and later pandemic (T2). Focusing on Canadian provinces and territories, excluding Quebec, we provide a detailed analysis, stratified by sex, for youth aged 10 to 17 years. It is important to note that our analysis is specific to inpatient hospitalizations and does not encompass the entire spectrum of youth mental health–related events, such as outpatient and emergency department visits.

Methods

We conducted a retrospective cohort study using routinely collected administrative health data of hospital admissions between 1 April 2018 and 5 March 2022. This allowed us to capture mental health–related inpatient hospitalizations for approximately 2 years before and 2 years after the start of the COVID-19 pandemic (set as 15 March 2020). Our analysis included individuals aged 10 to 17 years with a valid Medicare health card number at the time of hospitalization.

Data were obtained from the Canadian Institute for Health Information's Discharge Abstract Database (DAD) housed at the Public Health Agency of Canada. The Discharge Abstract Database is a comprehensive national (excluding Quebec) database that has been capturing hospital discharge abstracts for acute, chronic and rehabilitative care since 1988.[16] The use of these administrative data is authorized under section 44 of Ontario's *Personal Health Information Protection Act*, which does not require review by a research ethics board.[17]

Outcomes

The primary outcome was an inpatient hospitalization for a diagnosis related to mental health and addiction, including any diagnosis of deliberate self-harm or substance use-related disorder. The secondary outcomes were: (1) inpatient hospitalization with a diagnosis of deliberate self-harm; and (2) inpatient hospitalization with a diagnosis of substance use disorder (including poisoning codes).[18] The code algorithms used were based on Canadian Institute for Health Information (CIHI) definitions.[18-20] Unless otherwise stated, the primary and secondary outcomes were summarized as number of weekly events per 100 000 persons. An event constitutes one episode of care, which refers to all continuous inpatient hospitalizations (including transfers within or between facilities) as defined by the Canadian Institute for Health Information (CIHI). Transfers were considered one episode of care if they occurred less than 7 hours after discharge, regardless of whether there was a transfer code, or less than 12 hours after discharge if at least one of the visits had a transfer code.[21] Two or more separate events from the same individual are counted as multiple events rather than a single event. We estimated annual population counts of youth aged 10 to 17 years using Statistics Canada's annual population estimates, broken down by sex and region.[22] The same estimated population was used for the entire calendar year; this assumed a constant annual population growth, which appeared to be supported by the data. Age was calculated on the date of admission and province was determined based on the issuing health card.

Statistical analysis

We conducted an interrupted time-series analysis to assess the impact of the pandemic on trends and rates of mental health-related hospitalizations before and after 15 March 2020. We used segmented linear regression analysis on the weekly hospitalization rates in all of Canada (except Quebec), as well as each region (i.e. province/territory) spanning 104 weeks (2 years) before the pandemic.

We expected trends during the early weeks of the pandemic to differ from those during the overall pandemic as individuals and institutions adjusted to changes in service delivery and diagnosis of mental health-related events. Hence, we examined two interruptions: (1) early pandemic period spanning 16 weeks, and (2) the rest of the pandemic period spanning 89 weeks. We refer to the pre-pandemic period as T0 (1 April 2018 to 14 March 2020), the early pandemic period as T1 (15 March 2020 to 5 July 2020) and the later pandemic period as T2 (6 July 2020 to 5 March 2022). We chose 5 July 2020 as the end of T1 as some American studies had shown that hospitalization rates returned to expected rates between late June and mid July.[23] Furthermore, this was also the first period where most provinces and territories relaxed some public health measures.[24]

We combined data from the territories (Yukon, Northwest Territories and Nunavut) and the Atlantic provinces (New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland and Labrador) due to a small number of events for some analyses. To ensure that patterns within different youth age groups were assessed, we also stratified the Canada-wide results by age: 10 to 14 years and 15 to 17 years.

The model included coefficients for T0 (102 weeks), T1 (16 weeks) and T2 (89 weeks). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December).[25] We confirmed that model assumptions of homoscedasticity, linearity and normality (assessed graphically) were met for all models. We tested for autocorrelation using the Durbin–Watson statistic and used the Cook D statistic to ensure there were no influential data points.[25] All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, US) with a modified version of an interrupted time-series SAS macro.[26]

For each study group, we presented the baseline hospitalization rate per 100 000 as well as the trend (stable, statistically significantly increasing, statistically significantly decreasing) during three periods (T0, T1 and T2).

Results

There were 73 907 mental health and addiction–related hospitalizations of youth across Canada (except Quebec) during our study period (209 weeks). The mean age was 14.8 years and the median was 15 years (IQR = 2). Females had higher overall mental health and addiction–related hospitalization rates than males across all provinces in an approximately 2:1 ratio (Table 1).

Changes in mental health and addiction–related inpatient hospitalization

The pre-pandemic (T0) provincial/territorial baseline rates for mental health and addiction–related hospitalizations ranged from 6.27 (in Manitoba) to 85.59 (in the territories) weekly events per 100 000 persons. These rates were stable for all provinces and territories during this period (Figures 1a and 1b). In general, hospitalization rates for females were higher than for males. Adjusted for seasonality, the national hospitalization rate during T0 was 12.82 (95% CI: 12.14 to 13.50) weekly events per 100 000 persons (Table 2).

During T1, the average weekly hospitalization rate dropped from 12.82 (95% CI: 12.14 to 13.50) by 7.71 (95% CI: 6.41 to 9.02) events per 100 000 persons, compared to the baseline period. The level change in hospitalization rate dropped to 5.11 (95% CI: 3.80 to 6.41), equating to a 60% (95% CI: 50% to 70%) percentage decrease compared to T0. We also observed a statistically significant increasing trend in the weekly rates per 100 000 persons as the early pandemic progressed. This rate increase was also statistically significant among males in British Columbia, Ontario and Manitoba and females in British Columbia, Ontario, Alberta, Saskatchewan and Manitoba, from highest to lowest rate of increase per sex (Figures 1a and 1b; graphical data not shown for Saskatchewan and Manitoba).

During T2, the national weekly hospitalization rate was similar to T0 for the entire cohort and for males. The female national hospitalization rate increased from 18.20 (95% CI: 17.17 to 19.22) events per 100 000 persons in T0 to 20.29 (95% CI: 18.41 to 22.17) events per 100 000 persons, equating to an 11% (95% CI: 1% to 21.8%) increase (Figures 1a and 1b). There was no statistically significant change in the trend for hospitalization rate during T2 for either males or females at the national or provincial/territorial levels. There were also no notable differences in the national trend for youth aged 10 to 14 years and 15 to 17 years compared to the trend for youth overall.

TABLE 1
Mental health and addiction-related hospitalizations of youth (10–17 years) by geographic region and by sex, Canada (except Quebec), 1 April 2018 to 5 March 2022

Region	Females		Males	
	Number of events	Crude rate[a] (per 100 000)	Number of events	Crude rate[a] (per 100 000)
Alberta	7331	3349	3447	1505
British Columbia	9589	4698	4161	1975
Manitoba	1601	2313	643	910
New Brunswick	1670	5100	814	2404
Newfoundland and Labrador	780	3827	278	1298
Nova Scotia	716	1847	326	798
Northwest Territories	337	13823	101	4352
Nunavut	203	6621	149	4677
Ontario	25 871	4086	9697	1473
Prince Edward Island	437	5868	191	2562
Saskatchewan	3829	6307	1491	2368
Yukon	108	5866	69	3649
Canada[b]	52 472	4059	21 367	1591

[a] The crude rate is the rate over the entire study period (209 weeks) for mental health and addiction–related inpatient hospitalizations per 100 000 persons. We calculated this rate by dividing the number of observed events over the 209-week study period by the region-specific population estimate based on the calendar year 2022; we assumed the population size was constant over the entire study period. As an example, the female-specific national crude rate was 4059 mental health-related hospitalizations per 100 000 persons over the 209-week study period. The male-specific national crude rate was 1591 mental health-related hospitalizations per 100 000 persons over the 209-week study period.

[b] The 2022 national (excluding Quebec) population estimates for female and male youth (10–17 years) were 1 292 833 and 1 342 702, respectively.

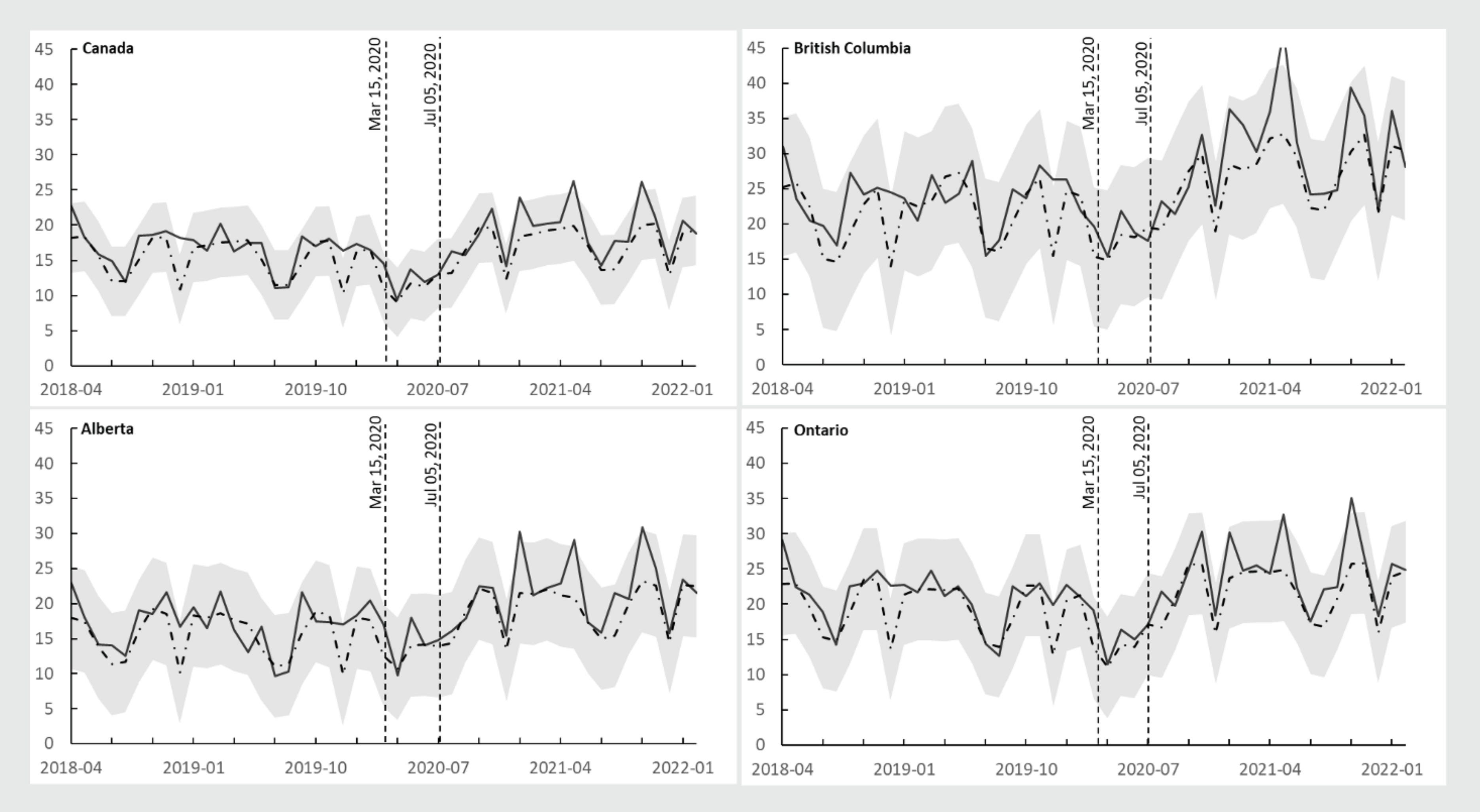
Changes in self-harm–related inpatient hospitalizations

The self-harm–related hospitalization rate during T0 was higher for females than for males for all provinces; the national rate for the entire cohort was 1.90 (95% CI: 1.76 to 2.04) weekly events per 100 000 persons, and rates remained stable during this time (Table 2). During T1, the rates also remained stable for the entire cohort. There was a statistically significant increasing trend in the national rate of hospitalizations of females during T2, as well as for British Columbia, Ontario, Alberta and the Atlantic provinces, from highest to lowest rate of increase (Figures 2a and 2b; graphical data not shown for Atlantic provinces); we observed no statistically significant change in trend for males. At the national level, the level rate for females increased from 3.18 (95% CI: 2.92 to 3.44) in T0 to 3.79 (95% CI: 3.42 to 4.16) events per 100 000 persons in T2, equating to a 19% (95% CI: 7% to 31%) increase. We also found a statistically significant increasing trend in rates for females aged 10 to 14 years and 15 to 17 years. However, the level change was only statistically significant for females aged 10 to 14 years; the rate increased from 1.85 (95% CI: 1.66 to 2.03) in T0 to 2.46 (95% CI: 2.16 to 2.76) events per 100 000 persons in T2, equating to a 32% (95% CI: 16% to 49%) increase.

Changes in substance use disorder–related inpatient hospitalizations

The substance disorder–related hospitalization rate during T0 was higher for females than males across all regions. At T0, the national substance disorder–related hospitalization rate was 2.69 (95% CI: 2.45 to 2.94) events per 100 000 persons (Table 2). During T1, the substance disorder–related hospitalization rate decreased to 1.41 (95% CI: 1.04 to 1.79) events per 100 000 persons, equating to a 50% decrease (95% CI: 39% to 66%). There was a statistically significant decrease in the national trend for substance disorder–related hospitalizations during T1 for both sexes and among females. There were no significant level changes or trends in the rates of hospitalizations with substance disorder among both males and females across all regions during T2 (Figures 3a and 3b). We observed

FIGURE 1A
Weekly hospitalization rate (per 100 000) with mental health and addiction diagnosis of female youth (10–17 years) in Canada (except Quebec) and British Columbia, Alberta and Ontario, April 2018 to March 2022

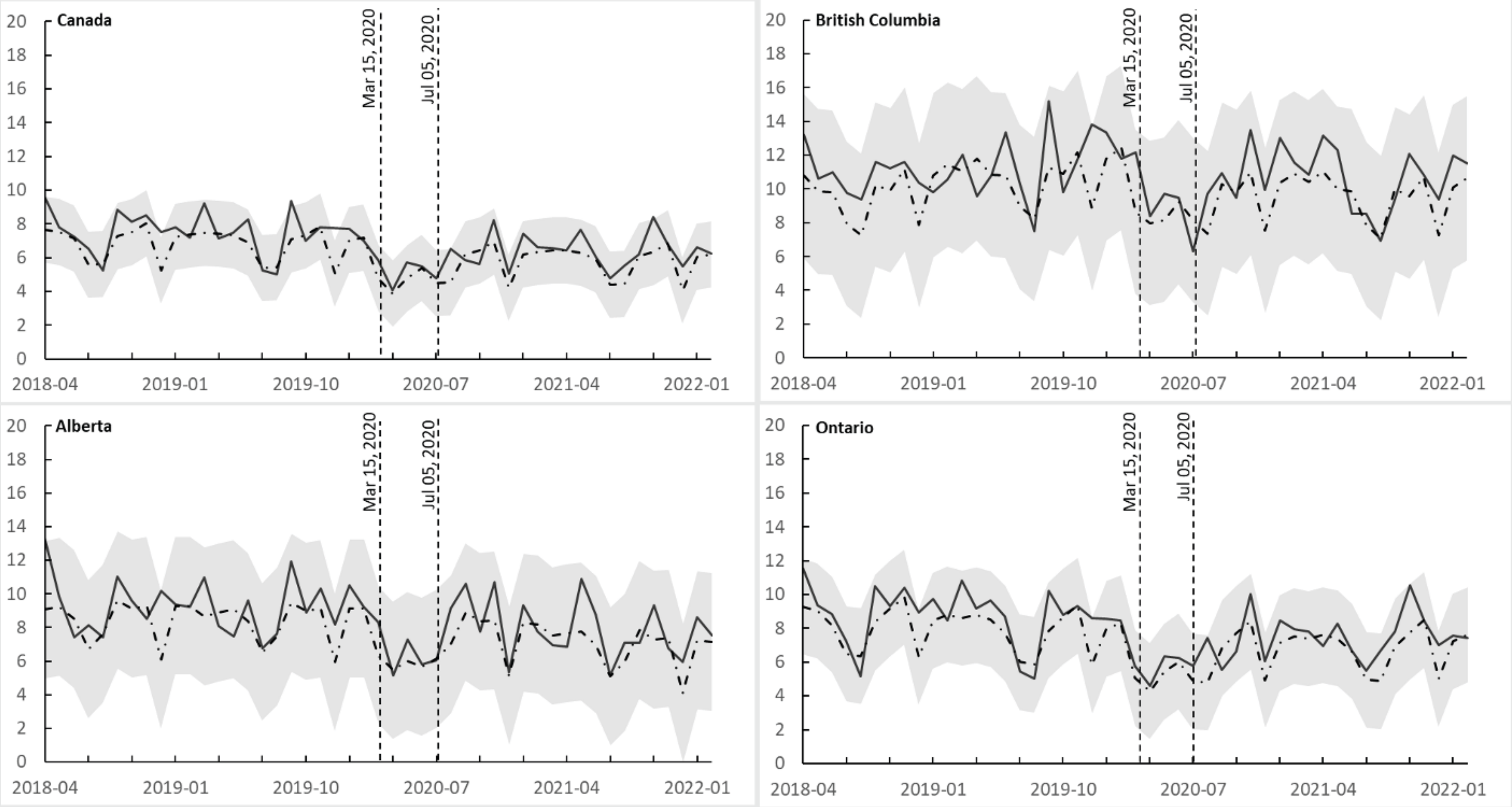


Notes: All models included coefficients for the pre-pandemic period (102 weeks, 1 April 2018 to 14 March 2020, referred to as T0), the early pandemic period (the first 16 weeks, 15 March 2020 to 5 July 2020, referred to as T1) and the later pandemic period (89 weeks, 6 July 2020 to 5 March 2022, referred to as T2). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December).

All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

FIGURE 1B
Weekly hospitalization rate (per 100 000) with mental health and addiction diagnosis of male youth (10–17 years) in Canada (except Quebec) and in British Columbia, Alberta and Ontario, April 2018 to March 2022



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All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

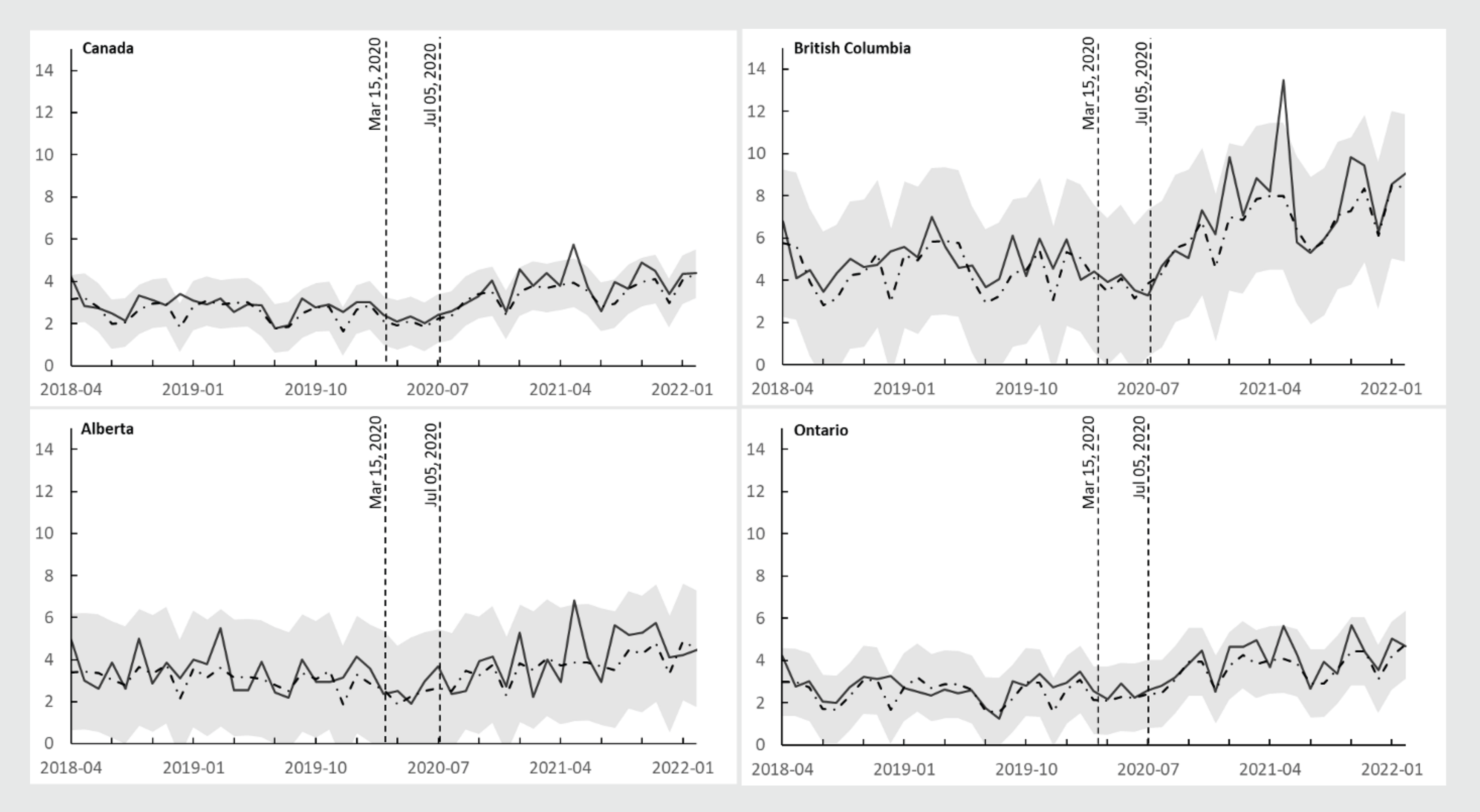
TABLE 2
Average Canada-wide weekly rates per 100 000 persons of hospitalizations with mental health and addiction, self-harm and substance disorders, all youth, by sex, and by age group (10–14 years and 15–17 years), Canada (except Quebec), April 2018–March 2022

Period	Weekly hospitalization rate and changes in weekly hospitalization rate during different periods of the pandemic, beta coefficients[a] per 100 000 (95% CI)		
	Mental health and addiction	Self-harm	Substance use disorder
All youth aged 10–17 years			
T0	12.82 (12.14 to 13.50) ↔	1.90 (1.76 to 2.04) ↓	2.69 (2.45 to 2.94) ↓
T1	−7.71 (−9.02 to −6.41) ↑	−0.66 (−0.93 to −0.38) ↔	−1.28 (−1.65 to −0.90) ↑
T2	0.66 (−0.60 to 1.93) ↔	0.33 (0.13 to 0.54) ↑	0.015 (−0.27 to 0.30) ↔
Females aged 10–17 years			
T0	18.20 (17.17 to 19.22) ↔	3.18 (2.92 to 3.44) ↔	3.45 (3.13 to 3.76) ↔
T1	−10.91 (−12.79 to −9.02) ↑	−1.04 (−1.56 to 0.53) ↔	−1.71 (−2.27 to −1.15) ↑
T2	2.09 (0.21 to 3.97) ↔	0.62 (0.25 to 0.99) ↑	0.09 (−0.33 to 0.51) ↔
Males aged 10–17 years			
T0	7.65 (7.24 to 8.06) ↔	0.67 (0.56 to 0.78) ↔	1.97 (1.73 to 2.21) ↔
T1	−4.64 (−5.53 to −3.75) ↑	−0.28 (−0.44 to −0.12) ↔	−0.86 (−1.21 to −0.50) ↑
T2	−0.70 (−1.50 to 0.09) ↔	0.06 (−0.058 to 0.18) ↔	−0.06 (−0.30 to 0.19) ↔
All youth aged 10–14 years			
T0	3.62 (2.97 to 4.26) ↔	0.47 (0.32 to 0.61) ↔	0.41 (0.30 to 0.52) ↔
T1	1.47 (0.59 to 2.35) ↔	0.11 (−0.08 to 0.30) ↔	0.30 (0.14 to 0.46) ↓
T2	0.01 (−0.67 to 0.68) ↑	−0.13 (−0.27 to 0.01) ↔	0.01 (−0.10 to 0.13) ↔
Females aged 10–14 years			
T0	11.26 (10.51 to 12.01) ↔	1.85 (1.66 to 2.03) ↔	1.45 (1.27 to 1.62) ↔
T1	−7.67 (−9.16 to −6.17) ↑	−0.80 (−1.19 to −0.40) ↔	−0.94 (−1.25 to −0.63) ↑
T2	2.47 (1.07 to 3.87) ↔	0.61 (0.31 to 0.91) ↑	0.11 (−0.13 to 0.34) ↔
Males aged 10–14 years			
T0	4.45 (4.09 to 4.81) ↔	0.25 (0.16 to 0.33) ↔	0.37 (0.26 to 0.47) ↑
T1	–3.13 (–4.01 to –2.25) ↑	–0.11 (–0.25 to 0.02) ↔	–0.46 (–0.62 to –0.30) ↔
T2	–0.52 (–1.16 to 0.11) ↔	0.00 (–0.08 to 0.08) ↔	–0.16 (–0.31 to 0.00) ↓
All youth aged 15–17 years			
T0	9.94 (8.54 to 11.33) ↔	1.61 (1.25 to 1.97) ↔	2.54 (2.28 to 2.79) ↔
T1	1.16 (−0.80 to 3.12) ↔	−0.01 (−0.43 to 0.41) ↔	−0.52 (−1.06 to 0.01) ↔
T2	−0.61 (−2.28 to 1.05) ↔	−0.22 (−0.55 to 0.12) ↔	−0.60 (−1.01 to −0.19) ↓
Females aged 15–17 years			
T0	29.72 (27.92 to 31.52) ↔	5.40 (4.88 to 5.91) ↓	6.77 (6.10 to 7.43) ↓
T1	−16.45 (−19.44 to −13.47)↑	−1.47 (−2.32 to −0.61) ↔	−3.03 (−4.37 to −1.69) ↑
T2	1.46 (−1.61 to 4.52) ↔	0.63 (−0.06 to 1.31) ↑	0.06 (−0.83 to 0.96) ↔
Males aged 15–17 years			
T0	12.93 (12.02 to 13.85) ↔	1.38 (1.10 to 1.66) ↔	4.62 (4.06 to 5.17) ↔
T1	–7.23 (–8.85 to −5.62) ↑	–0.57 (–0.95 to −0.18) ↔	–1.54 (–2.45 to −0.63) ↑
T2	–1.02 (–2.30 to 0.27) ↔	0.17 (–0.13 to 0.47) ↔	0.11 (–0.46 to 0.69) ↔

Abbreviations: CI, confidence interval; ↑ (upward arrow), statistically significant increasing trend for hospitalization during the respective period; ↓ (downward arrow), statistically significant decreasing trend in hospitalization rate during the respective period; ↔ (left and right arrow), stable and not statistically significant trend in hospitalizations during the respective period. Please see the main text of the manuscript for more details on how to interpret these numbers.

[a] The beta coefficient for T0 is the baseline rate at the pre-COVID-19 pandemic period, whereas the coefficients for T1 and T2 represent the level changes compared to T0. All models included coefficients for the pre-pandemic period (102 weeks, 1 April 2018 to 14 March 2020, referred to as T0), the early pandemic period (the first 16 weeks, or 15 March 2020 to 5 July 2020, referred to as T1) and the later pandemic period (89 weeks, 6 July 2020 to 5 March 2022, referred to as T2). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December). See text for interpretation details.

FIGURE 2A
Weekly hospitalization rate (per 100 000) with self-harm diagnosis of female youth (10–17 years) in Canada (except Quebec) and in British Columbia, Alberta and Ontario, April 2018 to March 2022

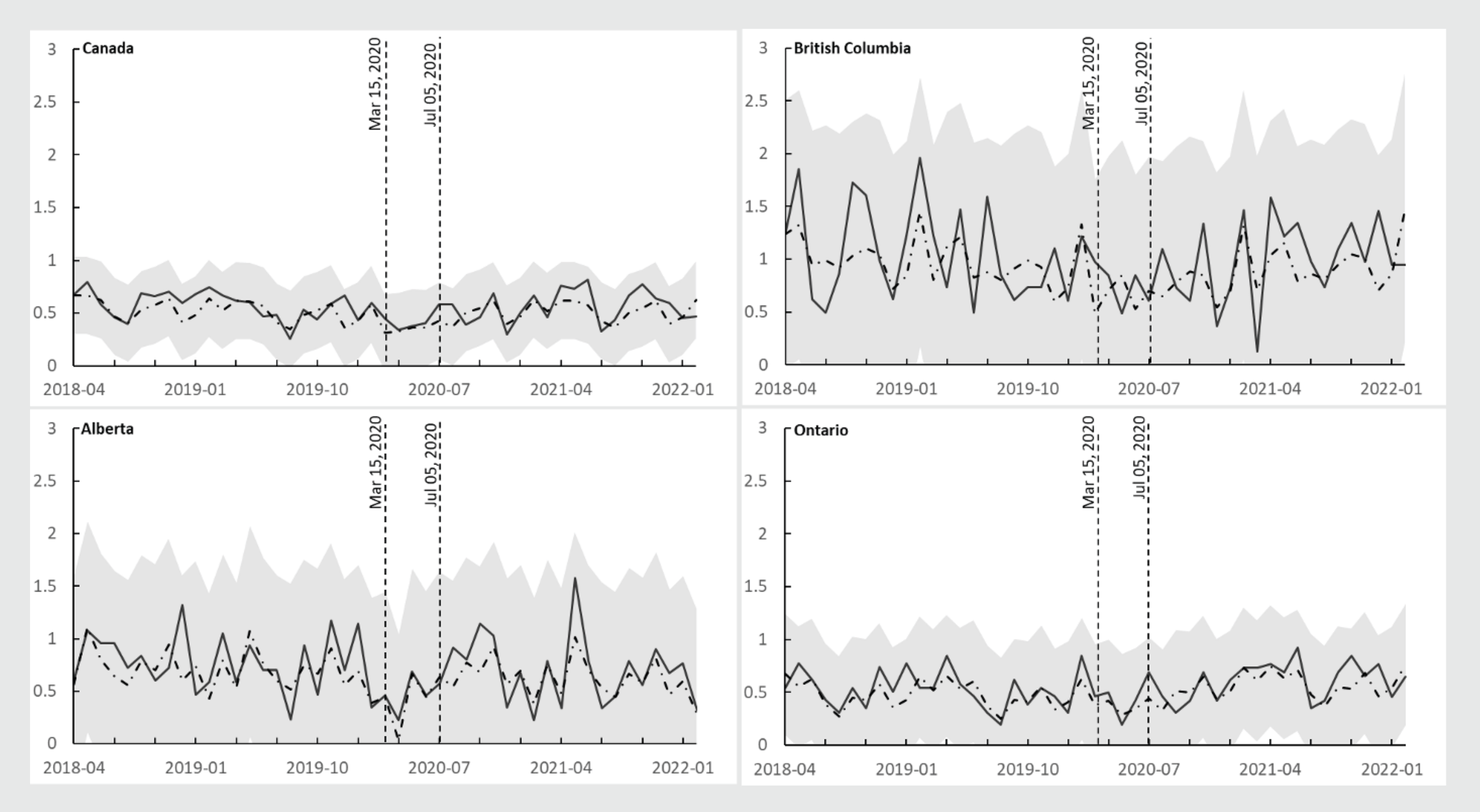


Notes: All models included coefficients for the pre-COVID-19 pandemic period (102 weeks, 1 April 2018 to 14 March 2020, referred to as T0), the early pandemic period (the first 16 weeks, 15 March 2020 to 5 July 2020, referred to as T1) and the later pandemic period (89 weeks, 6 July 2020 to 5 March 2022, referred to as T2). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December).

All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

FIGURE 2B
Weekly hospitalization rates (per 100 000) with self-harm diagnosis of male youth (10–17 years) in Canada (except Quebec) and in British Columbia, Alberta and Ontario, April 2018 to March 2022



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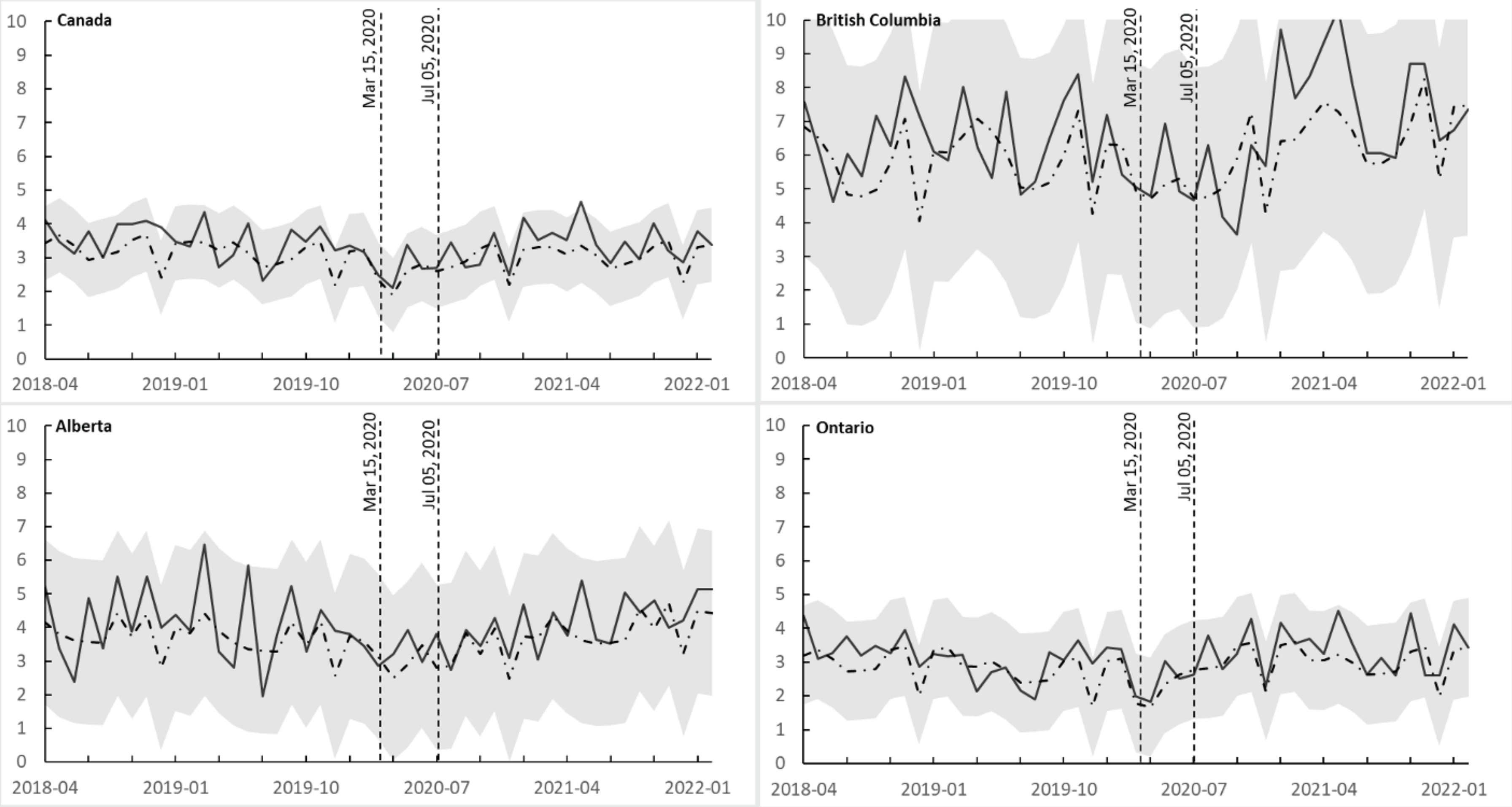
All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

FIGURE 3A
Weekly hospitalization rate (per 100 000) with substance use disorder diagnosis of female youth (10–17 years) in Canada (except Quebec) and in British Columbia, Alberta and Ontario, April 2018 to March 2022

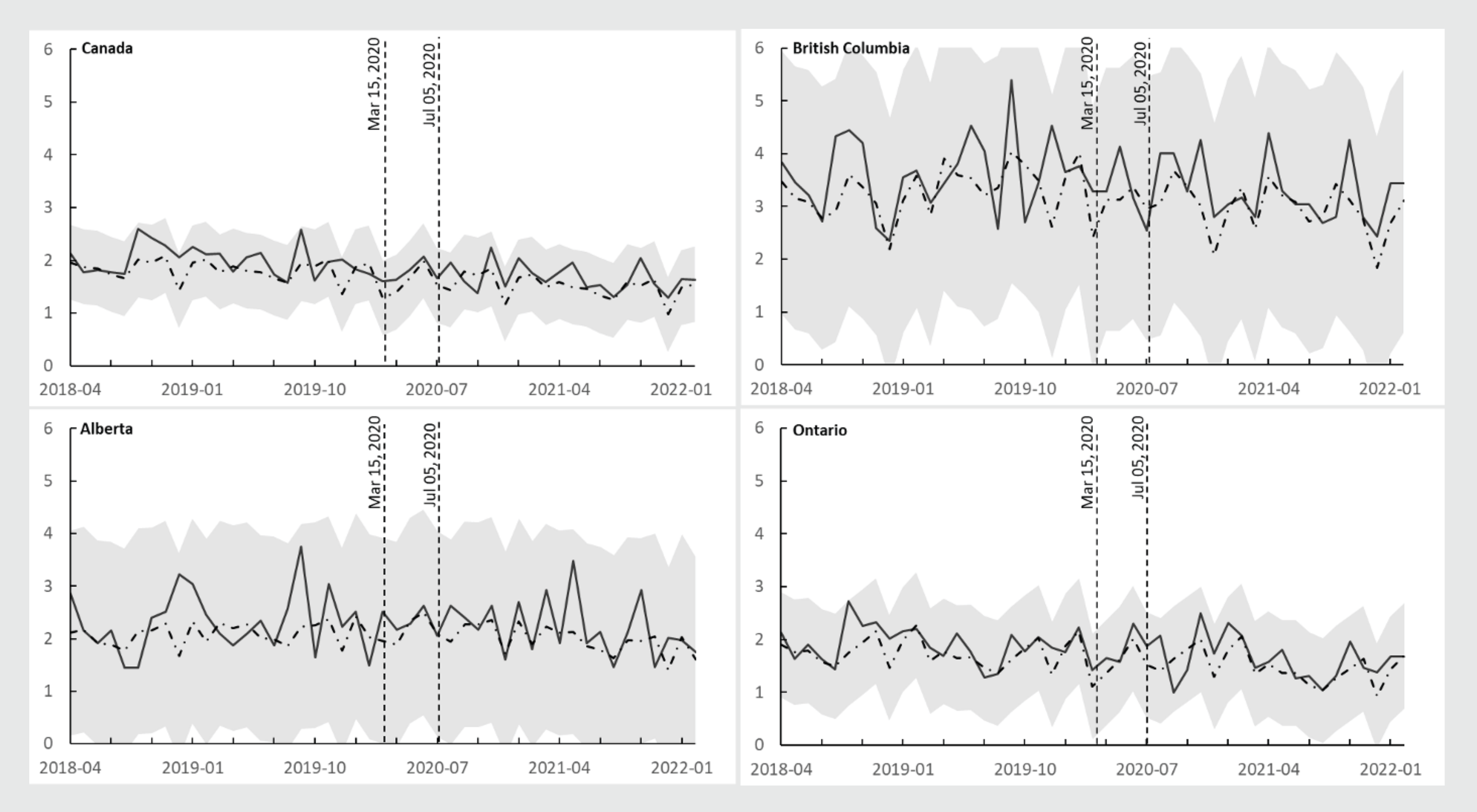


Notes: All models included coefficients for the pre-COVID-19 pandemic period (102 weeks, 1 April 2018 to 14 March 2020, referred to as T0), the early pandemic period (the first 16 weeks, 15 March 2020 to 5 July 2020, referred to as T1) and the later pandemic period (89 weeks, 6 July 2020 to 5 March 2022, referred to as T2). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December).

All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

FIGURE 3B
Weekly hospitalization rate (per 100 000) with substance use disorder diagnosis of male youth (10–17 years) in Canada (except Quebec) and in British Columbia, Alberta and Ontario, April 2018 to March 2022



Notes: All models included coefficients for the pre-COVID-19 pandemic period (102 weeks, 1 April 2018 to 14 March 2020, referred to as T0), the early pandemic period (the first 16 weeks, 15 March 2020 to 5 July 2020, referred to as T1) and the later pandemic period (89 weeks, 6 July 2020 to 5 March 2022, referred to as T2). All analyses considered autocorrelation with lag one and adjusted for seasonality by adding a covariate for each month (i.e. January to December).

All rates for Canada excluded Quebec. The population for the presented provinces represented 81% of the youth in the Canadian population (excluding Quebec). Graphs for the other Canadian jurisdictions are not shown for improved presentation.

In each graph, the dashed line is the predicted event rate, and the solid black line is the observed event rate (per 100 000). The shaded area shows the 95% confidence interval for the predicted values.

similar results for youth aged 10 to 14 years and those aged 15 to 17 years.

Discussion

We conducted a Canada-wide analysis to understand rate changes in mental health and addiction–related hospitalizations among youth during different phases of the COVID-19 pandemic. We found regional variations, with the territories showing the highest hospitalization rates before and during the pandemic;[16] this finding may be attributed to a complex interplay of factors, one of which could be limited outpatient resources in the territories, resulting in a greater reliance on inpatient hospitalizations. While there was no general increase in the mental health and addiction–related hospitalization rate, we observed a concerning rise in the self-harm–related hospitalization rate among females nationally and within most provinces.

Some Canadian studies have shown an increase in mental health–related outpatient and emergency department visits, especially among young females.[2,11,16,27-29] However, our study did not find a corresponding increase in the mental health and addiction–related inpatient hospitalization rate.[30] We also did not find significant changes in substance disorders, which is in line with past findings. Presentations to the emergency department for substance abuse by youth decreased during the pandemic, apart from opioid-related emergency department visits.[31,32] While there is evidence that there might have been an increase in the frequency of alcohol and cannabis use by youth during the pandemic, our results and past findings suggest this does not lead to an increase in visits to the hospitals and emergency departments.[33,34]

The rise in the rate of self-harm–related hospitalizations among female youth is alarming and calls for attention; evidence suggests it may have started before the pandemic.[35] This trend should guide policy makers and clinicians in allocating resources and shaping public health strategies to meet the mental health needs of this demographic. Our study also raises questions about whether the observed sex differences in hospitalization rates, particularly for self-harm and, to a lesser extent, substance disorders, could be related to systemic biases in clinical decision-making and/or gender differences in help-seeking behaviors.[29,36,37]

Our findings should not be interpreted to mean that mental health and addiction conditions have not increased among young people in Canada. The increase in self-reported mental health conditions and unmet needs of mental health care post-pandemic among youth continues to be corroborated by Statistics Canada and other large Canadian surveys.[5,38] Further, our findings may only pertain to the most severe mental health and addiction–related events, and non-hospitalized mental health and addiction events may have continued to increase. In other words, in the majority of the provinces, mental health and addiction events are not taking up inpatient hospitalizations.

Strengths and limitations

The strength of our study lies in its comprehensive coverage of included Canadian provinces and territories. However, our study also has several limitations. First, we used administrative data and diagnostic coding algorithms with high specificity but moderate to low sensitivity, potentially underestimating mental health and addiction–related hospitalization rates.[39] Second, the exclusion of Quebec limits the study's nationwide applicability. Third, the pandemic strained health care systems, altering hospital visit protocols and health care worker availability, which may have influenced our observed rates. Fourth, the observed trends, especially during the early pandemic period (T1), could be attributed to delayed health care–seeking behaviours for mental health and addiction–related issues due to individuals' reluctance to interact with the health care system during the pandemic, as observed in other health care contexts.[40-42] Fifth, underlying systemic biases in clinical decision-making may also affect hospital admission rates. For example, if health care providers are more inclined to admit females than males for mental health conditions, this could skew the observed sex-specific hospitalization rates.[10,43,44] Lastly, our findings might be influenced by unaccounted factors such as neighborhood-level socioeconomic status, racial/ethnic backgrounds and access to either the means or opportunity to self-harm or use substances.

Conclusion

While our study indicated no significant increase in overall mental health and addiction–related hospitalizations among Canadian youth during the pandemic, the rise in self-harm hospitalization rate among females warrants focused attention. These findings highlight the need for ongoing monitoring and research to better understand and address the mental health challenges faced by Canadian youth.

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Conflicts of interest

The authors have no conflicts of interest.

Justin J. Lang is one of this journal's Associate Scientific Editors, but has recused himself from the review process for this article.

Authors' contributions and statement

CD: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, validation, visualization, writing original draft, writing review and editing

AAA: conceptualization, data curation, formal analysis, investigation, funding acquisition, methodology, project administration, validation, visualization, supervision, writing – original draft, writing – review and editing

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Original quantitative research

Psychological well-being and its associations with sociodemographic characteristics, physical health, substance use and other mental health outcomes among adults in Canada

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Abstract

Introduction: Psychological well-being (PWB) is an important component of positive mental health (PMH) and an asset for population health. This study examined correlates of PWB among community-dwelling adults (18+ years) in the 10 Canadian provinces.

Methods: Using data from the 2019 Canadian Community Health Survey Rapid Response on PMH, we conducted linear regression analyses with sociodemographic, mental health, physical health and substance use variables as predictors of PWB. PWB was measured using six questions from the Mental Health Continuum—Short Form, which asked about feelings of self-acceptance, personal growth, environmental mastery, autonomy, positive relations and purpose in life during the past month.

Results: In unadjusted and adjusted analyses, older age, being married or in a common-law relationship and having a BMI in the overweight category (25.00–29.99) were associated with higher PWB, while reporting a mood disorder, anxiety disorder, high perceived life stress, engaging in heavy episodic drinking and frequent cannabis use were associated with lower PWB. Sex, having children living at home, immigrant status, racialized group membership, educational attainment, household income tertile, having a BMI in the obese category (≥30.00), major chronic disease and smoking status were not significantly associated with PWB.

Conclusion: This research identifies sociodemographic, mental health, physical health and substance use factors associated with PWB among adults in Canada. These findings highlight groups and characteristics that could be the focus of future research to promote PMH.

Keywords: *psychological well-being, positive mental health, mental illness, sociodemographic characteristics, substance use, physical health, population health*

Highlights

- This study examined psychological well-being and its associations with sociodemographic, mental health, physical health and substance use factors among individuals aged 18 years and older in Canada.
- Older age, being married or in common-law relationship, and having a BMI in the overweight category were associated with higher psychological well-being.
- Reporting a mood disorder, an anxiety disorder, high perceived life stress, engaging in heavy episodic drinking and frequent cannabis use were associated with lower psychological well-being.

Introduction

The promotion of well-being is a public health priority in both Canada and globally, as evidenced in national and international mental health strategies.[1,2] While well-being and related concepts have increasingly received attention by researchers internationally and over time,[3] some have argued that the primary focus of epidemiological and public health research on disease states and their risk factors need to be supplemented with research on positive psychological states and health assets to gain a complete understanding of population health.[4]

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Hedonia and eudaimonia represent two distinct components of well-being.[5] While both are components of positive mental health (PMH) and are related, they can have unique psychological, social and biological correlates.[6-8] Hedonia typically covers aspects of feeling good, including experiencing positive emotions and satisfaction with life.[5] In contrast, eudaimonia can be defined as functioning well,[5] which is captured in Ryff's concept of psychological well-being (PWB) as including self-acceptance, personal growth, purpose in life, environmental mastery, autonomy and positive relations with others.[9]

PWB has been associated with a range of health outcomes, for example, better subjective health, fewer sleep problems, lower levels of inflammation and reduced cardiovascular events such as myocardial infarctions.[8] Some aspects of PWB (e.g. purpose in life) have also been associated with reduced risk of all-cause mortality.[8,10] Within Canada, previous research has found that individuals who report higher PWB tend to report better well-being on other measures of PMH (e.g. life satisfaction), as well as less distress and fewer functional limitations.[11] Moreover, negative bivariate associations have been found between PWB and alcohol, cannabis and cigarette use among youth in Canada.[12,13]

In 2016, the Public Health Agency of Canada (PHAC) released the Positive Mental Health Surveillance Indicator Framework as a tool to monitor and report on PMH outcomes and associated risk and protective factors in the Canadian population;[14,15] PWB was identified as a key PMH outcome in the Framework. Given the importance of mental health promotion nationally and internationally, identifying factors associated with PWB is essential to build upon previous findings, inform continued surveillance and identify groups who may benefit from interventions that promote higher PWB. Thus, the objective of this study was to examine associations between PWB and a range of sociodemographic, mental health, physical health and substance use variables among adults in Canada.

Methods

Study design and population

This secondary data analysis used the 2019 Canadian Community Health Survey (CCHS) Rapid Response on PMH. The CCHS is a voluntary cross-sectional survey, conducted annually by Statistics Canada, of individuals aged 12 years and older living in all the Canadian provinces and territories.[16] The survey coverage excluded individuals who were institutionalized or living in foster homes, full-time members of the Canadian Forces, and individuals living on reserves and in other Indigenous settlements in the provinces and in two specific health regions in Quebec; these exclusions represent less than 3% of the Canadian population.[16] Data for the Rapid Response on PMH were collected between January and March 2019 from non-proxy respondents living in the 10 Canadian provinces, with a response rate of 58.3%. We limited our analyses to adults aged 18 years and older (N = 11 486).

Measures

Psychological well-being

PWB was measured using six questions from the Mental Health Continuum—Short Form.[17] These asked about feelings of self-acceptance, personal growth, environmental mastery, autonomy, positive relations with others and purpose in life in the past month. In accordance with the adult Positive Mental Health Surveillance Indicator Framework[15] and previous research,[11,18] response options for each question were converted into number of days in the past month as follows: "every day" as 28 days (4 weeks × 7 days per week); "almost every day" as 20 days (4 weeks × 5 days per week); "about 2 or 3 times a week" as 10 days (4 weeks × 2.5 days per week); "about once a week" as 4 days (4 weeks × 1 day per week); "once or twice" as 1.5 days; and "never" as 0 days. Mean scores were generated by summing item scores and dividing by the total number of items; scores ranged from 0 to 28. The Mental Health Continuum—Short Form PWB subscale has been validated in previous Canadian population health surveys[11] and had an acceptable internal consistency in the Rapid Response dataset (Cronbach $\alpha = 0.79$).

Sociodemographic variables

We examined a number of sociodemographic characteristics: sex (male, female); age (continuous); marital status (married/in a common-law relationship, single/separated/divorced/widowed); household income tertile (low, middle, high); respondent's highest level of education (high school graduation or less, postsecondary graduation); immigrant status (yes [landed immigrant/non–permanent resident], no [Canadian-born]); racialized group member (yes [identified as Indigenous or any racialized background], no [only identified as White]); and household composition (children of any age living at home, no children living at home). Income data were based on a combination of tax data (~20%), collected respondent data (~15%) and imputed income amounts (~65%).

Mental health variables

Perceived life stress was examined using the question "Thinking about the amount of stress in your life, would you say that most of your days are…?" Response options included "not at all stressful," "not very stressful," "a bit stressful," "quite a bit stressful" and "extremely stressful." Consistent with the PHAC Suicide Surveillance Indicator Framework,[19] respondents who answered "extremely stressful" or "quite a bit stressful" were categorized as having high perceived life stress.

Presence of a mood disorder was assessed with the question "Do you have a mood disorder such as depression, bipolar disorder, mania or dysthymia?" Presence of an anxiety disorder was assessed with the question "Do you have an anxiety disorder such as a phobia, obsessive-compulsive disorder or a panic disorder?" Respondents who answered "yes" to the first question were categorized as having a mood disorder and "yes" to the second question as having an anxiety disorder.

Physical health variables

The derived body mass index (BMI) variable (HWTDVBCC) created by Statistics Canada was modified to report on BMI. This derived variable was calculated based on the self-reported height and weight of the respondent (excluding those who reported being pregnant or did not answer the pregnancy question when asked). Sex-specific corrections were applied to adjust for the tendency of individuals to overestimate their height and underestimate their weight.[20] After these adjustments, respondents' BMI were classified as normal/underweight (≤24.99), overweight (25.00–29.99) or obese (≥30.00) for analysis.[21] The normal weight and underweight category groups were combined because the percentage of individuals with a BMI classified as underweight was low, and the interpretation of results was similar when the two groups were examined separately in sensitivity analyses.

Consistent with the Suicide Surveillance Indicator Framework,[19] respondents were categorized as having at least one major chronic disease if they reported having asthma; chronic bronchitis, emphysema or chronic obstructive pulmonary disease; heart disease; diabetes; a current or previous cancer diagnosis; or if they experienced the effects of a stroke.

Substance use variables

Current smoking status was assessed with the question "At the present time, do you smoke cigarettes every day, occasionally or not at all?"

Heavy episodic drinking was based on the 2018 *Canada's low-risk alcohol drinking guidelines*[22] and was assessed using the question "How often in the past 12 months have you had 5 (male) / 4 (female) or more drinks on one occasion?" Response options ranged from "never" to "more than once a week." Individuals who indicated "never" or who reported not having an alcoholic drink during the past 12 months were categorized as not engaging in heavy episodic drinking in the past year, while those who reported drinking that many drinks "less than once a month" or more often were categorized as engaging in heavy episodic drinking in the past year.

Cannabis use was assessed using the question "How often did you use cannabis in the past 12 months?" Based on *Canada's Lower-risk Cannabis Use Guidelines* relating to frequency and intensity of use,[23] respondents who indicated that they used cannabis "more than once a week" or "daily or almost daily" were categorized as engaging in frequent cannabis use, while those who responded "once a week" or less frequently were categorized as not engaging in frequent cannabis use.

Statistical analyses

We conducted analyses using SAS Enterprise Guide version 7.1 (SAS Institute, Cary, NC, US). Descriptive statistics were reported using weighted percentages, means and medians with 95% confidence intervals (CIs). To account for the complex survey design, we calculated 95% CIs using the bootstrap resampling method with 1000 replications. Survey sampling weights and bootstrap weights were provided by Statistics Canada. We conducted unadjusted linear regression analyses to examine the bivariate association between each potential explanatory variable and PWB. We then conducted an adjusted linear regression analysis with variables that were statistically significant in the unadjusted analyses to simultaneously examine how each variable was related to PWB when adjusting for the other variables. To ensure that the sample composition remained consistent for unadjusted and adjusted results, all regression analyses were restricted to the 87.0% of respondents (N = 9993) with complete data on all relevant variables. Regression coefficients with p values less than 0.05 were interpreted as being statistically significant.

Multicollinearity did not appear to be an issue as none of the correlation coefficients between explanatory variables exceeded 0.60 and variance inflation factors in the adjusted model were all less than or equal to 1.43. These multicollinearity checks were weighted but bootstrapping was not applied for variance estimation due to SAS limitations. A residual plot was generated to confirm the assumption of homoscedasticity for the adjusted model.

Results

Descriptive statistics

The majority of the population was married or in a common-law relationship (63.2%), had completed postsecondary education (64.1%), were non-immigrants (71.9%) and were not members of racialized groups (72.4%). Half of the individuals had children living at home (50.9%) (Table 1).

Most respondents did not report a mood (89.9%) or an anxiety (89.9%) disorder and had low perceived life stress (78.5%). The majority did not report having a major chronic disease (74.5%); however, around two-thirds were classified as having BMI in the overweight or obese category (65.5%). Most did not engage in frequent cannabis use (92.7%), were nonsmokers (84.8%) and did not engage in heavy episodic drinking (56.6%) in the past year.

Median household income before taxes was $91 744 and the mean age was 48.2 years. On average, PWB was experienced on 22.4 days in the past month.

Linear regression results

In the unadjusted analyses, older age (B = 0.03; 95% CI: 0.02 to 0.04), being married or in a common-law relationship (B = 1.12; 95% CI: 0.76 to 1.48) and having BMI in the overweight category (B = 0.69; 95% CI: 0.28 to 1.10) were significantly associated with higher PWB. In contrast, reporting a mood disorder (B = −4.54; 95% CI: −5.25 to −3.83), an anxiety disorder (B = −3.45; 95% CI: −4.19 to −2.71), high perceived life stress (B = −1.53; 95% CI: −2.01 to −1.04), heavy episodic drinking in the past year (B = −0.69; 95% CI: −1.03, −0.34) and frequent cannabis use in the past year (B = −1.93; 95% CI: −2.61 to −1.24) were significantly associated with lower PWB in the unadjusted analyses. Sex, having children living at home, immigrant status, racialized group membership, educational attainment, household income tertile, having a BMI in the obese category (vs. underweight/normal weight category), having a major chronic disease and smoking status were not significantly associated with PWB in the unadjusted analyses (Table 2).

In the adjusted analyses, older age (B = 0.01; 95% CI: 0.005 to 0.02), being married/in a common-law relationship (B = 0.58; 95% CI: 0.22 to 0.94) and having a BMI in the overweight category (B = 0.58; 95% CI: 0.16 to 0.99) were significantly associated with higher PWB, while reporting a mood disorder (B = −3.55; 95% CI: −4.22 to −2.87), anxiety disorder (B = −1.10; 95% CI: −1.81 to −0.38) or high perceived life stress (B = −0.89; 95% CI: −1.35 to −0.43) or engaging in heavy episodic drinking (B = −0.42; 95% CI: −0.77 to −0.08) and frequent cannabis use (B = −0.84; 95% CI: −1.49 to −0.19) were significantly associated with lower PWB.

Discussion

In this study, we examined associations between PWB and sociodemographic characteristics, mental health, physical health and substance use using data from almost 10 000 adults in Canada. We found that PWB was positively associated with two sociodemographic factors (i.e. age and being married or in a common-law relationship) and one physical health characteristic (i.e. having a BMI in the overweight category) and negatively associated with several mental health (i.e. reporting a mood disorder, an anxiety disorder and high perceived life stress) and substance use variables (i.e. engaging in heavy episodic drinking and frequent cannabis use in the past year). These associations with PWB were robust as they all remained

TABLE 1
Descriptive characteristics of 2019 CCHS Rapid Response on PMH respondents (N = 11 486)

Characteristics	Value (n or %)
Mean number of days PWB was experienced in the past month (N = 10 658), n	22.4
Sociodemographic variables	
Sex (N = 11 486), %	
Male (n = 5335)	49.2
Female (n = 6151)	50.8
Mean age (N = 11 486), years	48.2
Marital status (N = 11 475), %	
Single, separated, divorced or widowed (n = 5180)	36.8
Married or in a common-law relationship (n = 6295)	63.2
Household composition (N = 11 474), %	
No children living at home (n = 7666)	49.1
Children living at home (n = 3808)	50.9
Immigrant status (N = 11 412), %	
Non-immigrant (n = 9406)	71.9
Immigrant (n = 2006)	28.1
Racialized group member (N = 11 352), %	
No (n = 9432)	72.4
Yes (n = 1920)	27.6
Highest level of respondent education (N = 11 336), %	
High school education or less (n = 4383)	35.9
Postsecondary (n = 6953)	64.1
Median household income (N = 11 486), $	91 744.0
Mental health variables	%
Mood disorder (N = 11 467)	
No (n = 10 251)	89.9
Yes (n = 1216)	10.1
Anxiety disorder (N = 11 473)	
No (n = 10 334)	89.9
Yes (n = 1139)	10.1
Perceived life stress (N = 11 454)	
Not at all, not very or a bit stressful (n = 9234)	78.5
Extremely or quite a bit stressful (n = 2220)	21.5
Physical health variables	%
BMI (N = 10 900)	
Underweight/normal weight (<25.00) (n = 3519)	34.5
Overweight (25.00–29.99) (n = 3932)	36.2
Obese (≥30.00) (n = 3449)	29.3
Major chronic disease (N = 11 384)	
No (n = 7881)	74.5
Yes (n = 3503)	25.5
Substance use variables	%
Smoking status (N = 11 483)	
Daily smoker (n = 1549)	10.9
Occasional smoker (n = 456)	4.3
Non-smoker (n = 9478)	84.8
Alcohol use (N = 11 444)	
No heavy episodic drinking in past year (n = 6691)	56.6
Heavy episodic drinking in past year (n = 4753)	43.4
Cannabis use (N = 11 205)	
Infrequent use in past year (n = 10 328)	92.7
Frequent use in past year (n = 877)	7.3

Abbreviations: BMI, body mass index; CCHS, Canadian Community Health Survey; PMH, positive mental health; PWB, psychological well-being.

Note: All estimates are weighted to represent the target population.

statistically significant when simultaneously controlling for each other in the adjusted analysis.

Higher age was associated with higher PWB in the current study, which is consistent with previous Canadian findings showing that PMH outcomes are often most commonly observed among older adults.[15,18,24] While we examined overall PWB, more detailed investigations into specific dimensions of PWB have found more nuanced patterns of results, with some aspects of PWB increasing as people age (e.g. environmental mastery) and other aspects decreasing (e.g. purpose in life).[25] Future Canadian research could expand upon the current study by exploring different aspects of PWB and/or investigating correlates of PWB within developmental stages (early adulthood, mid-adulthood, older adulthood) to see if they might differ across the life course.

Marital status was also robustly associated with PWB. Longitudinal research has found overall increases in all six aspects of PWB when people are married for the first time, while some aspects of PWB decrease when people are separated/divorced (i.e. self-acceptance and positive relations) or widowed (i.e. purpose in life).[26] Other longitudinal research indicates that the transition to cohabitation or marriage is generally associated with increases in happiness.[27] There are many pathways through which long-term romantic relationships may promote PMH—for example, romantic partners can provide friendship, social support and emotional regulation.[28,29]

Having a BMI in the overweight category but not the obese category was consistently associated with a higher PWB score, which was unexpected but not idiosyncratic to this study. For instance, a meta-analysis found that mental health–related quality of life was higher among individuals with BMI in the overweight category (vs. normal category), although their physical health–related quality of life was lower.[30] The literature on BMI and mental health more broadly can be inconsistent and nuanced, with associations sometimes depending on sex, age, stigma and measure of mental health.[31,32] Studies are needed to explore whether adults in Canada with BMI in the overweight category are more likely to report higher well-being for other PMH measures and whether this

TABLE 2
Linear regression models examining associations between sociodemographic, mental health, physical health and substance use variables and PWB, 2019 CCHS Rapid Response on PMH (N = 9993)

Explanatory variables	Unstandardized regression coefficient, *B* (95% CI)	
	Unadjusted	Adjusted
Sex		
Male	Reference	–
Female	−0.21 (−0.56 to 0.13)	–
Age (continuous)	0.03 (0.02 to 0.04)***	0.01 (0.005 to 0.02)**
Marital status		
Single, separated, divorced, or widowed	Reference	Reference
Married or in a common-law relationship	1.12 (0.76 to 1.48)***	0.58 (0.22 to 0.94)**
Household composition		
No children living at home	Reference	–
Children living at home	0.21 (−0.16 to 0.57)	–
Immigrant status		
Non-immigrant	Reference	–
Immigrant	−0.15 (−0.60 to 0.31)	–
Racialized group member		
No	Reference	–
Yes	−0.42 (−0.91 to 0.06)	–
Highest level of respondent education		
High school or less	Reference	–
Postsecondary	−0.11 (−0.45 to 0.24)	–
Household income tertile		
Low	Reference	–
Middle	0.32 (−0.07 to 0.71)	–
High	0.37 (−0.05 to 0.78)	–
Mood disorder		
No	Reference	Reference
Yes	−4.54 (−5.25 to −3.83)***	−3.55 (−4.22 to −2.87)***
Anxiety disorder		
No	Reference	Reference
Yes	−3.45 (−4.19 to −2.71)***	−1.10 (−1.81 to −0.38)**
Perceived life stress		
Not at all, not very or a bit stressful	Reference	Reference
Extremely or quite a bit stressful	−1.53 (−2.01 to −1.04)***	−0.89 (−1.35 to −0.43)***
BMI category		
Underweight/normal weight (<25.0)	Reference	Reference
Overweight (25.0–29.9)	0.69 (0.28 to 1.10)**	0.58 (0.16 to 0.99)**
Obese (≥30)	0.33 (−0.13 to 0.79)	0.44 (−0.03 to 0.90)
Major chronic disease		
No	Reference	–
Yes	0.04 (−0.36 to 0.44)	–
Smoking status		
Daily smoker	Reference	–
Occasional smoker	0.65 (−0.36 to 1.65)	–
Non-smoker	0.50 (−0.03 to 1.02)	–
Alcohol use		
No heavy episodic drinking in past year	Reference	Reference
Heavy episodic drinking in past year	−0.69 (−1.03 to −0.34)***	−0.42 (−0.77 to −0.08)*
Cannabis use		
Infrequent use in past year	Reference	Reference
Frequent use in past year	−1.93 (−2.61 to −1.24)***	−0.84 (−1.49 to −0.19)*
Adjusted R^2	–	0.09

Footnotes on the following page

varies after stratifying by factors such as sex to better understand the relationship between BMI in the overweight category and higher PWB score observed in this study.

Beyond these positive associations, we found that individuals reporting a mood disorder or anxiety disorder tended to have lower PWB than those not reporting these mental illnesses. Symptoms such as sadness, hopelessness, fatigue, lack of interest, negative self-perceptions, excessive worry, sleep disturbance, restlessness and difficulty concentrating may make it more difficult for individuals with internalizing disorders to experience PWB.[33] Indeed, mood and anxiety disorders are associated with limitations in functioning and well-being.[33,34] Moreover, lower scores on all six PWB components have been observed among individuals with depression (vs. without depression),[35] and changes in depressive symptoms have been shown to predict changes in PWB (and vice versa) over a 16-year period among older adults.[36] Despite the robust associations between reporting a mood or an anxiety disorder and having PWB in the current study, it is important to note that much of the variance in PWB remains unexplained. These results are in line with the dual-continuum model of mental health that conceptualizes PMH (e.g. PWB) and mental illness as related but distinct concepts, with each contributing to overall mental health.[37,38]

Individuals who indicated that most of their days were extremely or quite a bit stressful tended to report lower PWB than those who perceived less stress in their life. The cognitive appraisal of frequent and intense stressful transactions with the environment could hinder aspects of PWB, such as the sense that a person has autonomy or mastery over their environment, although we did not examine how well individuals thought they could cope with the level of stress in their lives.[39] Nevertheless, this finding extends Canadian knowledge on the link between perceived stress and other PMH outcomes, including sense of community belonging, in the general adult population,[40] and self-rated mental health and life satisfaction among adults with a mood and/or anxiety disorder.[41] Ongoing promotion of PMH among individuals reporting high levels of stress or with mood or anxiety disorders may strengthen population PWB.[42]

TABLE 2 (continued)
Linear regression models examining associations between sociodemographic, mental health, physical health and substance use variables and PWB, 2019 CCHS Rapid Response on PMH (N = 9993)

Abbreviations: BMI, body mass Index; CCHS, Canadian Community Health Survey; PMH, positive mental health; PWB, psychological well-being; R^2, coefficient of determination.

Note: All estimates are weighted.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

In terms of substance use, engaging in heavy episodic drinking and in frequent cannabis use were significantly associated with lower PWB. Previous Canadian research with youth also found that heavy episodic drinking and frequent cannabis use were more common among those with low psychological and social well-being (albeit autonomy had a positive association with substance use when sociodemographic characteristics and other aspects of well-being were controlled for).[13] Interestingly, smoking status was not associated with PWB in our study, whereas previous research found that recent cigarette use was associated with lower psychological and social well-being among youth in Canada.[12] Inconsistent evidence for the relationship between smoking and aspects of PWB (i.e. purpose in life) have been noted previously.[43] Future studies are needed to obtain a better understanding of the relationship between substance use and PMH by assessing motivations for use, examining polysubstance use and the use of other substances not measured in the current survey, taking into account group dynamics, distinguishing between those who abstain versus those who use at a low-risk level, examining associations with other PMH outcomes, and investigating the frequency of heavy episodic drinking.

Although we were able to identify multiple correlates of PWB, we also observed that some variables were not significantly associated with PWB. For instance, PWB differences across sex, education and immigrant status were not observed in this study, nor in analyses of the 2015 CCHS.[18] PWB also did not differ between racialized versus non-racialized group members or for those with versus without children living at home. Differences in other PMH outcomes for these sociodemographic characteristics have been documented among adults in Canada,[24] which highlights the importance of monitoring numerous PMH indicators. The lack of significant results for household income and major chronic disease status was unexpected. Previous analyses of the 2015 CCHS found that adults in the three highest household income quintiles had higher odds of high PWB than adults in the lowest household income quintile.[18] The use of a more extreme reference group, the larger sample size and other methodological or analytical differences in the previous analyses may explain the conflicting results for household income. Previous Canadian research found that adults with chronic physical conditions were less likely to have flourishing mental health (albeit not after adjustment for various sociodemographic characteristics, positive health behaviours and chronic pain).[44] More research is needed to understand these inconsistent findings.

Strengths and limitations

A key strength of this study includes the use of data from a population health survey that allowed us to examine a range of potential PWB correlates among community-dwelling adults living in the 10 Canadian provinces. In terms of limitations, PWB is multifaceted and has a range of potential correlates that were not measured or controlled for (e.g. personality),[7] which could result in residual confounding. The use of self-reported data is subject to social desirability or recall biases, particularly for more sensitive content such as substance use.[45] Although BMI was adjusted using sex-specific corrections to account for common reporting biases, some misclassification could have occurred due to the limitations of BMI for some populations (e.g. very muscular individuals, older adults, members of some racialized groups).[21] The categorization of some of the explanatory variables in this study was broad (e.g. marital status, racialized group member); differences in PWB could have been missed between specific populations that were grouped together. Moreover, the findings of this study may not be generalizable to individuals who were excluded from the target population (e.g. those living in institutions or in Indigenous settlements, full-time members of the Canadian Armed Forces) or excluded from analyses (e.g. those aged less than 18 years, those who reported being pregnant). Lastly, given that the data analyzed were cross-sectional, causality and directionality of the observed associations cannot be ascertained.

Conclusion

According to Ryff,[9] PWB is experienced when people feel competent, self-determined and connected with others, when they have a sense of growth, purpose and meaning in life and when they accept who they are. We found that reporting a mood disorder, an anxiety disorder or high perceived life stress, and engaging in heavy episodic drinking and frequent cannabis use were consistently associated with lower PWB, whereas older age, being married or in a common-law relationship and having a BMI in the overweight category were consistently associated with higher PWB. Our results identify potential risk and protective factors of PWB, and highlight the need for future research on interventions aimed at increasing PWB. This is especially pertinent now given the decreased prevalence of other PMH outcomes (e.g. fewer adults reporting very good or excellent mental health),[46] the increased prevalence of some potential risk factors (e.g. more adults screening positive for major depressive disorder; more adults reporting an increase versus a decrease in their alcohol and cannabis consumption)[47,48] and larger inequalities in PMH outcomes among some groups (e.g. younger vs. older adults)[25] that have been observed in Canada during the COVID-19 pandemic. It will be important to explore the degree to which PWB has also been impacted.

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Conflicts of interest

Heather Orpana is one of this journal's Associate Scientific Editors, but recused herself from the review process for this article.

The authors have no conflicts of interest to disclose.

Authors' contributions and statement

MV: Conceptualization, formal analysis, methodology, project administration, visualization, writing – original draft, writing – review & editing.

ZMC: Formal analysis, methodology, validation, writing – review & editing.

MMB: Conceptualization, writing – review & editing.

EP: Conceptualization, writing – review & editing.

HO: Conceptualization, writing – review & editing.

CAC: Formal analysis, methodology, validation, writing – review & editing.

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Evidence synthesis

Methods for evaluating intersectoral action partnerships to address the social determinants of health: a scoping review

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Abstract

Introduction: Many of the social and economic factors that shape conditions for population health and health equity (e.g. income, education and employment) lie outside of the health sector. Intersectoral action (ISA) is pivotal to building diverse partnerships that address these social determinants of health. Despite the significant role of ISA, there are few comprehensive reports from the health sector on how such partnerships are evaluated. The purpose of this scoping review is to provide an overview of examples of ISA partnership evaluations, including the identification of evaluation methods, tools and indicators.

Methods: A literature search of two academic databases, Embase and MEDLINE, identified seven relevant studies published between 2012 and 2022.

Results: Common evaluation approaches were network analysis, community- or system-level analysis, partnership evaluation and longitudinal process evaluation. Five of the studies assessed the strength and functionality of partnerships, with reach (e.g. distance between partners) used most frequently as an indicator.

Conclusion: Despite the complexity of evaluating ISA partnerships, such evaluations are crucial for assessing impacts on health outcomes and social determinants of health, goal achievement, accountability and sustainability. Different evaluation models are available to program planners and evaluators involved in ISA initiatives.

Keywords: *intersectoral action, social determinants, evaluation, methods*

Highlights

- Intersectoral action is an essential approach to addressing the social determinants of health. However, literature evaluating intersectoral action is limited.
- Network analysis, system-level analysis, partnership evaluation and longitudinal process evaluation are promising approaches to evaluating intersectoral initiatives.
- Assessing the reach of intersectoral partners to each other and to the target population is important to understanding the effectiveness of intersectoral partnerships.

Introduction

A growing body of literature reports that action on the social determinants of health, such as housing, income, employment and food security, is critical to improving population health.[1,2] Intersectoral action (ISA) is a key approach to addressing complex public health challenges with the potential to impact such determinants.[3] ISA requires that multiple sectors work together towards a common goal, which could include health equity, population health or non-health sector goals such as well-being or the environment.[3]

ISA is an important approach for health actors to promote Health in All Policies (HiAP), which sustains and influences policies supporting health and health equity.[4] While ISA constitutes the third of the four pillars of the HiAP approach,[4] ways of working and work methods, the value of partnerships in intersectoral collaboration warrant examination of best practices.

ISA is also recognized as a core competency for public health in Canada (“partnerships, collaboration and advocacy”).[5] It may be particularly important for actors working in health policy settings who must collaborate to codevelop policies, mediate partners’ competing interests and advocate for health in advancing mutual goals.

Intersectoral approaches can involve partners (e.g. from government, the private sector, community organizations) from various sectors (e.g. health, education, housing, labour and employment, criminal

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justice) or within the same sector (e.g. government), across various departments (e.g. health, education, agriculture, finance) or jurisdictions (e.g. federal, provincial or territorial, municipal or county).

Many collaborative policy initiatives have used ISA to address complex health challenges. Governments in South Australia and Finland, among others,[4] have implemented HiAP approaches and used ISA to integrate health considerations into the policies and programs of other sectors.[6-8] For example, HiAP in South Australia involves joint governance by the central government and the health department, with the latter working closely with other government agencies to provide technical expertise and facilitate the integration of health considerations into sector-specific policies and programs.[6] An example seen more frequently in low- and middle-income countries is the development of One Health approaches that bridge multiple sectors by focusing on the interaction between humans, animals and their shared environment and on the implications of this overlap on health.[9]

While previous reports have demonstrated the importance of ISA to public health practice[3,10] and its potential positive effect on advancing health equity,[11-14] there is a lack of published information on how ISA is evaluated in terms of its effectiveness in achieving intended goals, its impact on health outcomes and social determinants of health, and the tools, methods and indicators used in its execution. This literature gap may be due in part to the complexity of ISA processes and the difficulty of attributing health and related outcomes to ISA. A report on evaluation methods for ISA implementation discussed a breadth of strategies for use by policy makers (e.g. increasing political will, sustaining effective processes, designing and implementing interventions), noting that each be subjected to an individual evaluation in its own right.[15]

The purpose of this scoping review is to evaluate the effectiveness of ISA, particularly focusing on the effectiveness of partnerships within ISA, hereafter referred to as "ISA partnerships," by providing an overview of evidence-based methods and key findings from recent peer-reviewed public health literature. Evaluating the effectiveness of ISA partnerships may involve determining how partners collaborate to achieve their goals and measuring impact, communication and overall success of intersectoral efforts in addressing complex issues.

The objectives of this review are to: (1) consolidate domestic and international examples of ISA partnership evaluations; (2) identify methods, tools and indicators used in ISA partnership evaluations; and (3) understand the barriers and facilitators to evaluating ISA partnerships.

Methods

We searched health-related literature to identify studies that explicitly evaluated ISA partnerships for their effectiveness, including their impacts on health outcomes and social determinants of health, following the 2020 guidelines developed for scoping reviews by JBI.[16] We also followed the Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) checklist.[17]

Search strategy

We searched two electronic databases, Embase and MEDLINE, in February 2022, for relevant academic literature published between 2012 and 2022. Our search combined terms from two themes: "intersectoral action" and "program evaluation," on the recommendation of a health sciences librarian who developed our search strategy. This search was applied to both title and abstract keywords and subject headings, and was limited to peer-reviewed articles published in English within the last 10 years to ensure recency of retrieved reviews.[11-13] The search strategy for MEDLINE is shown in Table 1; the search strategy in Embase used the same search terms and limits.

Study selection

Articles were eligible for review if they:

(1) reported on an ISA intervention or ISA-related activity that addressed at least one social determinant of health and involved the collaboration of two or more sectors, as determined by the coauthors during screening of the titles and abstracts of retrieved records; and

(2) explicitly mentioned the evaluation of ISA partnerships by assessing their effectiveness, successes and challenges or through other means.

Therefore, results of interest included ISA partnerships that involve two or more sectors, including but not limited to health, education and social services.

Outcomes of interest included the evaluation of ISA partnerships, at community, regional or national levels, with a focus on effectiveness, functionality and identified impacts on health outcomes and social determinants of health.

In order to examine a broad range of relevant empirical studies, we only excluded those studies that did not evaluate an ISA partnership or ISA intervention or that only examined outcomes (versus the ISA process). We also excluded clinical trials, conference abstracts, commentaries and literature reviews.

Three authors (RA, AN, KL) independently conducted abstract screening on duplicate samples of articles (n = 50) to ensure consensus and agreement on eligibility criteria. Once the eligibility criteria were established, the principal author (RA) screened the remaining abstracts (n = 899).

Next, two authors (RA, JN) conducted the full-text review of 28 articles using a data extraction form developed by RA. Descriptive data extracted from the articles included the country of study; the target population; the ISA program (including relevant activities/strategies and outputs); and outcomes. Data on the evaluation of ISA initiatives included the evaluation objective; the type of evaluation (e.g. process, impact); methods and tools used for evaluation; indicators of ISA (e.g. reach, network membership or interaction, systems change, etc.); conceptualization of effectiveness; evidence for results achieved because of ISA; and barriers and facilitators to ISA evaluation. We used qualitative content analysis, following the methods of Krippendorff,[18] to identify commonalities and themes to do with the types of evaluations, methods and tools used to assess intersectoral collaboration. Data management and coding of themes was conducted using Microsoft 365 Excel (Microsoft Corp., Redmond, WA, US).

Results

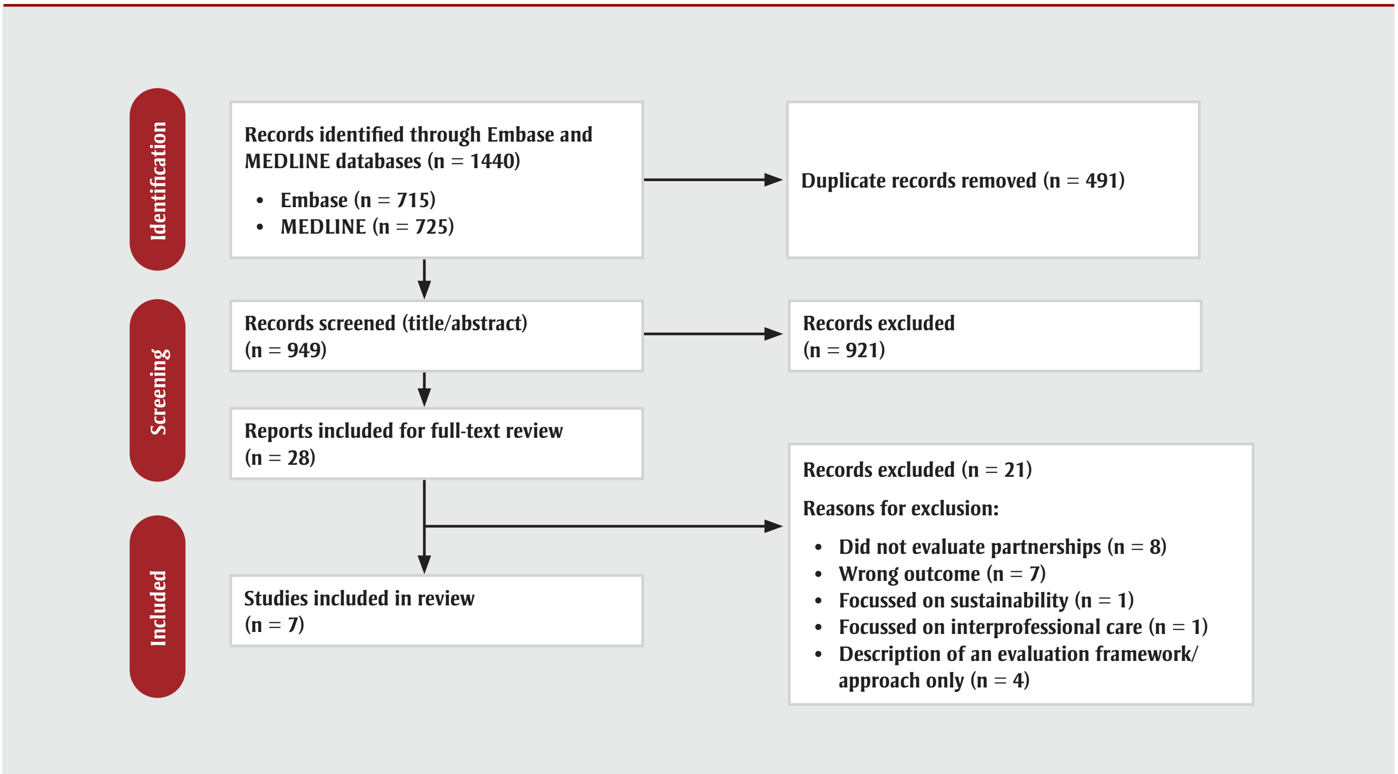
Search strategy results

We identified 1440 articles based on the search strategy (see Figure 1). After the removal of duplicates, 949 articles underwent

TABLE 1
MEDLINE database search strategy

#	Searches	Number of results
1	(((intersector* or inter sector* or multisector* or multi-sector* or interagenc* or inter agenc* or interdepartment* or inter department* or cross sector* or all sectors) adj4 (collaborat* or cooperat* or coordinat* or participat* or alliance* or unite* or work* together or synerg* or joint or partner* or project* or program* or strateg* or affair* or plan* or policy or policies)) or health in all policies or HiAP).ti,kf,kw.	1190
2	(((intersector* or inter sector* or multisector* or multi-sector* or interagenc* or inter agenc* or interdepartment* or inter department* or cross sector* or all sectors) adj4 (collaborat* or cooperat* or coordinat* or participat* or alliance* or unite* or work* together or synerg* or joint or partner* or project* or program* or strateg* or affair* or plan* or policy or policies)) or health in all policies or HiAP).ab. /freq=2	1103
3	*Intersectoral Collaboration/	1087
4	1 or 2 or 3	2964
5	exp *program evaluation/	17 533
6	(evaluat* or assess* or measure* or perform* or framework* or outcome* or success* or fail* or lesson? learned or effective* or efficacy or feasib* or impact* or sustain* or benchmark* or facilitator? or barrier?).ti,kf,kw.	3 212 135
7	((evaluat* or assess* or measure* or perform* or framework* or outcome* or success* or fail* or lesson? learned or effective* or efficacy or feasib* or impact* or sustain* or benchmark* or facilitator? or barrier?) adj4 (collaborat* or cooperat* or coordinat* or participat* or alliance* or unite* or work* together or synerg* or joint or partner* or project* or program* or strateg* or affair* or plan* or policy or policies)).ab. /freq=2	93 123
8	5 or 6 or 7	3 270 870
9	4 and 8	924
10	limit 9 to yr="2012 -Current"	779
11	limit 10 to english	725

FIGURE 1
PRISMA-ScR flow diagram[17] of search strategy methods



Abbreviation: PRISMA-ScR, Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews.

title and abstract screening and 28 articles were identified for full-text review. After full-text review, we included seven articles in this scoping review. These were published between 2013 and 2018, and included evaluations from Australia, Canada and the United States.

Models and indicators

Evaluated intersectoral interventions were in the areas of healthy eating, physical activity, child health, injury prevention, geriatric care, health promotion and chronic disease prevention, and more broadly, health equity. The range of sectors or partners involved in the intervention also differed depending on the focus of the program or on program activities. For example, a multisector collaborative in Minnesota, US that served as a bridging hub for coordinating the delivery of health promotion programs was evaluated with partners from the health care system, community-based organizations and public health.[19] Another example included a cooperative with partnerships across primary care, mental health services, community support services and other local community agencies to coordinate cross-sectoral services to older adults.[20]

An overview of models and indicators used in the studies included in this scoping review is provided in Table 2.

Evaluation types and focus

The types of evaluation differed depending on the goals and outcomes measured. Two studies used a network analysis approach to map and assess the relationships and connectedness between individuals or organizations in a network.[19,21] Network analysis identifies patterns and dynamics of individuals or organizations within a network, yielding insights into the overall network structure, influential entities and flow of information, resources or influence.[21] Collie-Akers et al.[22] used a community- or systems-based evaluation approach to measure the progress of a collaborative health promotion coalition in Kansas, US that had the goal of reducing health inequity in a low-income neighbourhood. Two studies evaluated partnerships by assessing their strength,[20,23] while one assessed partnership functioning over time via a longitudinal process.[24] One study used the Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) framework to assess the impact of intersectoral partnerships within SCI Action Canada, a large health initiative that promotes physical activity among people with spinal cord injuries.[25] This study combined activity-specific with additional approaches, so that in some cases partnership activities were evaluated based on the RE-AIM dimension targeted, and in others, data were gathered across activities to assess other RE-AIM dimensions (e.g. reach).

Overall, the evaluation approaches that most of the studies used did not focus primarily on measuring the direct impact of the intersectoral initiative on health outcomes. Five of the studies assessed the strength and functionality of partnerships,[20,22-25] such as identifying areas for improvement in planning or collaborative action implementation; three assessed intervention partnerships over time;[20,23,24] and the remainder focused on mapping partnership structure and links to demonstrate the strength of relationships between partners.[19,21]

Evaluation methods and analyses

Five studies[19-22,25] used quantitative methods while the remaining two used mixed methods. Five studies used survey designs, including a network survey,[21] the Victorian Health Promotion Foundation Partnership Analysis Tool (VPAT) Partnership Checklist,[23,24] the Partnership Self-Assessment Tool (PSAT)[20] and a level of collaboration survey.[19] Where quantitative data were collected and analyzed, studies used *t* tests and variance estimates to interpret findings. Three studies[20,23,24] used ranking or scores for different survey items. One of these studies used the PSAT to calculate a mean score for items related to six dimensions of partnerships, that is, synergy, leadership, efficiency, administration and management, non-financial resources and financial resources.[20] The mean score indicated how well collaborative processes were working, with high scores indicating strength and low scores indicating a need for improvement. Similarly, two studies[23,24] that used the VPAT to assess the effectiveness of partnerships calculated aggregate scores across key factors for partnership development and success including the need for partnerships, choosing appropriate partners and making sure these partnerships are effective, among others.

Most studies that used surveys included a qualitative component to add context and understanding to quantitative findings. For example, Riggs et al.[24] conducted a longitudinal mixed methods partnership evaluation over 2.5 years using three components: organizational ethnography, partnership survey and semistructured interviews. The authors observed partnership and staff meetings and program classes, and interviewed partners on their understanding of the partnership's purpose, role, strengths and challenges.[24]

Four studies[19,21,22,24] included visual displays, such as network maps and graphs, to show collaborative progress or partnerships. Studies that conducted network analyses showed the strength of ties between partners using multidimensional scaling and algorithms.[19,21] In their network analysis, An et al.[21] also assessed partnerships using network characteristics, namely density, reciprocity, centralization and homophily.

Indicators and use of scores

All of the studies included in this scoping review used indicators for evaluation and/or scores to assess partnership collaboration. The most common indicator, "reach," used by four studies, evaluated the level of engagement or participation of the target population or partners involved in the ISA initiative. In the studies that used a network analysis approach,[19,21] "reach" referred to the extent of engagement or connections between partners or organizations within a network, with the "betweenness centrality indicator" signifying the length of the path between the partners or organization and all others that pass through the network, with a shorter path indicating more direct influence. "Network density," which refers to the extent to which partners or organizations within a network are connected to one another through relationships or collaborations, was also used as a measure to assess network-level reach.[21]

Two studies examined the reach of the target population through intersectoral initiative activities.[22,25] Collie-Akers et al.[22] examined the impact of a collaborative health promotion coalition on low-income residents by measuring the percentage of the study population that experienced a community or system change. For example, the authors reported that at least 21% of the population was exposed to community change as a result of the conversion of an underutilized park into a soccer

TABLE 2
Indicators and models used in the evaluation studies (n = 7)

Author (year) / Country	Indicators	Model/survey/tool
An et al. (2017)[21] United States	Network density: Network density measures the degree to which the agencies in a network are connected. Density value ranges from 0 (completely unconnected) to 1 (completely connected). Network reciprocity: a measure of the likelihood of agencies in a directed network to be mutually linked. Network centralization: 2 indicators to measure network centralization: • Betweenness centrality of individual agencies, an indicator of an agency's influence in a network, equals the number of shortest paths from all agencies to all others that pass through that agency • Betweenness centralization measures the degree to which connections in a network are controlled by a small number of agencies Network homophily: the principle that a connection is more likely to occur between similar agencies than between dissimilar ones. A correlation coefficient measures the degree of network homophily, with values ranging from −1 (when connections only exist between agencies of different type) to 1 (when connections only exist between agencies of the same type). The correlation coefficient was calculated based on the 8 predetermined agency types, i.e. K-12 schools, early childhood centres, emergency food providers, health-related agencies, social resource centres, housing complexes, continuing education organizations and other miscellaneous agencies. Between-network correlation: measures the degree to which 2 networks are correlated. Correlation coefficients were calculated for all pairs of the 4 networks, i.e. communications, funding, cooperation and collaboration networks.	Network analysis / Network survey
Collie-Akers et al. (2019)[22] United States	Intensity scores, as defined by: • duration (i.e. one-time event, occurring more than once or ongoing) • reach (what proportion of the total priority population experienced the change) • strategy (i.e. provided information and enhanced skills; enhanced services and support; modified access, barriers and opportunities; changed consequences; and modified policies and broader conditions)	Community- or system-level analysis: Community-based Participatory Research
Finch et al. (2016)[23] Australia	VPAT scores: Total scores (possible range: 35−175) were categorized into the 3 recommended VPAT levels indicating the degree of partnership functionality. The VPAT checklist: used to assess partners' perceptions across 7 domains: (1) determining the need for a partnership (2) choosing partners (3) making sure partnerships work (4) planning collaborative action (5) implementing collaborative action (6) minimizing the barriers to partnership (7) reflecting on and continuing the partnership Items within each VPAT domain were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), then summed to give an overall domain score representing partnership function.	VPAT Partnership Checklist
Gutmanis and Hillier (2018)[20] Canada	PSAT score: calculation of mean score (range: 1–5) for each item of 6 dimensions of partnerships: synergy, leadership, efficiency, administration and management, non-financial resources and financial resources: • Scores of 1–2.9 = area needs a lot of improvement • Scores of 3–3.9 = more effort is needed in this area to maximize the partnership's collaborative potential • Scores of 4–4.5 = although the partnership is doing well, it has potential to progress • Scores of 4.6–5 = partnership excels in this area	Partnership Self-Assessment Tool (PSAT)

Continued on the following page

TABLE 2 (continued)
Indicators and models used in the evaluation studies (n = 7)

Author (year) / Country	Indicators	Model/survey/tool
Leppin et al. (2018)[19] United States	Network membership: the number and names of organizations in a network, including their type, sector/mission, size Network Interaction: geographical location of organizations and the ties that connect them, including presence and types of subnetworks Role and reach of the bridging hub: measures of in-degree and betweenness centrality and proportions of organizations linked to the bridging hub and/or number of subnetworks bridged Network collaboration: measures of collaboration or frequency of interactions, trust and reciprocity of communication or a combination of these	Social Network Analysis
Riggs et al. (2014)[24] Australia	VPAT scores are categorized into 3 levels indicating degree of partnership functionality: • Scores of 0–49 = the whole idea of the partnership should be rigorously questioned • Scores of 50–91 = the partnership is moving in the right direction, but it requires more attention to be really successful • Scores of 92–140 = a partnership based on genuine collaboration has been established. The challenge is to maintain its impetus and build on the current success	VPAT Partnership Checklist
Sweet et al. (2014)[25] Canada	Indirect reach: • the number of Canadians without a spinal cord injury (SCI), e.g. family members, health care providers, who were sent information from SCI Action Canada, who were invited to a presentation or who participated in an initiative • the number of unique visitors to the SCI Action Canada website Intended reach: the number of resources sent out to SCI or disability-specific organizations for distribution to adults with SCI Direct reach: • the number of Canadians with SCI who attended SCI Action Canada events • the number of Canadians with SCI who participated in SCI Action Canada programs, initiatives and research studies • the number of resources given to Canadians with SCI Adoption: the number of partners engaged in the partnership Implementation: the degree to which the partnership's strategic plan was completed as intended Organizational maintenance: the extent to which partners remained engaged in the partnership over the years Effectiveness: • difference in LTPA prior to and after the launch of SCI Action Canada • whether LTPA participation rates increased in the SCI population • change in the proportion of Canadians with SCI meeting the physical activity guidelines for adults with SCI • % of Canadians with SCI who are aware of ▫ SCI Action Canada, and/or ▫ the physical activity guidelines for adults with SCI	RE-AIM (Reach, Effectiveness, Adoption, Implementation and Maintenance) framework

Abbreviations: LTPA, leisure time physical activity; PSAT, Partnership Self-Assessment Tool; RE-AIM, Reach, Effectiveness, Adoption, Implementation and Maintenance; SCI, spinal cord injury; VPAT, Victorian Health Promotion Foundation Partnership Analysis Tool.

field. Sweet et al.[25] evaluated SCI Action Canada using the RE-AIM framework, with reach measured using three different indicators: indirect reach, intended reach and direct reach.

Two studies used VPAT scores to assess partner perceptions across seven domains, that is, determining the need for a partnership, choosing partners, making sure partnerships work, planning collaborative action, implementing collaborative action, minimizing the barriers to partnership, and reflecting on and continuing the partnership.[23,24] The scores were then categorized into three levels, indicating the degree of partnership functionality from weak to strong. Similarly, Gutmanis and Hillier[20] used PSAT scores to identify the strengths, weaknesses and synergies of partnerships across the areas of leadership, efficiency, administration and management and sufficiency of resources. Similar to VPAT, PSAT scores are categorized into levels indicating how well the partnership excels in each area.

Barriers and facilitators to evaluating intersectoral programs

Barriers and facilitators across the studies affect the process of assessing intersectoral initiatives. Given that most evaluation tools used surveys with self-reported responses, results were subject to measurement error, recall bias, nonresponse bias, missing/inaccurate data and other limitations. Several studies noted how difficult it was to obtain high response rates to surveys, either due to an inability to reach participants or because participants were not interested in responding or lacked the time.[19-21]

Another challenge reported by the studies included in this scoping review[20,21,23] and elsewhere[26] was the lack of consistent and long-term partnerships, complicated by changing representatives and leadership turnover. In addition, survey tools were limited to addressing changes in partnerships; for instance, Riggs et al.[24] found that the views of respondents had changed between the partner survey when the data were first collected and a subsequent qualitative interview. Other complex factors in ISA initiatives are those that influence relationship and partnership building, such as perceived authority and empowerment in the decision-making process.[20]

Despite the drawbacks to evaluating intersectoral initiatives, common facilitators promoting the use of tools included their usability, cost-effectiveness and minimal time commitment for participants.[20] Visualizations facilitated reflection and understanding, and allowed for adjusting efforts if needed.[22] Some studies also reported positive discussions on evaluation results to do with communication, roles and responsibilities, shared interests and trust.[23,24] The use of qualitative methods, such as ethnography, in some cases helped to build rapport and trust with participants by ensuring that evaluation findings were relevant and useful to all partners.[24]

Discussion

Evaluating the effectiveness of ISA partnerships provides critical insights for enhancing collaboration and improving the overall effectiveness of ISA in addressing complex public health challenges, as a necessary element of HiAP implementation. We identified four examples of evaluations that assess the effectiveness of ISA partnerships from Australia, Canada and the United States. The most common evaluation approach was network analysis. Other evaluation approaches were community- or system-level analyses, partnership evaluations and longitudinal process evaluations. Through this scoping review, we also identified various tools used in evaluations including network surveys, VPAT, PSAT and level of collaboration surveys.

Our findings show that evaluation is important for assessing partnership effectiveness, accountability and transparency while promoting learning within collaborative partnerships. Specifically, evaluation helps to assess the effectiveness of certain partnerships in achieving project outcomes and goals, which can increase health actors' understanding of partners' policy priorities, strengthening codevelopment processes.[4] Evaluations can also improve knowledge of partners' areas of expertise, further building trust and improving communication between partners during collaborations and negotiations.[4]

This scoping review revealed that qualitative methods such as semistructured interviews can help promote partner engagement by including the partners' views on what they considered effective in achieving their goals.[24] This collaborative approach can encourage a sense of ownership and responsibility for the evaluation findings and recommendations. In addition, evaluation tools can hold partners accountable and promote transparency by clearly describing partnership roles and conditions for success. This finding is consistent with reports on HiAP development, implementation and evaluation in which key factors such as accountability, transparency and sustainability are embedded.[27,28]

The aim of this scoping review was to help fill the knowledge gap on how program planners and evaluators can assess the dynamics of intersectoral partnership collaboration as a key component of HiAP, the factors that contribute to effective collaboration and the barriers and challenges. The seven studies included in this scoping review were conducted in countries where ISA is increasingly recognized as a key strategy for population health and health equity, namely Australia,[23,24,29] Canada[20,25,30] and the United States.[19,21,22,31] While the sample of articles analyzed is not large enough to determine trends or draw conclusions, the focus of work from these settings aligns with recent policy developments that cross sectors and involve the coordinated efforts of departments and ministries to jointly act on health or other well-being outcomes (e.g. South Australia's 2007 HiAP program,[7] Canada's 2021 Quality of Life Strategy[32]). As such, the results not only highlight the proliferation of intersectoral initiatives, but also demonstrate the importance of implementing ISA effectively to achieve desired goals.

Despite this promise and the development of new intersectoral initiatives internationally,[6] there remains a gap in the evaluation of intersectoral efforts in the academic literature. The reasons for this gap may include the difficulty of attributing successful outcomes of ISA initiatives to their partnerships as well as the complex nature of issues being addressed that require long-term observation. The literature in this scoping review described various models that can navigate the complexity of ISA partnerships and demonstrate the value of these initiatives even if direct outcomes cannot be attributed to specific partnerships. The model most commonly used by the studies in this scoping review was network analysis, possibly because of its strength in evaluating relationships between network members and in examining how relationships impact program outcomes.[19,21] The ability of network analysis to produce a comprehensive map of an intersectoral network, including its key members, connections and communication patterns, can be useful for evaluating intersectoral initiatives.[19] The Esmaili et al. review also found network analysis, including social network analysis, to be one of the most commonly used models of intersectoral collaboration.[33]

Some of the tools identified in this scoping review may help to overcome some of the challenges health actors face when seeking to collaborate with other sectors. "Health imperialism," or the overemphasis of health in intersectoral policy goals,[34] can create conflicts to do with resources, values and divergent interests in policy codevelopment, and is a recognized barrier to developing ISA partnerships.[4] Some evaluation tools, like the PSAT, offer insights into areas where conflicts within a partnership may arise, such as in communication and information sharing, roles and responsibilities, the decision-making processes, and the adaptability and flexibility of partners.[20] Although the use of this tool can shed light on potential conflicts, strategies to negotiate these differences are still needed. To support new ways of implementing HiAP, for example, the World Health Organization suggests being prepared to negotiate, being flexible and adaptable, and creating platforms for dialogue and problem solving related to policy, among other strategies.[4]

It is also important to note the benefits and drawbacks to the types of data utilized in evaluations. Network analysis, for instance, does not assess qualitative aspects that are vital to collaborations (e.g. trust, shared values, power dynamics) but focuses on the structure of partnerships. Triangulating quantitative data with qualitative data can therefore offer a more comprehensive understanding of intersectoral partnerships. For example, Riggs et al.[24] added a qualitative dimension to their evaluation by using an organizational ethnography approach as well as semistructured interviews; this led to a more in-depth analysis of their survey results. Across the studies, partners' views on key components of effective partnerships, including trust, respect and open communication, were found to improve program delivery, enhance long-term relationships and facilitate partners' consensus on decisions.[23,24] These findings also align with existing literature on facilitators to intersectoral collaboratives, where trust, respect and open communication between partners were highlighted.[35-37] It is therefore important to establish key characteristics of an effective partnership at the outset of plans to evaluate partnerships.

Strengths and limitations

The primary limitation of this study is the focus of the search strategy on ISA, a term and concept stemming from the health field. The use of the two particular databases may have resulted in health literature and health sector findings being overrepresented. It is possible that studies from non-health sectors unfamiliar with health sector terminology used alternative terms to describe ISA initiatives that were not captured in the search. In addition, our search of peer-reviewed literature may have missed relevant work from grey literature sources. There may be relevant findings, for example, from community settings. As no pertinent literature reviews in this topic area were identified prior to undertaking this work, we did not systematically sample from the reference lists of existing reviews.

Finally, it is important to acknowledge that ISA is insufficient as a measure for assessing the effectiveness of HiAP. While ISA captures the collaborative ways of working that are critical to HiAP implementation, an evaluation of HiAP would require assessing the other pillars: governance and accountabilities, leadership at all levels and resources, financing and capabilities.[4] However, ISA does represent an important step towards the codevelopment of healthy public policies, and we hope that this scoping review encourages groups who have evaluated ISA partnerships to publish their results and add to the evidence base.

Despite these limitations, this study has shown there to be a significant gap between the number of studies reporting on ISA initiatives and the number of studies that evaluated these efforts (i.e. seven full-text articles). Our findings are anticipated to be of use mainly for those working in the health sector.

Conclusion

More evaluations of ISA initiatives are needed in order to better understand the effectiveness of these initiatives so that they may contribute to the implementation of HiAP approaches for health and health equity.

We encourage program managers and practitioners who have completed evaluations to share their findings broadly. Each ISA initiative has unique challenges, and it is beneficial to learn how various projects were able to respond to these in different settings. We also suggest conducting more work on the evaluation of ISA initiatives that focus on:

- How to address changes in partnerships when evaluating their impact and how to withstand these changes throughout implementation;
- How to integrate equity, diversity and inclusion into evaluations; and
- How to take into account the impact of structural and social determinants of health on ISA partnerships (e.g. power dynamics, examining the representation and participation of diverse interested parties, resource distribution, decision-making structures, etc.).

In this article we identified methods, tools and indicators that program managers, researchers and program evaluators can use when conducting evaluations on intersectoral partnerships. Evaluations in this area have the potential to identify disparities and promote evidence-based decision-making. By identifying areas for improvement within ISA partnerships, evaluations play an important role in advancing equitable health outcomes for diverse populations.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

RA: Conceptualization, methodology, writing – original draft, writing – review & editing.

AN: Conceptualization, methodology, supervision, writing – review & editing.

JN: Methodology.

KL: Methodology, supervision, writing – original draft, writing – review & editing.

All authors have reviewed and approved the final manuscript.

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Call for papers: Generating stronger evidence to inform policy and practice: natural experiments on built environments, health behaviours and chronic diseases

Guest editors: Dr. Stephanie Prince Ware (Public Health Agency of Canada), Dr. Gavin McCormack (University of Calgary)

HPCDP Journal Editors: Robert Geneau and Margaret de Groh (Public Health Agency of Canada)

Where we work, learn, play, eat and live has important implications for health. The built environment has been associated with the development of chronic disease, and with health behaviours often seen as critical pathways for this relationship.[1,2] Built environments refer to components of the physical environment that are human-made or human-modified and include structures and buildings, recreation facilities, green spaces and parks, transportation systems and community design.

Natural experiments are interventions that occur without a researcher's ability to manipulate the intervention or exposure to the intervention.[3,4] Natural experiments offer the opportunity to evaluate the effects of "naturally occurring" interventions such as changes to the built environment (e.g. creation of a new bike path, park improvements, infrastructure changes to schools or workplaces, construction of a new recreation facility or grocery store) on health behaviours and chronic disease risk. Natural experiments are often more practical for investigating the health impacts of environmental interventions when compared to traditional experimental studies (e.g. randomized controlled trials). Compared to cross-sectional studies, natural experiments provide a means to generate rigorous evidence to better establish causality, as well as to understand the implementation of interventions in "real-world" scenarios.

This special issue answers the 2017 Canadian Public Health Officer annual report's call to further evaluate the health impacts of community design features in Canada.[5] This special issue resonates with the expanding scholarly and policy-oriented interest in the utility of natural experiments as a critical tool in advancing the body of evidence and for informing interventions to improve public and population health.[6,7] Specifically, the objective of this special issue on natural experiments is to provide timely evidence to further understand the effectiveness of built environment interventions on health behaviours and chronic disease prevention in a Canadian context.

Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice is seeking relevant topical research articles that present new findings or synthesize/review existing evidence on natural experiments of the built environment (or related policies) that influence health behaviours with implications for chronic disease prevention in Canada.

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- Built environments, including community or neighbourhoods, workplaces, schools, transportation infrastructure, home environments, recreation environments, parks, playgrounds, green spaces, public open spaces, natural environments and seniors' residences.
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- Chronic diseases and health-related outcomes, including body mass index, fitness, blood pressure, blood lipids, blood sugar, injuries, falls, mental health, stress, depression, anxiety, Alzheimer's disease, dementia, obesity, metabolic syndrome, cardiovascular disease, cancer, diabetes and lung disease.

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