



# Developments and Changes in Primary Public Health Outcome Indicators Associated with the Legalization of Non-Medical Cannabis Use and Supply in Canada (2018): A Comprehensive Overview

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## Abstract

Canada legalized non-medical cannabis use and supply for adults in 2018. We examined developments and changes associated with the legalization policy reform on key indicators for public health, namely cannabis (including frequent/problematic) use prevalence, cannabis-related hospitalizations, cannabis-impaired driving, and cannabis sourcing. We identified peer-reviewed and “grey” study data that featured population-level or other quasi-representative samples and comparable outcome data for pre- and post-legalization periods, including possible trends of changes over time. Cannabis use has increased in select population groups, with use modes shifting away from smoking. Evidence on cannabis-related hospitalizations (e.g., for mental health) is mixed. The prevalence of cannabis-impaired driving appears to be generally steady but THC exposure among crash-involved drivers may have increased. Increasing proportions of users obtain cannabis products from legal sources but some—especially regular—users continue to use illicit sources. Overall, data suggest a mixed and inconclusive picture on cannabis legalization’s impacts on essential public health indicators, including select extensions in trends from pre-legalization.

**Keywords** Cannabis · Policy · Health · Outcomes · Legalization · Canada

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## Introduction

Cannabis is and remains defined as illegal in the vast majority of countries, and on this basis, the most commonly used illegal drug globally (UNODC, 2022). Over the past decade, public control approaches for non-medical cannabis use and supply have evolved towards liberalized policies in an increasing number of jurisdictions (Fischer et al., 2020a, 2020b; Hall et al., 2019; Pardo, 2014). These have included varying forms of “decriminalization” of personal use and supply and, more recently, the “legalization” and regulation of adult cannabis use and supply in Uruguay, 18 US states, Malta, and Thailand. Additional countries including Germany, Luxembourg, and Mexico are considering cannabis legalization for policy reform.

Canada—the only G-7 country so far to have done so—implemented the legalization of non-medical cannabis use and supply on 17 October 2018 (Government of Canada, 2021b, 2022). Legalization was brought on as a policy reform initiative of a newly elected Liberal federal government, whose “Cannabis Act” (CA) provided the legal framework to regulate non-medical cannabis use and supply. The CA facilitated the creation of a commercial, federally regulated cannabis production industry. It also sets the parameters for legal product availability, retail systems, use controls, some subject to additional specifications by Canada’s 13 jurisdictions of provinces/territories (Cox, 2018; Lancione et al., 2020).

In most provinces/territories, persons ages 19 years or older—the same legal age limit as for alcohol—can legally access cannabis. The exceptions are Alberta (18 years) and Quebec (21 years). A general possession limit of 30 g of dried cannabis or equivalent applies. Most provinces/territories restrict cannabis use in public; operate either a publicly run, or public/private hybrid model of cannabis-only storefronts in combination with online sales from licensed producers for retail distribution. Most also allow “home growing” of (up to four) cannabis plants (CCSUA, 2022). In 2019, the federal government expanded the menu of legal cannabis products (e.g., dried flower or oils) available by allowing the sale of edibles and extracts (Government of Canada, 2022). The CA retained prohibitions on illegal cannabis production, distribution, and importation. It also created a range of new offenses, including, for example, the possession of cannabis over the legal limit, distribution of cannabis to youth and the possession of > 5 g of cannabis by (underage) youth. In addition, per se laws were established for cannabis-impaired driving (based on cannabinoids in body fluids at 2 ng of THC/milliliter of blood and up) (MADD Canada, 2022).

Cannabis legalization was implemented with three explicit policy objectives: (1) to “keep cannabis out of the hands of youth” (or reduce youth cannabis use); (2) to “keep profits out of the pockets of criminals” (or eliminate illicit cannabis markets); and (3) to “protect public health and safety by allowing adults access to legal cannabis” (or to improve overall public health and safety outcomes through legalization).

Legalization—in Canada as much as elsewhere—remains a controversial “policy experiment” (Fischer et al., 2016; Kelsall, 2017; Leyton, 2019; UNODC, 2022). It is essential for evidence-based policy monitoring and development to assess the policy’s associated outcomes. To date, most research on cannabis legalization effects has occurred in the USA, including comparisons of health and safety outcomes between legalization and non-legalization states (Chiu et al., 2021; Hall et al., 2019; Hammond et al., 2020; O’Grady et al., 2022). The results have been described as “mixed,” i.e., with some legalization being associated with adverse developments in some areas but not in others, while also

too preliminary for definitive conclusions. Previously tabled conceptual frameworks have proposed indicators of principal importance for monitoring legalization's impacts on public health (Fischer et al., 2018; Lake et al., 2019). Four years into the implementation of cannabis legalization in Canada, select data indicators and sources are available that allow an at least preliminary assessment of empirically documented developments and possible changes in several of these key areas. On this basis, the objective of this paper has been to comprehensively assess and document the developments and impacts of cannabis legalization in Canada on primary public health outcome indicators as defined above.

## Methods

For our comprehensive assessment and overview of outcomes association with legalization policy reform, we focused on identifying and collecting original indicator data previously identified as essential for monitoring the main public health outcomes of cannabis legalization in Canada (Fischer et al., 2018). These included the following substantive outcomes for which multiple (i.e., > 1) indicator datasets were available: cannabis use prevalence; high-frequency cannabis use; problematic cannabis use/use disorder; mode/products of cannabis use, cannabis-related hospitalizations/morbidity, cannabis-impaired driving and related motor-vehicle-crashes, and sourcing of cannabis products. Our search was operationalized by way of the above indicator terms and identifying related content data, and focused on identifying publicly available indicator data from samples that were national or provincial in scope, or comprised a clearly specified, population-representative or quasi-representative sample (e.g., hospital registry- or admission-based) population and analysis approach. Searches for available data were conducted up until 15 August 2022. Data focusing on primarily medical cannabis use, or based on selective sub-samples, for example as defined by specific health conditions (e.g., pregnant women), were not considered for inclusion.

We only included studies that featured clearly delineated, comparable outcome data for specified periods or timepoints that minimally included at least one observation for both before and after the implementation of legalization (i.e., 17 October 2018). We considered pre-legalization data for 2015 onward; the most recent post-legalization data was for 2021. Given the topical foci, our data search and identification process included both peer-reviewed journal- and “grey” literature (e.g., government/survey reports)-based data, based on both scientific database and Internet- and/or manual searches.

Descriptive or analytical data results for reported pre- and post-legalization observations of pre-identified indicator data for general population samples and selected (e.g., age group-specific) main sub-populations were identified and extracted as available. Descriptive data results (e.g., prevalence, proportions, or case numbers) were narratively summarized, organized, and presented by indicator topic, with a focus on possible trends or significance of changes from before to after legalization. We report significant changes, trends, or differences for each of the respective indicators as available reported from information provided by the original data source. For ease of readability, analytical data specifics like confidence intervals and *p*-values were not included but instead can be found in the original sources referenced. Given the markedly diverse nature and sources of (both scientific journal and indexed as well as a substantive extent of “grey literature” (e.g., survey/report) data involved and reported here, this review did not endeavor to follow the strict and formal protocol (e.g., reporting) steps of a “systematic” review and hence is also not framed as

such; rather, it represents a comprehensive, broad-based overview of key indicator data as currently available which should be built on and extended by rigorous and in-depth (e.g., systematic review/meta-analytical, other) methods and approaches, also once required data details become available for the different outcome areas.

## Results

### Cannabis Use Prevalence

In the National Cannabis Survey's (NCS; ages 15+ years) general population sample, the prevalence of cannabis use (in the past 3 months) significantly increased from 14.0% in the first quarter (I)/2018 to 17.5 in the first quarter (I)/2019, and 20.0% in the fourth quarter (IV)/2020. The NCS reported the highest use rates among ages 18–24 years (28.1%, 34.8%, and 35.6%, respectively). The (only published) prevalence among underage users (< 18 years) was 19.2% in the last quarter of 2020 (Rotermann, 2021).

In the annual samples of the Canadian Cannabis Survey (CCS) for 2017–2021, the prevalence of cannabis use in the past 12 months varied slightly, from 22% in 2017 and 2018, to 25% in 2019, 27% in 2020, and 25% in 2021. The prevalence of use was highest among those aged 20–24 years (45%, 44%, 51%, 52%, 49%), and higher than the total sample population among underage respondents (41%, 36%, 44%, 47%, 37%) (Government of Canada, 2017, 2018a, 2019, 2020, 2021a, 2021b).

In the Canadian Student Tobacco, Alcohol and Drugs Survey (CTADS; 2018/19, with data collected October 2018–June 2019) comprising more than 62,000 post-secondary students in grades 7–12, the prevalence of cannabis use (in the past year) was 18% and 29% in grades 10–12 only. There were no changes in the prevalence of use from 2016/17 based on its predecessor, the Youth Smoking Survey (YSS; 2016/17) (Government of Canada, 2018b).

In a large, multi-provincial cross-sectional cohort of high-school students (COMPASS study, grades 9–2), the rate of “ever use” of cannabis increased from 30.5% pre-legalization (2016/17 school year) to 32.4% post-legalization (2018/19) ( $p=0.0090$ ). There were no changes in frequency-of-use metrics examined (Zuckermann et al., 2021).

In the provincial CAMH Monitor survey of Ontario's general population adults (18+ years), Canada's most populous province, cannabis use in the past 12 months increased from 19.4% in 2017 and 19.9% in 2018 to 25.6% in 2019 and 31.9% in 2020 (Nigatu et al., 2020a; Nigatu et al., 2020b).

### Frequency/Patterns of Use

In the NCS' total population sample, the proportion who reported daily or near daily cannabis use (in the past 3 months) increased modestly from 5.4% in (I)/2018 to 6.1% in (I)/2019, 7.9% in (IV)/2020 (Rotermann, 2021). Based on changes in use prevalence, these rates would represent generally stable proportions of frequent cannabis users over time. The rate of increase in daily/near daily use was highest among young adult users ages 18–24 years (9.9%, 12.5%, 16.3%), respectively.

In the CCS, the proportion of those who reported cannabis use (in the past 12 months) who reported daily/near-daily use 2017–2021 was generally steady at approximately a quarter of users (24%, 25%, 24%, 26%, 26%) (Government of Canada, 2017, 2018a, 2019, 2020, 2021a, 2021b).

Among the COMPASS study's multi-provincial sample of high school students (grade 9–12) who had reported cannabis use pre-legalization (2017/18), a latent class analysis showed significant transition effects to multimode cannabis use status and/or increasing frequency of multimode use in post-legalization assessments (2018/19), implying overall intensifying cannabis use patterns overtime (Doggett et al., 2022).

In the International Cannabis Policy Studies' (ICPS) total annual samples of respondents (ages 16–65 years) from Canada, daily/near-daily use of cannabis increased from 8.9% in 2018 before legalization to 11.3% (2019) and 11.8% (2020) following legalization (Hammond et al., 2022).

## Modes of Use

In the NCS, “smoking” herbal cannabis products as was the most common method of cannabis use, although its prevalence declined from 65.3% in I/2019 to 58.3% in IV/2020 and these decreases were negatively associated with age. The corresponding—steady—overtime prevalence values of cannabis “vaping” were 12.9% and 11.9%, and “consumption as food or drink” was 13.2% and 18.6% (Rotermann, 2021).

In the Canadian Cannabis Survey (CCS), “cannabis” was the most common mode of cannabis use, while decreasing from 94% in 2017 to 74% in 2021. Conversely, “edibles” use increased from 34% to 54% in and so did “vaping/e-cigarette use” from 20% in 2017 to 28% in 2021. Changes for each of these use modes were significant between at least some of the survey years (Government of Canada, 2017, 2018a, 2019, 2020, 2021a, 2021b).

The ICPS' annual survey (2018, 2019, 2020) of Canadian respondents aged 16–65 years who had used cannabis in the past 12 months in 2018, 2019, and 2020 identified dried flower (81%, 76%, 73%), edibles (38%, 44%, 53%), and oral liquids (22%, 32%, 34%) as the most commonly used products form. There were significant changes over time in the use of each of these product types (Hammond et al., 2022).

In the CTADS (2018/19) and YSS (2016/17) surveys of secondary students, “smoking” was reported as the most common method of cannabis consumption. It however decreased from 80 to 76%, while there were increases in the use of “edibles” (34 to 45%) and “vaporizing/vaping” (30 to 42%) over the periods (Government of Canada, 2018b).

## Problematic Use (As Defined by Standardized Assessments)

There was a modest increase in the proportion of past-year cannabis users in Ontario's general adult population (CAMH Monitor) who had a score on the ASSIST-CIS 4+ (Alcohol, Smoking and Substance Involvement Screening Test), indicating “moderate or high risk” of cannabis use problems from 53.3 (2017) to 58.6% (2018) and 57.9% (2019) (Nigatu et al., 2020a; Nigatu et al., 2020b).

Based on a hospital registry-recruited adult community cohort ( $n=1502$ ) in Hamilton, Ontario, among those reporting cannabis use and assessed in the month before legalization in 2018, there was a significant decrease in the severity of cannabis misuse but not

problematic use as measured by the Cannabis Use Disorder Identification Test (CUDIT) at 6 months and 12 months after legalization (Turna et al., 2021).

### **Morbidity/Hospitalizations (General/Adult Populations)**

A study of emergency department (ED) presentations in the provinces of Alberta and Ontario from 01 April 2015 to 31 December 2019 found that cases of ICD-10-CA-defined cannabis-induced psychosis doubled. However, time-series analysis of the data did not find significant step-function effects in weekly ED counts after legalization for cannabis-induced psychosis (0.34) or schizophrenia (24.34), nor for ED counts of alcohol-induced (0.61) or amphetamine-induced psychosis (1.93) that were assessed for comparison (Callaghan et al., 2022).

An interrupted time-series analyses of cannabis-attributable ED visits in the Ontario general population (ages 15+;  $n=13.8$  million) for the period January 2016–May 2021 found more varied trends over time. There was a significant increase in cannabis-attributable ED visits before legalization that was followed by a significant immediate 12% increase in rates of cannabis-attributable ED visits in the early legalization phase (Oct 2018–Feb 2020), followed by a significant attenuation of the pre-legalization slope. The more recent legalization phase (March 2020–May 2021) was associated with additional significant increases of 22% in rates of cannabis-attributable ED visits and 17% in the proportion of all-cause ED visits attributable to cannabis, yet with insignificant increases in monthly slopes (Myran et al., 2022a, 2022b).

An interrupted time-series analysis of ED visit data for 14 urban EDs in Alberta (01 October 2013–July 31, 2019) estimated that three-in-1000 ED visits were cannabis related. The number of cannabis-related ED presentations significantly increased after by 3.1 visits per ED per month after legalization. Cannabis-related calls to poison control also increased by 4.0 calls/month (Yeung et al., 2020).

Data from a retrospective patient cohort (12+ years;  $n=1247$ ) who attended emergency psychiatrist services in a Quebec university hospital over the 5 months immediately following cannabis legalization compared with data from 2 years prior to legalization ( $n=1368$ ) found a significant increase in cannabis-related presentations (28.0 to 37.1%). It also found an increase in diagnoses of cannabis use disorder (17.7 to 24.3%; see source study for diagnostic standards) among adults but not underage patients. There were no differences in diagnoses of psychotic disorders (27.4 to 29.2%) but a greater proportion presented with a personality disorder (39.6 to 44.9%) after legalization (Vignault et al., 2021).

A retrospective chart review of ED visits with a cannabis-related (ICD-10) discharge code at an academic hospital in Hamilton, Ontario, found no difference in the overall rate of ED visits (2.44 vs. 2.94 visits/1000) in the 6 months before and after legalization. However, there was a 56% increase in visits among adults aged 18–29 and after legalization. More of these patients required clinical observation rather than interventions (25% vs. 48%), bloodwork and imaging studies decreased (53% vs. 12%), while treatment with benzodiazepines increased (24% vs. 51%) (Baraniecki et al., 2021).

### **Morbidity/Hospitalizations (Youth/Child Populations)**

Analyses of health administrative data on ED visits for the child population (aged 0–9 years) in Ontario, Canada, 01 January 2016–31 March 2021 showed a total of 522

cannabis-related ED visits, including 81 visits during the pre-legalization period, 124 visits during period 1 of legalization (October 2018–January 2020), and 317 visits during period 2 of legalization (February 2020–March 2021), representing a significant increase. There were 19 ED visits (3.6%) requiring intensive care unit admission but no deaths were recorded. Period 2, which included the introduction of legal cannabis edibles, represented a larger increase. Furthermore, the proportion of cannabis-related ED visits with hospitalization increased significantly during period 2 compared to the other periods (Myran et al., 2022a, 2022b).

An analysis of trends found that cannabis-related hospitalizations in Quebec non-significantly increased from 5.2/100,000 for the period October 2017–March 2018 (before legalization) to 9.5/100,000 in October 2018–March 2019 (after legalization) among boys ages 10–14 years. However, the proportion of cannabis-related substance-related hospitalizations in this sub-group did significantly increase from 39.3 to 70% from pre- to post-legalization, while there were no significant changes in boys aged 15 to 19 years or among girls in any age group (Auger et al., 2021).

Trend analyses of cannabis-related visits to urban EDs in Alberta involving patients ages < 18 years (01 October 2013–29 February 2020) did not find a change in the volume of visits after legalization after accounting for pre-existing trends. Rates of unintentional cannabis ingestions significantly increased in children and older adolescents. However, presentation patterns remained similar apart from a reduction in other co-ingestion product use among older adolescents and an increase in cases involving hyperemesis (Yeung et al., 2021).

A retrospective analysis of an under-age (< 19 years) patient cohort attending a large pediatric ED in Toronto did not find significant differences in the median monthly numbers of ED presentations with cannabis intoxication, from 232 (77.8%) from the pre-legalization period (2008–2017) to 66 (22.1%) in the peri-/post- legalization period (2017–2019). However, there was a significantly higher proportion of ICU admissions in the latter period (13.6% vs. 4.7%), and indicators of clinical severity (e.g., mental, respiratory status) were higher after legalization. There were also more children < 12 years (12.1% vs. 3.0%) treated for unintentional cannabis exposures (14.4% vs. 2.8%) and edibles ingestion (19.7% vs. 7.8%) (Cohen et al., 2022).

## Cannabis-Related Driving and Traffic-Injuries

In the CCS, the proportions of those who had used cannabis in the past 12 months and indicated that they had driven a vehicle within 2 h of smoking cannabis varied slightly, from 29% in 2017, 27% in 2018, 32% in 2019, before decreasing to 25% in 2020 and 22% in 2021. After 2019, this included driving a vehicle after 2 h of smoking or 4 h after ingesting cannabis (Government of Canada, 2017, 2018a, 2019, 2020, 2021a, 2021b).

In Ontario's total general adult population ages 18+ years (CAMH Monitor), the prevalence of self-reported driving within 1 h of consuming cannabis in the past 12 months remained steady at 2.6% in 2017, 3.1% in both 2018 and 2019, and 2.7% in 2020 (Nigatu et al., 2020a; Nigatu et al., 2020b). Given observed increases in cannabis use prevalence through this period, these rates suggest a decline (of approximately one-third) in the annual self-reported rates of driving after cannabis use among users.

There were no significant changes found to be associated with cannabis legalization (2018) on ED visit for traffic injuries (2015–2019) in a time-series analysis of data focusing on all and youth-only drivers in the provinces of Alberta and Ontario. In Alberta, there

were 52,752 traffic-injury presentations with an increase of 9.17 visits and 3265 presentations and a decrease of 0.66 visits among youth drivers; correspondingly in Ontario, there were 186,921 presentations/28.9 increase in all drivers and 4565 presentations/increase of 0.09 visits among youth drivers; all non-significant) (Callaghan et al., 2021a, 2021b).

A study assessed blood levels of THC in 4339 (3550 pre- and 789 post-legalization) drivers moderately injured in an MVC and treated in four British Columbia trauma centers (January 2013–March 2020). This study found significantly elevated levels of THC in blood for different cut-off levels (9.2% of drivers for  $>0$  nanogram (ng)/milliliter, 3.8% for  $>2$  ng/milliliter, and 1.1% for  $>5$  ng/milliliter before legalization, and 17.9%, 8.6%, and 3.5%, respectively after legalization. By comparison, there were no significant changes in the prevalence of alcohol-positive cases (Brubacher et al., 2022).

### Sourcing of Cannabis Products

In the NCS's total sample, the proportion of current cannabis users who reported sourcing cannabis from "legal sources" increased from 22.9% in (I)/2018 to 47.4% in (I)/2019 and 68.4 in (IV)/2020 (Rotermann, 2021). Self-growing' by the user or another person increased from 8.0% to 9.0% and 14.2%, while sourcing from "friends and family" declined from 47.0%, 37.0%, and 28.6%, respectively.

In the CCS (pre-legalization) in 2018, 4-in-5 of users declared their intention to obtain their cannabis from legal sources when these would become available. Subsequently, the self-reported, actual "usual" use of legal cannabis sourcing options was 24% for "legal storefront," 13% "legal online" purchases, and 6% "self-growing" in 2019, with reported following increases for each option, namely to 41%/13%/7% in 2020 and 53%/11%/8% in 2021, respectively (Government of Canada, 2017, 2018a, 2019, 2020, 2021a, 2021b).

The ICPS' cross-sectional surveys of Canadian respondents (16–65 years) who had purchased dried cannabis flower products in the past 12 months ( $n=4923$ ) showed that the proportion of those who had last purchased from legal sources increased from 45.7% in 2019 to 58.1% in 2020. The corresponding percentage of dried flower consumers who reported any purchasing from legal sources in increased from 55.7 to 67.5%. These increases coincided with significant decreases in the mean price of legal dried flower in 2020 (\$12.63 vs. \$11.16) which was more expensive than an illegal dried flower in both years (\$12.63 vs. \$9.04 in 2019; \$11.16 vs. \$9.41 in 2020) (Wadsworth et al., 2022a, 2022b).

Among the ICPS' 2019 and 2020 cannabis user respondents from jurisdictions with legal cannabis markets in Canada or US states, 61.1% reported an illegal cannabis purchase (authors' own estimates based on data from the source study). Among Canadian respondents, the most common reasons for cannabis purchasing from illicit sources ( $n=6041$ ) were that legal sources (2020) had "higher prices" (35%), were inconvenient or sold cannabis of poorer "product quality" (both 17%), or had a more limited "product selection" (14%) than illegal sources. Those respondents citing higher prices as a barrier to legal purchases were significantly more likely to reside in provinces with higher prices of legal cannabis and used cannabis weekly/monthly or daily/almost daily (Goodman et al., 2022).

The ICPS' survey of Canadian respondents (ages 16–65; 2018–2020) also found that a significantly higher proportion of cannabis consumers in 2019 (7.9%) and 2020 (8.8%) had engaged in home cultivation in the past 12 months than before legalization (2018; 5.8%). The median annual number of plants grown was 3.3–3.5 in all years. Home cultivation after legalization was less common in provinces that prohibited home cultivation (3.2% vs. 6.8%) than in those that permitted it (Wadsworth et al., 2022a, 2022b).



Among secondary students in the CTADS (2018/19) and YSS (2016/17), the percentage of those that said that cannabis was “fairly or very easy” to obtain remained stable at 40%. In total, 71% of self-identified cannabis users reported in 2018/19 that the ease of obtaining cannabis was unchanged since legalization, and 24% said that it had become “easier” to get cannabis (Government of Canada, 2018b).

## Discussion

The legalization of non-medical cannabis use and supply was implemented in Canada in 2018 as a policy reform with several main objectives (Government of Canada, 2021b). While cannabis legalization remains controversial as a policy option, assessing the effects on previously identified principal public health outcomes associated with the policy reform is timely and necessary (Fischer et al., 2018). The present paper presents an initial, comprehensive overview of key indicators relevant for public health outcomes associated with the recent implementation of cannabis legalization in Canada.

Current data suggest that the prevalence of cannabis use, and specifically of frequent (e.g., daily/near-daily) use as a known high-risk use pattern have remained high, or increased in some age groups in the population from pre- to post-legalization in Canada. The prevalence of use is highest among young adult users (e.g., early 20 s). Evidence also suggests that cannabis use among (underage) youth, among whom cannabis access remains illegal, has remained steady or increased. Attribution of these increases to legalization is uncertain because of substantial evidence that the COVID-19 pandemic (since 2020) has contributed to changes—mostly increases—in cannabis use and use intensity (e.g., frequency) in both legalization- and non-legalization settings (Chong et al., 2022; Roberts et al., 2021). On this basis, any related (post-2020) data ought to be considered and interpreted with these possible dynamics in mind. In addition, the data reviewed have shown an increasing diversification of modes of cannabis use. While smoking herbal cannabis products remains the predominant method, the use of e-cigarettes, vaping, and edibles have increased.

Canadian studies of the impacts of legalization on hospitalizations for acute cannabis-related adverse effects have had mixed results. Some studies, including adult and infant patient populations, found increases in ED presentations for acute adverse effects (e.g., including mental health problems) related to cannabis use but others have not. Moreover, where increases have occurred, these have not necessarily represented significant changes in trends from pre- to post-legalization. Hospitalizations represent severe cannabis use-related morbidity and the consequential burden of disease and healthcare costs.

Studies of the effects of legalization on cannabis-impaired driving also present a mixed picture. Survey data indicate considerably varied rates of driving after using cannabis but without signs of increases. This may reflect increasing risk awareness and/or the initial deterrence effects of new “per se” laws prohibiting cannabis-impaired driving implemented after legalization in Canada (Solomon et al., 2018). One major study found substantial increases in rates and levels of THC exposure among drivers hospitalized for MVCs after legalization in BC (Brubacher et al., 2022). This area requires more comprehensive data and monitoring given the importance of cannabis-related MVCs for public health and US-based studies showing moderate increases in cannabis-related MVC fatalities after legalization (Lane & Hall, 2019; Santaella-Tenorio et al., 2020; Tefft & Arnold, 2021; Windle et al., 2021).

There have been consistent increases in consumers' reported use of "legal" cannabis sources and hence, increases in the proportion of users obtaining—regulated and presumably safer—cannabis products since legalization. This has coincided with a gradual but substantial increase in the number of legal cannabis retail outlets across Canada (Mahamad et al., 2020; Wadsworth et al., 2021). Recent data suggest that approximately two-thirds of Canadian users rely on at least one of the multiple available legal sources. Almost one in ten engage in "home growing" of cannabis for their use. However, these estimates also leave a considerable number of cannabis users—a crudely estimated 1–2 million individuals—who still rely on illegal markets for their cannabis use (Amlung & MacKillop, 2019; Goodman et al., 2020). Survey data suggest that these predominantly include high-frequency/intensity and therefore high-risk users who are of primary concern for adverse public health outcomes (Goodman et al., 2022; Wadsworth et al., 2022a, 2022b).

Consistent with previous analyses, the data indicate mixed early impacts of cannabis legalization in Canada on key public health indicators (Fischer et al., 2021). More detailed, comprehensive data and analyses on key indicators are needed for more definitive conclusions. This is similar to recent comprehensive impact assessments in US states that have implemented legalization (Chiu et al., 2021; Hall et al., 2019; Smart & Pacula, 2019). Simultaneously, there is a mixed balance sheet at this stage when evaluated against legalization's policy objectives.

First, available evidence suggests that legalization has not substantially reduced cannabis use among young (underage) people. This group is most vulnerable to the adverse health and social impacts of cannabis use but they are excluded by their age from the possible protections of legalization and so may not be benefitting directly from this policy reform. Second, there have been substantial increases in the sourcing of cannabis from the legal cannabis retail system but illegal cannabis sources and markets continue to provide cannabis, especially to the most frequent users who account for a disproportionate amount of total consumption. Third, it remains unclear to what extent legalization has facilitated cannabis use that is safer for health. There is some evidence that risky use patterns (e.g., higher frequency and/or use of higher potency cannabis) and hospitalizations for acute adverse outcomes have increased in some jurisdictions after legalization. It is, however, unclear to what extent these increases are extensions of pre-legalization trends that may also reflect liberal use and access provisions for 'medical cannabis' in Canada after 2000 (Fischer et al., 2015; Leung et al., 2022). Broader analytical perspectives are needed for comprehensive empirical impact assessments.

There is also very limited evidence on the extent to which the variations in Canada's province/territory-based regulatory systems for legal cannabis (e.g., re: use age and restrictions, retail infrastructure) have differentially affected cannabis-related use, patterns, or outcomes (Caulkins & Kilborn, 2019; Cox, 2018; Lancione et al., 2020). Insights on these issues will be important for designing regulatory options in other jurisdictions.

As already mentioned in the above, our paper presents a comprehensive overview of outcome indicators that relies on a combination of scientific publication and "grey" literature-based (i.e., surveys, reports) data. It is meant to provide a comprehensive and empirical "big picture" assessment of developments and trends for previously identified, principal data indicators of relevance for public health associated with the "policy experiment" of non-medical cannabis legalization in Canada as implemented in 2018. Again, the COVID-19 pandemic, among other principal extrinsic factors, may have influenced cannabis use and related outcomes since 2020, which have been subject to primary examinations elsewhere and require respective consideration in data interpretation. Future efforts should focus on extending and adding analytical depth to this work based on rigorous methods

(e.g., systematic reviews, meta- and other data-analytical approaches) and additional data as they approach for the indicator topics of interest.

On the current evidence, cannabis legalization in Canada has not unequivocally produced all its intended benefits for public health compared to pre-legalization policies. This provides for essential insights also for other jurisdictions considering similar policy reforms. However, public health is only one domain relevant for impacts. A more comprehensive assessment of key outcomes associated with legalization will require consideration of its social impacts. These, for example, include community safety, crime and social cost effects but also the extent to which the elimination of the criminal enforcement and penalties for personal cannabis use and their adverse consequences (e.g., criminal records, educational/employment barriers, social injustice) have impacted on the lives and social welfare of the 5–6 million cannabis users (Callaghan et al., 2021a, 2021b; Fischer et al., 2020a, 2020b; Lu et al., 2021). Such comprehensive evaluations have yet to be implemented, but may eventually conclude that legalization has been an overall more measured and socially beneficial option for cannabis control in Canada (French et al., 2022).

**Author Contribution** HB and BF developed the concept for the paper. HB and BF co-developed and executed the data search and identification strategy, and the extraction of data. BF led the manuscript draft writing. HB and WH provided substantial intellectual content contributions towards data presentation, analysis, and interpretation, and substantively contributed to all content areas of the paper during several revisions of the paper. All authors approved the final version of the paper submitted.

**Data Availability** The empirical core of this paper consists of study data and other information generally available in and accessed from the public realm (see references for corresponding source publications or documents).

## Declarations

**Ethics Approval** N/A

**Conflict of Interest** Prof. Fischer has provided scientific advice to different government- and non-governmental entities on issues of cannabis policy option and the assessment of health and social outcomes over the past years. He furthermore has held research grants and contracts in the areas of substance use, health, and policy from public funding and government (i.e., public-only) organizations. Prof. Hall and Mrs. Boury do not have any conflict-of-interest to declare.

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