International Journal of Drug Policy 127 (2024) 104385

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Research Paper

How have cannabis use and related indicators changed since legalization of cannabis for non-medical purposes? Results of the Canadian Cannabis Survey 2018–2022

Samantha Goodman, Matthew J. Dann, Fathima Fataar, Hanan Abramovici *

Office of Cannabis Science and Surveillance, Controlled Substances and Cannabis Branch, Health Canada, Canada

ARTICLE INFO

Keywords:
Cannabis
Legalization
Canada
Risk perceptions
Public education

ABSTRACT

Background: Cannabis use for non-medical purposes was legalized and regulated in Canada through the *Cannabis Act* in October 2018. This paper examined trends in use of cannabis for non-medical purposes and related indicators from pre- to post-legalization in Canada (2018–2022).

Methods: Data from 5 years of the Canadian Cannabis Survey, an annual web-based survey administered to Canadians 16 years of age or older, were used in the analysis (n_{2018}=12,952; n_{2019}=11,922; n_{2020}=10,821; n_{2021}=10,733; n_{2022}=10,048). Cannabis measures include questions about use, types of products, sources, risk perceptions and beliefs, and exposure to public education campaigns and health warnings. Adjusted logistic regression models tested differences in outcomes over time.

Results: Past 12-month cannabis consumption increased among Canadians from 22 % in 2018 to 27 % in 2022 (AOR=1.41;99 % CI:1.28–1.54). Similarly, daily/almost daily (DAD) consumption increased from 5 % in 2018 to 7 % in 2022 (AOR=1.36;99 % CI:1.16–1.59). Consumption of dried flower, hash/kief, and concentrates/extracts (e.g., wax, shatter, budder) decreased since 2018, whereas consumption of edibles, beverages and vape pens/cartridges increased ($p < 0.001$). Legal purchasing increased from 4 % in 2018 to 69 % in 2022, while accessing cannabis through social and illegal sources decreased over time ($p < 0.001$).

Conclusion: More Canadians are reporting cannabis consumption since legalization and regulation of cannabis for non-medical purposes, continuing a pre-existing trend despite an increase in awareness of the risks of consuming cannabis. Trends in product use indicate a transition from dried flower and concentrates/extracts towards consumption of cannabis foods, drinks and vape pens/cartridges. The legal market is increasingly displacing the illicit cannabis market in Canada.

Introduction

On October 17, 2018, cannabis for non-medical purposes was legalized and regulated under Canada's *Cannabis Act*. The *Act* aims to strictly regulate cannabis production, distribution, sales, and possession through a federal framework, with additional restrictions implemented at the provincial/territorial level (Government of Canada, 2023a). Legalization occurred in two distinct phases: phase I (2018–2019) legalized and regulated dried cannabis, cannabis plants and seeds as well as cannabis oil for oral use; phase II (2019 onwards) legalized and regulated all other classes of cannabis, including edibles, extracts and concentrates (e.g., vape liquids, shatter, wax, budder, hashish/kief) and topical products (Government of Canada, 2018a, 2023a).

Canada has one of the highest rates of cannabis use worldwide, and data suggest that increases in rates of cannabis use observed since the legalization and regulation of cannabis for non-medical purposes (herein 'legalization') continue a pre-existing trend. According to various national drug use and health surveys, cannabis use in Canada has almost doubled in the past decade, with over a fifth (21−22 %) of Canadians reporting past-year use in 2019 and 2021, compared to 11−12 % in 2012/2013 (Government of Canada, 2023b, 2023c; Statistics Canada, 2015; Statistics Canada, 2023a). These rates of past-year use are slightly higher than those in the US (19 % in 2021) (SAMHSA, 2021) – where nearly half of states have now legalized cannabis for

* Corresponding author at: Office of Cannabis Science and Surveillance, Controlled Substances and Cannabis Branch, Health Canada, 150 Tunney's Pasture Driveway, Ottawa, ON, Canada.
E-mail address: hanan.abramovici@hc-sc.gc.ca (H. Abramovici).

https://doi.org/10.1016/j.drugpo.2024.104385

Available online 22 March 2024

recreational (i.e., non-medical) use (U.S. News, 2023) – and substantially higher than the average in Europe (8 % in 2022) (EMCDDA, 2023), where cannabis remains an illegal substance. Rates of cannabis use in Canadian youth are also high. In a 2013 UN report, Canadian youth aged 11–15 years had the highest rates of past-year cannabis use among 29 of the world's most advanced countries (UNICEF Office of Research, 2013). More recent data from the 2021/22 Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS) reported that 18 % of students in grades 7–12 reported past-year cannabis use (Government of Canada, 2023d).

Liberalization of cannabis laws has also been associated with shifts in cannabis product use from traditional forms of use such as smoking dried flower and hashish/kief to more processed forms of cannabis as legal markets are established and continue to evolve. For example, legislation legalizing cannabis use in the US has been associated with higher odds of using cannabis edibles and vapes among both adults and youth (Borodovsky et al., 2016; Borodovsky et al., 2017). In the International Cannabis Policy Study (ICPS), individuals in US states with legal recreational cannabis use laws were significantly more likely than those in Canada (pre-legalization) or US states without recreational cannabis use laws to report use of edibles, drinks, vape oils/liquid extracts, concentrates, and topical products (Goodman et al., 2020). In Canada, the National Cannabis Survey (NCS) indicated decreases in the use of dried flower, hash/kief, and solid concentrates, and increases in the use of edibles, liquids (drinks), and vape pens/cartridges from the first quarter of 2018 (pre-legalization) to fourth quarter of 2020 (post-legalization) as the commercial availability of these other non-dried forms of cannabis increased (Rotermann, 2021).

The purpose of the *Act* is to protect public health and public safety, which includes increasing public awareness of the health risks of cannabis use (Government of Canada, 2018b). As part of the *Act,* Canada mandated salient health warning messages on cannabis product labels. Specific messages are rotated across products, and cover subjects such as cannabis-impaired driving, use during pregnancy and breastfeeding, the association between frequent use and mental health problems, and risk of use during adolescence (Government of Canada, 2019a). Two studies conducted in the early years post-legalization found increases in reported noticing and free recall of health warning messages in Canada from pre- to post-legalization; both recall and recognition of message content were associated with the specific health warnings present on Canadian cannabis packages (Goodman & Hammond, 2021; Goodman et al., 2022).

Public education campaigns are another means of providing information on the health risks of cannabis use. The Canadian government initiated several public education campaigns immediately prior to and early on in cannabis legalization. Campaigns focused on various topics, including impaired driving, with campaign materials available online for later access (Government of Canada, 2018b). Several studies on risk perceptions with respect to cannabis were also conducted pre-legalization. For example, in a 2017 study, 90 % of adults in Ontario, Canada agreed that driving under the influence of cannabis increased the risk of motor vehicle accidents, whereas only 55 % of those who had driven after cannabis use agreed (McDonald et al., 2021). A few studies have examined changes in risk perceptions and knowledge of cannabis harms from pre- to post-legalization. One study found no change in risk perceptions pre- versus 6-months post-legalization among a sample of Canadian university students, with approximately 6 in 10 believing that regularly smoking cannabis poses a great/moderate risk of harm (Mader et al., 2022). ICPS data indicated that in 2022, 72 % and 76 % of Canadians aged 16–65 perceived a moderate/high/very high risk of smoking and vaping cannabis daily, respectively. Risk perceptions were lower for consuming edibles daily, with 62 % perceiving a moderate/high/very high risk (Hammond et al., 2023).

Part of the purpose of the *Act* is also to reduce the burden on the criminal justice system and to displace the illicit cannabis market, by imposing criminal penalties on illegal imports/exports, providing a legal framework for cannabis production and sales, and establishing strict product quality requirements (Government of Canada, 2018c). A few sources suggest that the *Act* is having the intended effect, in that fewer Canadians are accessing the illicit market. For example, NCS data showed that 23 % of Canadians had accessed the legal market in the first quarter of 2018, which increased to 68 % in the fourth quarter of 2020 (Rotermann, 2021). ICPS data also indicate that on average, 82 % of all cannabis purchased by Canadian consumers was from a legal source in 2022, compared to 61 % in fall 2019 (Hammond et al., 2023).

This paper examines early trends in non-medical cannabis use, product types, risk perceptions, and sources, as well as exposure to public education materials and health warnings on cannabis using data collected using the Canadian Cannabis Survey (CCS) from 2018 to 2022, representing one year of data pre-legalization and the first four years post-legalization. The main objective was to characterize the trends for the selected cannabis indicators pre- and post-legalization to determine if there have been any notable changes. Furthermore, we examined trends in past 12-month and daily/almost daily cannabis use stratified by sex and age to explore potential differences within groups over time. There are well-established sex and age differences in patterns of cannabis use; generally, males and youth and young adults are more likely to use cannabis, and frequent use is a risk factor for cannabis-related harms (Greaves and Hemsing, 2020; Kourgiantakis et al., 2022). Examining trends in past 12-month and daily/almost daily cannabis use indicators by sex and age will enable the monitoring and assessment of patterns related to cannabis use following legalization, and to help determine to what extent the *Cannabis Act* has met its goals of protecting public health and public safety.

Methods

Canadian Cannabis Survey

Given the need for ongoing surveillance on cannabis and related indicators to understand the impacts of legalization and regulation of cannabis in Canada, Health Canada, the Canadian Federal Ministry of Health, developed the CCS to monitor patterns of cannabis use and knowledge, attitudes, and risk perceptions about cannabis among Canadians 16 years of age and older. This annual, pan-Canadian, cross-sectional survey was launched in 2017 and collects data on several key themes, including: prevalence and frequency of cannabis use; products used; knowledge and risk perceptions of cannabis; exposure to public health materials; and sources of cannabis, among others. The survey and weighting procedure were substantially revised in 2018. The survey is reviewed annually to ensure content is relevant and up to date, while core content remains consistent to allow for comparability between cycles.

The survey firm (Advanis, 2023) uses random digit dialling to contact Canadians aged ≥16 years in all provinces and territories on mobile phones and landlines. Potential respondents are told the survey is about cannabis use in Canada; if interested, respondents are sent a link to the online survey by email or text message. Respondents may complete the survey in English or French. Respondents are informed they can skip questions they do not feel comfortable answering and that their responses will remain anonymous. Respondents who do not wish to finish the survey can close the survey browser at any time, and Advanis removes these incomplete data from final datasets (less than 1 % of respondents). In 2022, the response rate, calculated as the number of responding units divided by the potentially eligible sample, was 15.5 % (range for all years: 12.5 % to 21.1 %), and the average time to complete the survey was 29 min for a past 12-month cannabis consumer, and 13 min for a non-consumer. A detailed description of the survey methodology is available online (Health Canada, 2022).

Measures

Demographic measures included age (16–19; 20–24; 25–34; 35–44;

45–54; 55 and older), sex (male/female) and gender (man; woman; other gender; prefer not to say), education (less than high school diploma; high school diploma or equivalent; trade certificate or diploma; college, CEGEP, or other non-university certificate or diploma; university certificate or diploma below bachelor's level; bachelor's degree; university certificate, diploma or degree above the bachelor's degree; prefer not to say) and income (from 'less than $10,000′ to '$150,000 or more' increasing in $25,000 increments with an option of 'prefer not to say').

Cannabis use: Past 12-month cannabis use was established with the question, 'In the past 12 months, have you used cannabis for non-medical purposes?' (Yes/No). Frequency of cannabis use among past 12-month non-medical cannabis consumers was obtained with the question, 'In the past 12 months, how often did you typically use cannabis for non-medical purposes? (Less than 1 day per month/1 day per month/2 or 3 days per month/1 or 2 day(s) per week/5 or 6 days per week/Daily). In the analysis, those who reported using cannabis 5 or more days per week were categorized as daily/almost daily cannabis consumers.

Cannabis products: Respondents were asked, 'In the past 12 months, have you used the following cannabis products?' for the following products: dried flower/leaf; hashish/kief; cannabis oil for oral use; cannabis vape pen/cartridges; cannabis concentrates/extracts; cannabis edible food products; cannabis beverages; topicals; other, with yes/no/don't know/prefer not to answer response options.

Perceived risk of regular cannabis use: To assess risk respondents were asked, 'How much do you think people risk harming themselves when they do each of the following activities regularly?' for the following activities: smoke cannabis; vapourizing cannabis; eating cannabis. The response options were recoded to two categories for analysis: no risk/slight risk/don't know; moderate risk/great risk.

Belief that cannabis can be habit-forming: To examine beliefs, respondents were asked, 'Based on what you know or believe, can using cannabis become habit forming for some people?' (Yes; No/Don't know/Not sure).

Health warnings: To determine if respondents were familiar with health warnings they were asked, 'In the past 12 months have you seen health warnings on cannabis products/packages or Health Canada's website?' (Yes (either or both); No/Don't know/Not sure). The follow-up question, 'Was the information you saw in the health warning messages credible/believable?' (Yes; No/Somewhat/Don't know/Not sure) was asked to those who said they had seen a health warning.

Public education: To assess awareness of public education campaigns respondents were asked, 'In the past 12 months, have you seen/heard education campaigns, public health or safety messages about cannabis in any of the following places?' Response options included school, social media, tv/radio, inside/outside cannabis stores and not noticing any education campaigns or public health message. Responses were recoded to: Yes (saw any message); No.

Cannabis source: To assess where respondents sourced their cannabis, past 12-month consumers were asked, 'In the past 12 months from whom did you usually buy or receive the cannabis you used for non-medical purposes?' (I grew my own/It was specifically grown for me/From a legal storefront/provincially authorized retailer/From a legal non-medical website (provincially authorized retailer)/From an illegal storefront/From an illegal website/It was shared around a group of friends/From a family member/From a friend/From an acquaintance/From a dealer/Other). Responses were recoded into 4 categories: Legal retailer (storefront or website); social source (shared around a group, friend, family member, acquaintance); grown/grown for me; illegal retailer (storefront, website or dealer).

Data analysis

This study is the first to present a secondary analysis of data from the CCS, a national survey that is weighted to represent the Canadian population. Data were weighted based on age, sex and region (province/territory) using Canadian census estimates to more accurately reflect the general population. After excluding four participants who were missing age and six who were missing both sex and gender, the unweighted analytic sample comprised 56,476 participants (2018=12,952, 2019=11,922, 2020=10,821, 2021=10,733, 2022=10,048).

Binary logistic regression models were used to examine changes in the following outcomes over the 5-year study period: past 12-month and daily/almost daily (DAD) cannabis use; cannabis products used in the past 12 months; perceived risk of regularly smoking, vaping, and eating cannabis; belief that cannabis can be habit-forming; noticing and credibility of public education campaigns and health warning messages on cannabis; and usual source of cannabis for non-medical purposes. Models were adjusted for sex (male/female), age group (6 categories), education level (3 categories) and household income (4 categories). Given the differences in provincial/territorial cannabis regulations, a sensitivity analysis was conducted by including province/territory as a covariate in the models. The inclusion of province/territory in the models did not result in any substantial changes in the odds ratio estimates for any of the outcomes or affect the statistical significance of the other variables, so province/territory was omitted from the final models. The models on risk perceptions, belief that cannabis can be habit-forming, and noticing of public education campaigns were additionally adjusted for past 12-month cannabis use (yes/no). Questions on noticing public education campaigns and health warning messages were added in 2019; questions on perceived credibility for the two measures were added in 2020 and 2021, respectively. For cannabis use prevalence, stratified models were conducted to examine trends in cannabis use among separate sex and age groups. Due to space constraints, results of stratified models are presented in Supplemental Tables 1 and 2.

Chi-squared tests were used to test socio-demographic differences in the sample distribution over time. All analyses were conducted in STATA 17.0 using survey procedures (svy estimation). Adjusted odds ratios (AOR) and 99 % confidence intervals (CI) are shown; a conservative threshold of $p < 0.01$ was used for significance due to the large sample size. This analysis received ethics clearance from the Health Canada – Public Health Agency of Canada Research Ethics Board.

Results

The CCS sample was approximately half female and had a mean age of 45.9 years; remaining sample characteristics are shown in Table 1. Note that race/ethnicity was not asked in the 2018 and 2019 survey cycles and therefore could not be included in analytical models. In 2020–2022, approximately three-quarters of the CCS sample identified as 'White' exclusively, similar to the proportion in the Canadian population (approx. 70 %) (Statistics Canada, 2022). Both sex and gender are associated with cannabis use (CIHR, 2017). Sex at birth rather than gender identity was used in analyses due to the small number of responses for 'other gender' identity; however, the sample distribution for gender is reported in Table 1 for descriptive purposes.

Prevalence of cannabis use

Table 2 shows the results of adjusted regression models examining trends in prevalence of cannabis use and products used from pre-legalization in 2018 to 2022. Results indicated significant increases over time in both past 12-month and DAD cannabis use, with rates of both being approximately 1.4 times higher in 2022 versus 2018.

Past 12-month use of cannabis for non-medical purposes. Past 12-month use increased from 22 % in 2018 to 27 % in 2022. Overall, stratified models indicated significant increases in past 12-month use among both sexes from 2018 to 2022. In terms of age, stratified results showed increases in past 12-month use between 2018 and 2022 in all age groups except youth 16–19, whose use increased in 2019 and 2020 and then decreased to pre-legalization levels in 2021 and 2022.

Table 1
Sample characteristics of respondents aged 16 years and older, Canadian Cannabis Survey, 2018–2022 (n = 56,476).

Characteristic	2018 (n = 12,952) % (n)	2019 (n = 11,922) % (n)	2020 (n = 10,821) % (n)	2021 (n = 10,733) % (n)	2022 (n = 10,048) % (n)	Adjusted chi-square test *(Difference between survey waves)* (p-value)
Sex at birth						$p = 0.999$
Male	48.7 (6224)	48.7 (5984)	48.7 (5286)	48.7 (5014)	48.8 (4925)	
Female	51.3 (6728)	51.3 (5938)	51.3 (5535)	51.3 (5719)	51.2 (5123)	
Gender identity						**$p < 0.001$**
Man	47.7 (6092)	47.8 (5886)	48.2 (5236)	47.4 (4876)	47.7 (4801)	
Woman	51.2 (6710)	50.7 (5864)	50.6 (5440)	50.3 (5583)	49.2 (4913)	
Other gender identity	0.3 (40)	0.3 (50)	0.4 (60)	0.5 (71)	0.1 (121)	
Unstated	0.9 (100)	1.2 (122)	0.8 (85)	1.9 (203)	2.1 (213)	
Age group (years)						**$p = 0.002$**
16–19	5.6 (503)	5.6 (815)	5.6 (858)	5.6 (985)	5.3 (850)	
20–24	7.8 (879)	7.8 (1749)	7.8 (1800)	7.8 (1228)	7.2 (1174)	
25–34	15.9 (2330)	16.0 (2006)	16.0 (1727)	16.0 (1436)	16.2 (1370)	
35–44	15.7 (2695)	15.7 (2296)	15.7 (1710)	15.7 (1979)	16.1 (1880)	
45–54	17.4 (2497)	17.4 (2126)	17.4 (1830)	17.4 (1829)	15.3 (1762)	
55+	37.5 (4048)	37.5 (2930)	37.5 (2896)	37.5 (3276)	40.0 (3012)	
Highest education level						**$p < 0.001$**
High school or less/Unstated[+]	25.2 (3012)	26.8 (3403)	24.9 (3026)	25.6 (3054)	24.4 (2749)	
Trades/college or non-university diploma	32.8 (4397)	31.8 (3750)	29.2 (3188)	28.9 (3089)	29.0 (2895)	
At least some university	42.0 (5543)	41.4 (4769)	45.9 (4607)	45.4 (4590)	46.6 (4404)	
Household income						**$p < 0.001$**
Less than $50,000	20.9 (2640)	24.0 (3052)	21.7 (2575)	22.3 (2437)	19.8 (2058)	
$50,000-$99,999	31.2 (4113)	31.5 (3667)	30.5 (3222)	30.0 (3181)	30.2 (2969)	
$100,000 or more	34.0 (4512)	33.2 (3911)	35.4 (3740)	35.3 (3817)	38.9 (3898)	
Unstated	13.9 (1687)	11.4 (1292)	12.3 (1284)	12.3 (1298)	11.1 (1123)	

p-value from corrected Pearson's chi-squared test; df=degrees of freedom. Bolded values are significant at $p < 0.01$. [+]Due to insufficient cell sizes for Unstated education level, this category was combined with High school or less.

DAD use. DAD use among all respondents increased from 5 % in 2018 to 7 % in 2020, and then plateaued. Overall, stratified models indicated that in males, DAD use was higher in 2020 (9 %) and 2022 (8 %) vs. 2018 (7 %). In females, DAD use was higher in 2020–2022 (5 %) than in 2018 (4 %) and has plateaued since 2020. In terms of age, stratified results showed no change in DAD use over time in three age groups (16–19, 20–24 and 55+). There were significant changes over the 5-year-period in 25–34, 35–44, and 45–54-year-olds, but no clear trend emerged over time. Finally, a model examining DAD use among past 12-month cannabis consumers only (n = 15,700) indicated no change over time (F (4,51,162)=2.26; $p > 0.01$), with 25 % of past 12-month cannabis consumers reporting DAD use in both 2018 and 2022 (AOR=1.12; 99 %CI=0.94–1.34; $p = 0.10$).

Cannabis products used in past 12 months

Past 12-month cannabis consumers were asked to indicate the products they had consumed in the past 12 months. As shown in Table 2, dried flower/leaf remained the most common product in 2022, followed by edibles. Regression models indicated significant decreases in the consumption of dried flower/leaf, hash/kief, concentrates/extracts (e.g., shatter, wax, budder), and 'other' products, paralleled by significant increases in the consumption of edibles, vape pens/cartridges, and beverages. For oils for oral ingestion, there were significant changes over the study period, but no clear trend over time, and no significant change in topical use.

Risk perceptions

As shown in Table 3, there were significant changes in risk perceptions and exposure to public education over the study period. Briefly, the perceived risks of smoking and vaping cannabis were higher than the perceived risks of consuming edibles, and both increased since pre-legalization. The perceived risks of consuming edibles increased in 2019 and then returned to pre-legalization levels. Odds of believing that cannabis can be habit-forming were high, and increased since pre-legalization, with 89−90 % of respondents recognizing the risk of cannabis dependence in 2019–2022. Odds of perceiving that regularly smoking, vaping, or eating cannabis poses 'moderate' or 'great' risk to one's health and the odds of believing that cannabis can be habit forming were lower among past 12-month cannabis consumers than non-consumers ($p < 0.001$ for all).

Exposure to public education

Also shown in Table 3, reported exposure to public education campaigns about cannabis decreased from over three quarters of respondents in 2019 to just over half in 2022. Past 12-month cannabis consumers were more likely to report seeing/hearing campaigns than non-consumers. Perceived campaign credibility was high: 89−93 % of respondents rated the campaign they recalled as credible/somewhat credible, with a slight (statistically significant) decrease in 2022 versus 2020 only. There was no difference in campaign credibility between consumers and non-consumers. In 2019, 58 % of past 12-month consumers recalled seeing cannabis health warning messages in the past year; recall was higher in all subsequent years compared to 2019, with the most substantial increase occurring in 2020 (68 %). Recall of health warning messages decreased in 2021 and 2022 versus 2020. Perceived credibility of health warning messages was high, with 87−88 % of past 12-month consumers rating messages as credible/somewhat credible in 2021 and 2022 (no change).

Usual cannabis source

Fig. 1 shows usual source of cannabis reported by past 12-month cannabis consumers. Regression analyses indicated that usually purchasing from legal retailers (legal storefront or website) increased significantly over the study period (F(4,14,489)=367.31, $p < 0.001$). Purchasing from legal sources increased dramatically over time, with adjusted odds of usually purchasing from a legal store or website in 2019, 2020, 2021 and 2022 at approximately 16, 31, 49, and 59 times higher, respectively, than pre-legalization in 2018 ($p < 0.001$ for all),

Table 2
Changes in cannabis use for non-medical purposes, pre-vs. post-legalization.

Outcome	2018 (pre-legalization) (n = 12,952) % (n)	2019 (n = 11,922) % (n)	2020 (n = 10,821) % (n)	2021 (n = 10,733) % (n)	2022 (n = 10,048) % (n)	Adjusted Wald test *(effect of survey wave)* F(df), p-value
Past 12-month use (n = 56,094)						
Yes	21.9 (2900), *ref*	24.6 (3454), AOR=1.17 (99 %CI: 1.07–1.27), **p < 0.001**	26.9 (3405) AOR=1.37 (99 %CI: 1.25–1.50, **p < 0.001**	25.2 (2999), AOR=1.24 (99 %CI: 1.13–1.36), **p < 0.001**	27.2 (2996), AOR=1.41 (99 %CI: 1.28–1.54), **p < 0.001**	F(4,50,890)= 30.75, **p < 0.001**
Daily/almost daily use (n = 56,422)						
Yes	5.4 (716), *ref*	5.8 (843) AOR=1.05 (99 %CI: 0.91–1.22), p = 0.371	6.6 (833) AOR=1.30 (99 %CI: 1.11–1.51), **p < 0.001**	6.5 (795) AOR=1.27 (99 %CI: 1.09–1.48), **p < 0.001**	6.8 (764), AOR=1.36 (95 %CI: 1.16–1.59), **p < 0.001**	F(4,51,162)= 10.18, **p < 0.001**
Products used in past 12 months, *among past 12-month cannabis consumers*						
Dried flower/leaf (n = 14,752)	81.9 (2143), *ref*	77.4 (2472), AOR=0.74 (99 %CI=0.61–0.90), **p < 0.001**	73.8 (2568), AOR=0.64 (99 %CI=0.53–0.77), **p < 0.001**	68.4 (1934), AOR=0.49 (99 %CI=0.41–0.59), **p < 0.001**	65.3 (1858), AOR=0.43 (99 %CI=0.36–0.52), **p < 0.001**	F(4,14,414)= 42.80, **p < 0.001**
Edibles (food products) (n = 14,752)	41.1 (1063), *ref*	44.4 (1410), AOR=1.13 (99 %CI:0.97–1.32), p = 0.041	48.8 (1713), AOR=1.35 (99 %CI:1.16–1.57), **p < 0.001**	53.2 (1543), AOR=1.63 (99 %CI: 1.39–1.91), **p < 0.001**	52.7 (1524), AOR=1.59 (99 %CI: 1.36–1.87), **p < 0.001**	F(4,14,414)= 24.50, **p < 0.001**
Hash/kief (n = 14,752)	26.0 (667), *ref*	23.1 (779), AOR=0.84 (99 %CI: 0.71–1.01), p = 0.014	19.0 (709), AOR=0.70 (99 %CI: 0.59–0.85), **p < 0.001**	18.3 (556), AOR=0.68 (99 %CI: 0.56–0.82), **p < 0.001**	17.7 (522), AOR=0.67 (99 %CI: 0.55–0.82), **p < 0.001**	F(4,14,414)= 11.04, **p < 0.001**
Vape pens/cartridges (n = 14,752)	16.2 (414), *ref*	26.0 (838), AOR=1.81 (99 %CI: 1.49–2.20), **p < 0.001**	21.7 (771), AOR=1.44 (99 %CI: 1.19–1.76), **p < 0.001**	29.0 (858), AOR=2.22 (99 %CI: 1.83–2.70), **p < 0.001**	33.3 (989), AOR=2.75 (99 %CI: 2.27–3.34), **p < 0.001**	F(4,14,414)= 55.49, **p < 0.001**
Oil for oral ingestion^{+} (n = 12,140)	*n/a*	22.9 (757), *ref*	25.0 (916), AOR=1.10 (99 %CI: 0.93–1.30), p = 0.138	26.2 (769), AOR=1.18 (99 %CI: 0.99–1.40), p = 0.014	22. (630), AOR=0.94 (99 %CI: 0.79–1.13), p = 0.390	F(3,11,912)= 4.13, **p = 0.006**
Liquid concentrate (e.g., hash oil, butane honey oil)* (n = 2,612)	17.3 (465), *ref*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
Concentrates/extracts* (e.g., shatter, wax, budder) (n = 14,752)	18.7 (494), *ref*	17.3 (602), AOR=0.89 (99 %CI: 0.73–1.09), p = 0.133	13.4 (502), AOR=0.71 (99 %CI: 0.57–0.88), **p < 0.001**	11.8 (361), AOR=0.62 (99 %CI: 0.50–0.77), **p < 0.001**	12.2 (372), AOR=0.66 (99 %CI: 0.53–0.83), **p < 0.001**	F(4,14,414)= 11.98, **p < 0.001**
Beverages (n = 14,752)	4.3 (107), *ref*	4.3 (150), AOR=1.00 (99 %CI: 0.69–1.44), p = 0.993	6.0 (223), AOR=1.42 (99 %CI: 1.00–2.00), **p = 0.009**	15.5 (443), AOR=4.20 (99 %CI: 3.07–5.73), **p < 0.001**	18.8 (515), AOR=5.35 (99 %CI: 3.93–7.28), **p < 0.001**	F(4,14,414)= 118.07, **p < 0.001**
Topicals (e.g., lotion/ cream, bath products)$^{+}$ (n = 12,140)	*n/a*	8.0 (254), *ref*	6.9 (221), AOR=0.86 (99 %CI: 0.65–1.14), p = 0.169	9.5 (249), AOR=1.21 (99 %CI: 0.93–1.58), p = 0.064	8.3 (222), AOR=1.04 (99 %CI: 0.79–1.37), p = 0.727	F(3,11,912)= 3.31, p = 0.019
Other^{+} (n = 14,752)	4.2 (109), *ref*	1.8 (50), AOR=0.43 (99 %CI: 0.25–0.72), **p < 0.001**	2.2 (73), AOR=0.52 (99 %CI: 0.33–0.81), **p < 0.001**	0.9 (23), AOR=0.20 (99 %CI: 0.10–0.39), **p < 0.001**	1.1 (26), AOR=0.25 (99 %CI: 0.13–0.47), **p < 0.001**	F(4,14,414)= 16.37, **p < 0.001**

AOR=adjusted odds ratio; CI=confidence interval; df=degrees of freedom; ref=reference level. All models were adjusted for sex, age group, education, and income. Bolded values are significant at $p < 0.01$. $^{+}$Oils for oral ingestion and topicals were not asked in 2018. In the 2018 survey, topicals were included as an example under 'Other'. *Liquid concentrates was asked in 2018 only and has been included for reference purposes only. In 2019 onward, concentrates/extracts included both solid and liquid concentrates.

when the only 'legal source' was a Health Canada Licensed Producer (i.e., for medical purposes). At the same time, accessing cannabis from illicit sources (illegal storefront, website or dealer) decreased significantly over the study period (F(4,14,489)=159.19, $p < 0.001$), with adjusted odds in 2019, 2020, 2021 and 2022 being approximately 2, 4, 6 and 9 times lower, respectively than in 2018. The use of social sources also decreased over time (F(4,14,489)=262.37, $p < 0.001$), with adjusted odds of using a social source in 2019, 2020, 2021 and 2022 being approximately 2, 4, 6 and 7 times lower, respectively than in 2018. There was no change in reporting 'grew my own/specifically grown for me' over time (F(4, 14,489)=2.17, $p = 0.070$).

Discussion

This is the first study of its kind to examine trends over time in a variety of indicators using data from the CCS from before and after legalization and regulation of cannabis in Canada for non-medical purposes. Data are from a national cannabis survey which a review study highlighted as being more comprehensive than several cannabis measurement instruments internationally (Lazor et al., 2022). This study found increases in past 12-month cannabis and DAD cannabis use for non-medical purposes in both sexes over the 5-year study period that spans the coming into force of the *Cannabis Act*. This increase continues an already pre-existing trend wherein cannabis use has been steadily increasing in Canada prior to legalization (Government of Canada, 2023b, 2023c; Hammond et al., 2023; Statistics Canada 2015; Statistics Canada 2023a). The increasing trend for DAD cannabis use is an important consideration and should continue to be monitored, particularly since frequency of use is associated with greater risk of harms associated with cannabis use including cannabis dependence (Imtiaz et al., 2023; Steeger et al., 2021). Importantly, however, this increase was not observed in youth aged 16–19: after an initial increase in use following legalization, rates decreased to pre-legalization levels. Nevertheless, cannabis use rates among youth and young adults

Table 3
Changes in risk perceptions and exposure to public education, pre-vs. post-legalization of cannabis for non-medical purposes.

Outcome	2018 (pre-legalization) (*n* = 12,952) % (*n*)	2019 (*n* = 11,922) % (*n*)	2020 (*n* = 10,821) % (*n*)	2021 (*n* = 10,733) % (*n*)	2022 (*n* = 10,048) % (*n*)	Adjusted Wald test *(overall effect of survey wave)* F(df), *p*-value
Perceived risk of each method of cannabis administration ('moderate' or 'great' risk of regular use to one's health)						
Smoking cannabis (*n* = 55,932)	72.2 (9213), *ref*	74.0(8451), AOR=1.18 (99 %CI: 1.08–1.28), ***p* < 0.001**	72.6 (7541), AOR=1.09, (99 %CI: 1.00–1.19), *p* = 0.011	73.4 (7629), AOR=1.12 (99 % CI: 1.02–1.22), ***p* = 0.001**	73.9 (7229), AOR=1.17 (99 % CI: 1.07–1.29), ***p* < 0.001**	F(4,50,755)= 7.91, ***p* < 0.001**
Vaping cannabis (*n* = 55,922)	69.5 (8866), *ref*	72.0 (8187), AOR=1.20 (99 %CI: 1.13–1.28), ***p* < 0.001**	74.7 (7785), AOR=1.42 (99 %CI: 1.33–1.52), ***p* < 0.001**	74.8 (7788), AOR=1.40 (99 % CI: 1.31–1.49), ***p* < 0.001**	74.6 (7311), AOR=1.41 (99 % CI: 1.32–1.51), ***p* < 0.001**	F(4,50,746)= 41.43, ***p* < 0.001**
Eating cannabis (*n* = 55,906)	65.9 (8384), *ref*	67.8 (7737), AOR=1.16 (99 %CI: 1.07–1.26), ***p* < 0.001**	64.9 (6715), AOR=1.01 (99 %CI: 0.93–1.10), *p* = 0.679	66.3 (6836), AOR=1.06 (99 % CI: 0.98–1.15), *p* = 0.065	64.2 (6236), AOR=0.98 (99 % CI: 0.90–1.07), *p* = 0.637	F(4,50,736)= 7.85, ***p* < 0.001**
Agree that cannabis can be habit forming ('yes') (*n* = 55,913)	82.0 (10,499), *ref*	89.9 (10,692), AOR=1.99 (99 %CI: 1.78–2.22), ***p* < 0.001**	90.0 (9818), AOR=1.97 (99 % CI:1.75–2.22), ***p* < 0.001**	89.0 (9646), AOR=1.79 (99 % CI: 1.59–2.00), ***p* < 0.001**	89.4 (9031), AOR=1.85 (99 % CI: 1.64–2.08), ***p* < 0.001**	F(4,50,733)= 105.94, ***p* < 0.001**
Saw/heard public education campaign or health messages about cannabis* ('yes') (*n* = 41,825) 42,034	*n/a*	76.5 (8861), *ref*	77.8 (8618), AOR=1.09 (99 %CI: 0.99–1.20), *p* = 0.029	61.2 (6445), AOR=0.48 (99 % CI: 0.43–0.52), ***p* < 0.001**	52.0 (5175), AOR=0.32 (99 % CI: 0.29–0.35), ***p* < 0.001**	F(3,39,115)= 545.47, ***p* < 0.001**
Credibility of public education campaigns (yes/somewhat believable) (*n* = 20,083)	*n/a*	*n/a*	91.4 (7841), *ref*	92.5 (5951), AOR=1.17 (99 % CI: 0.98–1.40), *p* = 0.022	89.3 (4605), AOR=0.77 (95 % CI: 0.65–0.92), ***p* < 0.001**	F(2,19,457)= 16.39, ***p* < 0.001**
Noticed health warning messages on cannabis products or Health Canada's website* ('yes') *among past 12-month cannabis consumers* (*n* = 12,830)	*n/a*	58.2 (2143), *ref*	68.4 (2459), AOR=1.62 (99 %CI: 1.39–1.90), ***p* < 0.001**	64.3 (1982), AOR=1.38 (99 % CI: 1.18–1.61), ***p* < 0.001**	62.4 (1913), AOR=1.27 (99 % CI: 1.09–1.49), ***p* < 0.001**	F(3,48,793)= 23.09, ***p* < 0.001**
Credibility of health warning messages (yes/somewhat believable) *among past 12-month cannabis consumers* (*n* = 3894)	*n/a*	*n/a*	*n/a*	88.0 (1723), *ref*	87.0 (1627), AOR=0.84 (95 % CI: 0.64–1.10), *p* = 0.100	F(1,41,216)= 2.71, *p* = 0.100

AOR=adjusted odds ratio; CI=confidence interval; df=degrees of freedom; ref=reference level. All models were adjusted for sex, age group, education, income, and past 12-month cannabis use (except for noticing health warnings, which was analyzed among past 12-month consumers only). Bolded values are significant at $p < 0.01$. [+]Noticing public education campaigns and health messages were only asked in 2019–22. Credibility of public health campaigns was only asked in 2020–22 and credibility of health warning messages was only asked in 2021–22. Sample size (*n*) is reported for each regression model separately.

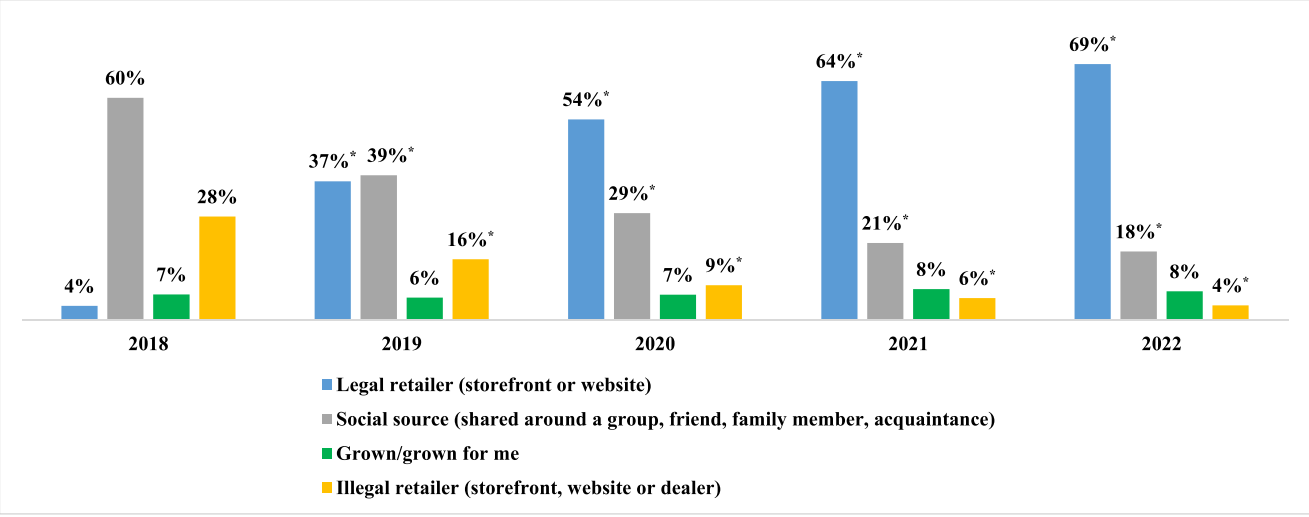

Fig. 1. Usual source of cannabis for non-medical purposes, among past 12-month cannabis consumers (*n* = 14,826)
*Significantly different from 2018 (pre-legalization), $p < 0.001$. Note that results for 'Other' source not shown (1–2 % across study period, with coefficients of variation of 16.6–33.3 for 2019–2022; 'interpret with caution').

continue to be higher than other age groups. In addition, the current data show that DAD cannabis use was higher in 2022 than 2018 for young adults. Youth and young adults are known to be more vulnerable to the adverse neurodevelopmental impacts of cannabis and other substance use as the brain continues to mature until approximately age 25 (Arain et al., 2013; Jacobus et al., 2019; Lubman et al., 2015). As the prevalence of cannabis use is highest in this age group, continued public education and awareness on the health risks of cannabis and how to lower risks from cannabis use will continue to be important.

Regarding cannabis product use, the data suggest a transition away from traditional smoked modes of cannabis administration such as dried flower and hashish/kief towards more processed cannabis products (e.g., edibles, drinks, vape pens/cartridges) post-legalization, consistent with past research (Borodovsky et al., 2016, 2017; Goodman et al., 2020; Rotermann, 2021). Unlike a previous study (Goodman et al., 2020), the current study suggests declining use of concentrates/extracts (e.g., wax, shatter, budder) since pre-legalization. This is positive from a public health perspective: these products tend to have very high THC levels, and use of high-potency products has been associated with increased risk of chronic and acute mental and behavioural outcomes (Arain et al., 2013). At the same time, the use of vape pens/cartridges which also carry very high THC levels, has increased substantially since 2018 and is highest among young people, consistent with other surveys conducted in Canada and the US (Government of Canada, 2019b; Hammond et al., 2021; ISQ, 2022; Lim et al., 2022; NIDA, 2020). Although vaping rather than smoking cannabis may reduce exposure to a number of harmful substances and carcinogens, given the higher amounts of THC it may lead to earlier onset of dependence among new users and may carry more risk than benefit when it comes to cognition, mental health, and driving impairment (Chaiton et al., 2022). Vaping liquid cannabis extracts has also been associated with e-cigarette or vaping product use-associated lung injury (EVALI) – although most cases have been linked to the intentional addition of vitamin E acetate to unlicensed cannabis vaping products in the US (Chaiton et al., 2022). Nevertheless, as this method of use is relatively novel, additional research is needed to better understand the potential harms of vaping cannabis and to compare any potential differences in health effects of vaping versus smoking cannabis in frequent consumers. Given the potential risk of dependence and the fact that THC concentrations in vape liquids can be as high as those in solid concentrates/extracts, public education initiatives on the health risks of vaping cannabis targeted at young people may also warrant consideration.

Study results regarding risk perceptions were generally promising. Most Canadians acknowledge the addictive nature of cannabis, as well as the health risks of regularly smoking or vaping cannabis. This suggests that public education efforts have thus far been effective, including mandatory health warnings on cannabis products, which since legalization have included the messages, "Cannabis can be addictive" and "The smoke from cannabis is harmful" (Government of Canada, 2019a). However, reported exposure to public education about cannabis has decreased since 2019, likely representing concentrated efforts to educate the public on lower-risk cannabis use immediately prior to and following cannabis legalization, followed by the refocussing of public health education to the COVID-19 pandemic in subsequent years. Ongoing public education efforts will be needed to maintain risk perceptions as social norms around cannabis as a legal substance stabilize over time. Regarding specific forms of cannabis use, perceived risk of regularly consuming edibles was lower than that of smoking or vaping cannabis. This belief aligns with the Lower-Risk Cannabis Use Guidelines, which advise consumers to choose non-smoking methods of consumption (i.e., oral ingestion) due to the negative effects of inhaled cannabis on lung health (Fischer et al., 2017). Legal cannabis edibles also carry lower risk from a potency standpoint compared to ingested/inhaled cannabis extracts because they are limited to 10 mg per package rather than 1000 mg THC per package (Government of Canada, 2019c). Of course, there is no limit on the potency of homemade edibles, and edibles containing over 100 mg of THC continue to be sold on the illicit market in Canada (OCS & OPP, 2022). Research has also linked cannabis legalization with increased rates of pediatric hospitalizations due to accidental edible ingestion (Myran et al. 2023); however, most edibles accidentally ingested by children and youth appear to originate from illicit or unknown sources (Grant et al., 2023). Assuming one is considering regulated products, it is logical that they would be associated with lower perceived risk than inhaled products. Consistent with previous research (Goodman & Hammond, 2022), risk perceptions were lower among cannabis consumers. This may be explained by optimism bias (Weinstein, 1980), which can lead people to perceive their health risk as lower than that of others and has been documented among consumers of tobacco and e-cigarettes (Kabwama et al., 2018; Strombotne et al., 2021; Weinstein et al., 2005).

Finally, data from the current study and several other sources indicate that cannabis consumers are increasingly turning to the legal cannabis market in lieu of illegal sources (BC Cannabis Secretariat, 2022; Hammond et al., 2023; Statistics Canada, 2023b; Wadsworth et al., 2022). Close to 70 % of consumers reported a legal store or website as their usual purchase source 4 years post-legalization in 2022. This increased transition to the legal market presents numerous public health benefits since products sourced from the legal market are subject to strict quality control and testing measures, both with respect to cannabinoid content and labelling as well as testing and controlling for various contaminants. Recent studies comparing cannabis products from the legal and illegal markets have reported significant cause for concern from illegally sourced cannabis products, including significant differences between the actual and labelled content of THC when available; high amounts of THC in edibles; significant levels of pesticides not authorized for use on cannabis; and microbial and other contaminants (BC Ministry of Public Safety & Solicitor General, 2022; NB RPC, 2021; OCS & OPP, 2022).

Limitations

This study is not without limitations. When recruited, CCS respondents are informed that the survey is about cannabis. This may create a participation bias in that those who use cannabis may be more likely to complete the survey. For this and other methodological reasons, the CCS provides prevalence estimates for cannabis use that are higher than other Canadian population-level surveys. Secondly, responses to survey questions analyzed herein referred to cannabis for non-medical purposes; the results of this manuscript therefore do not capture use, perceptions, or sourcing of cannabis for medical purposes. Finally, regression models indicated changes over time from 1 year pre- to 4 years post legalization. More sophisticated statistical methods and additional years of data post-legalization will be needed to forecast trends in Canada over time.

Conclusions

This study sheds light on trends in cannabis product use, risk perceptions and sourcing over a 5-year period spanning the coming into force of the *Cannabis Act* in Canada. Results indicate that past 12-month as well as DAD cannabis use for non-medical purposes has increased among both sexes in Canada. Furthermore, for the time being, the implementation of the *Act* did not appear to be associated with a continual incline in cannabis use among youth, although rates of cannabis use among young people continue to be among the highest in Canada. Targeted education efforts and surveillance of this age group will continue to be important. Trends in product use indicate decreasing use of traditional products such as dried flower and hashish/kief since legalization, paralleled by increasing popularity of edibles, drinks, and vapes. The health implications of this shift depend on the product type: for example, Canada limits legal edibles to 10 mg THC per package (Government of Canada, 2019c), making them a lower-risk form of

consumption compared to smoking dried flower or hashish/kief if consumed in small quantities, whereas vape pens/cartridges can contain higher levels of THC per package and may be linked with increased risk of dependence among new users (Chaiton et al., 2022). Public risk perceptions of cannabis appear to remain at reasonable levels and are highest among youth, likely reflecting the impacts of targeted public education in this age group. Finally, Canadians are increasingly sourcing their cannabis from licensed retailers, with almost 70 % of consumers reporting a legal store or website as their usual cannabis source 4 years post-legalization. This progress is encouraging, although additional research may be needed to determine how to encourage the remaining legal-age consumers to transition to the legal market. This paper also highlights the importance of ongoing monitoring and surveillance of cannabis use and related indicators. With additional countries and jurisdictions (e.g., several US states, Uruguay, Germany) liberalizing their cannabis laws, additional international data will help to inform our overall understanding of the impact of major policy changes such as cannabis legalization on a population's behaviour and related health and social outcomes.

CRediT authorship contribution statement

Samantha Goodman: Writing – original draft, Formal analysis. **Matthew J. Dann:** Writing – review & editing, Project administration, Methodology, Investigation. **Fathima Fataar:** Writing – review & editing, Formal analysis. **Hanan Abramovici:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We would like to thank Health Canada employees Jacqueline Burt, Adam Doane, Dr. George Mammen, Sieara Plebon-Huff, and Lynn Sukkarieh for internal review of the manuscript.

Funding

This study was funded by Health Canada.

Ethics approval

The authors declare that they have obtained ethics approval from an appropriately constituted ethics committee/institutional review board where the research entailed animal or human participation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2024.104385.

References

Advanis. (2023). *Who we are*. Retrieved from https://advanis.net/who-we-are/ (Accessed 8 September 2023).

Arain, M., Haque, M., Johal, L., Mathur, P., Nel, W., Rais, A., et al. (2013). Maturation of the adolescent brain. *Neuropsychiatric Disease and Treatment, 9*, 449–461. https://doi.org/10.2147/NDT.S39776

BC Ministry of Public Safety and Solicitor General. (2022). *Chemical analysis of illicit cannabis*. Retrieved from https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/public-safety/cannabis/chemical_analysis_of_illicit_cannabis_report.pdf (Accessed 8 September 2023).

BC Cannabis Secretariat. (2022). Cannabis in British Columbia: Results from the 2021 BC cannabis use survey. Retrieved from https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/public-safety/cannabis/2021_bc_cannabis_use_survey_report_final.pdf (Accessed 8 September 2023).

Borodovsky, J., Crosier, B., Lee, D., Sargent, J., & Budney, J. (2016). Smoking, vaping, eating: Is legalization impacting the way people use cannabis? *International Journal of Drug Policy, 36*, 141–147. https://doi.org/10.1016/j.drugpo.2016.02.022

Borodovsky, J., Lee, D., Crosier, B., Gabrielli, J., Sargent, J., & Budney, A. (2017). U.S. cannabis legalization and use of vaping and edible products among youth. *Drug and Alcohol Dependence, 177*, 299–306. https://doi.org/10.1016/j.drugalcdep.2017.02.017

Canadian Institutes for Health Research (CIHR). (2017). *Science fact or science fiction: Do sex and gender matter in cannabis use?*. Retrieved from https://cihr-irsc.gc.ca/e/50594.html (Accessed 8 September 2023).

Chaiton, M., Kundu, A., Rueda, S., & Di Ciano, P. (2022). Are vaporizers a lower-risk alternative to smoking cannabis? *Canadian Journal of Public Health, 113*(2), 293–296. https://doi.org/10.17269/s41997-021-00565-w

European Monitoring Centre for Drugs and Drug Addiction (EMCDDA). (2023). *Cannabis – The current situation in Europe (European Drug Report 2023)*. Retrieved from https://www.emcdda.europa.eu/publications/european-drug-report/2023/cannabis_en#prevalence-dashboard (Accessed 8 September 2023).

Fischer, B., Russell, C., Sabioni, P., van den Brink, W., Le Foll, B., Hall, W., et al. (2017). Lower-risk cannabis use guidelines: A comprehensive update of evidence and recommendations. *American Journal of Public Health, 107*(8), e1–e12. https://doi.org/10.2105/AJPH.2017.303818. Erratum in: *American Journal of Public Health, 2018, 108(5),* Article e2.

Goodman, S., & Hammond, D. (2021). Noticing of cannabis health warning labels in Canada and the US. *Health Promotion and Chronic Disease Prevention in Canada - Research, Policy and Practice, 41*(7/8). https://doi.org/10.24095/hpcdp.41.7/8.01

Goodman, S., & Hammond, D. (2022). Perceptions of the health risks of cannabis: estimates from national surveys in Canada and the United States, 2018-2019. *Health Education Research, 37*(2), 61–78. https://doi.org/10.1093/her/cyac006

Goodman, S., Leos-Toro, C., & Hammond, D. (2022). Do mandatory health warning labels on consumer products increase recall of the health risks of cannabis? *Substance Use and Misuse, 57*(4), 569–580. https://doi.org/10.1080/10826084.2021.2023186

Goodman, S., Wadsworth, E., Leos-Toro, C., & Hammond, D. (2020). Prevalence and forms of cannabis use in legal vs. illegal recreational cannabis markets. *International Journal of Drug Policy, 76*, Article 102658. https://doi.org/10.1016/j.drugpo.2019.102658

Government of Canada. (2018a). *Canada Gazette, Part I, Volume 152, Number 51: regulations amending the cannabis regulations (New Classes of Cannabis)*. Retrieved from https://gazette.gc.ca/rp-pr/p1/2018/2018-12-22/html/reg4-eng.html (Accessed 8 September 2023).

Government of Canada. (2018b). *Cannabis public education activities*. Retrieved from https://www.canada.ca/en/health-canada/news/2018/06/cannabis-public-education-activities.html (Accessed 8 September 2023).

Government of Canada. (2018c). *The Cannabis Act: The facts*. Retrieved from https://www.canada.ca/en/health-canada/news/2018/06/backgrounder-the-cannabis-act-the-facts.html (Accessed 8 September 2023).

Government of Canada. (2019a). *Health warning messages*. Retrieved from https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/laws-regulations/regulations-support-cannabis-act/health-warning-messages.html (Accessed 8 September 2023).

Government of Canada. (2019b). *Summary of results for the Canadian Student Tobacco, Alcohol and Drugs Survey 2018-19*. Retrieved from https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey/2018-2019-summary.html (Accessed 8 September 2023).

Government of Canada. (2019c). *Final regulations: edible cannabis, cannabis extracts, cannabis topicals*. Retrieved from https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-medication/cannabis/resources/final-regulations-edible-cannabis-extracts-topical-eng.pdf (Accessed 8 September 2023).

Government of Canada. (2023a). *Justice Laws Website. Cannabis Act. (S.C. 2018, c. 16)*. Retrieved from https://laws-lois.justice.gc.ca/eng/acts/c-24.5/ (Accessed 8 September 2023).

Government of Canada. (2023b). *Canadian Alcohol and Drugs Survey (CADS): summary of results for 2019*. Retrieved from https://www.canada.ca/en/health-canada/services/canadian-alcohol-drugs-survey/2019-summary.html (Accessed 8 September 2023).

Government of Canada. (2023c). *Canadian Tobacco Alcohol and Drugs (CTADS): 2013 summary*. Retrieved from https://www.canada.ca/en/health-canada/services/canadian-alcohol-drugs-survey/2013-summary.html (Accessed 8 September 2023).

Government of Canada. (2023d). *Summary of results for the Canadian Student Tobacco, Alcohol and Drugs Survey 2021-22.* Retrieved from https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey/2021-2022-summary.html. Accessed July 15 2023.

Grant, C., Plebon-Huff, S., Perwaiz, S., Abramovici, H., & Bélanger, R. E. (2023). Serious and life-threatening events associated with non-medical cannabis use in Canadian children and youth. *Paediatrics and Child Health*. https://doi.org/10.1093/pch/pxad036. Article pxad036.

Greaves, L., & Hemsing, N (2020). Sex and Gender Interactions on the Use and Impact of Recreational Cannabis. *International Journal of Environmental Research and Public Health, 17*(2), 509. https://doi.org/10.3390/ijerph17020509

Hammond, D., Corsetti, D., Fataar, F., Iraniparast, M., Danh Hong, D., & Burkhalter, R (2023). *International Cannabis Policy Study - Canada 2022 Summary*. Retrieved from https://cannabisproject.ca/wp-content/uploads/2023/06/2022-Canada-Report-June-26.pdf (Accessed 8 September 2023).

Hammond, D., Wadsworth, E., Reid, J. L., & Burkhalter, R. (2021). Prevalence and modes of cannabis use among youth in Canada, England, and the US, 2017 to 2019. *Drug*

and Alcohol Dependence, 219, Article 108505. https://doi.org/10.1016/j.drugalcdep.2020.108505

Health Canada. (2022). *The Canadian Cannabis Survey 2022: methodological report*. Retrieved from https://epe.lac-bac.gc.ca/100/200/301/pwgsc-tpsgc/por-ef/health/2022/124-21-e/index.html (Accessed 8 September 2023).

Imtiaz, S., Nigatu, Y. T., Ali, F., Douglas, L., Hamilton, H. A., Rehm, J., Rueda, S, Schwartz, RM, Wells, S, & Elton-Marshall, T. (2023). Cannabis legalization and cannabis use, daily cannabis use and cannabis-related problems among adults in Ontario, Canada (2001-2019). *Drug and Alcohol Dependence, 244*, Article 109765. https://doi.org/10.1016/j.drugalcdep.2023.109765

Institut de la statistique du Québec (ISQ). (2022). *Québec cannabis survey 2022. detailed table - Table 4*. Retrieved from https://statistique.quebec.ca/en/document/quebec-cannabis-survey-2022 (Accessed 8 September 2023).

Jacobus, J., Courtney, K. E., Hodgdon, E. A., & Baca, R. (2019). Cannabis and the developing brain: What does the evidence say? *Birth Defects Research, 111*(17), 1302–1307. https://doi.org/10.1002/bdr2.1572

Kabwama, S. N., Kadobera, D., & Ndyanabangi, S. (2018). Perceptions about the harmfulness of tobacco among adults in Uganda: findings from the 2013 Global Adult Tobacco Survey. *Tobacco Induced Diseases, 16*, Article 59. https://doi.org/10.18332/tid/99574

Kourgiantakis, T., Edwards, T., Lee, E., Logan, J., Vicknarajah, R., Craig, S. L., Simon-Tucker, M, & Williams, C. C. (2022). Cannabis use among youth in Canada: a scoping review protocol. *BMJ Open, 12*(6), Article e061997. https://doi.org/10.1136/bmjopen-2022-061997

Lazor, T., Blondal, E., Scheim, A., Cubillos, P., Werb, D., Milloy, M. J., et al. (2022). Measurement of public health impacts of cannabis legalization in Canada to reflect policy maker priorities: A rapid scoping review of instruments and content domains. *Drug and Alcohol Dependence, 236*(1), Article 109463. https://doi.org/10.1016/j.drugalcdep.2022.109463

Lim, C. C. W., Chan, G. C. K., Wadsworth, E., Stjepanović, D., Chiu, V., Chung, J. Y. C., et al. (2022). Trends and socio-demographic differences of cannabis vaping in the USA and Canada. *International Journal of Environmental Research and Public Health, 19*(21), Article 14394. https://doi.org/10.3390/ijerph192114394

Lubman, D. I., Cheetham, A., & Yücel, M. (2015). Cannabis and adolescent brain development. *Pharmacology and Therapeutics, 148*, 1–16. https://doi.org/10.1016/j.pharmthera.2014.11.009

Mader, J., Smith, J. M., Smith, J., Afzal, A. R., Arria, A. M., Bugbee, B. A., et al. (2022). Correlates of perceived harmfulness of regular cannabis use among Canadian university students before and after legalization. *Cannabis, 5*(3). https://doi.org/10.26828/cannabis/2022.03.003

McDonald, A. J., Hamilton, H. A., Wickens, C. M., Watson, T. M., Elton-Marshall, T., Wardell, J. D., et al. (2021). Driving under the influence of cannabis risk perceptions and behaviour: A population-based study in Ontario. *Canada. Preventive Medicine.* , Article 106793. https://doi.org/10.1016/j.ypmed.2021.106793

Myran, D. T., Tanuseputro, P., Auger, N., Konikoff, L., Talarico, R., & Finkelstein, Y. (2023). Pediatric hospitalizations for unintentional cannabis poisonings and all-cause poisonings associated with edible cannabis product legalization and sales in Canada. *JAMA Health Forum, 4*(1), Article e225041. https://doi.org/10.1001/jamahealthforum.2022.5041

National Institute on Drug Abuse (NIDA). (2020). *Vaping, marijuana use in 2019 rose in college-age adults*. Retrieved from https://archives.nida.nih.gov/news-events/news-releases/2020/09/vaping-marijuana-use-in-2019-rose-in-college-age-adults (Accessed 8 September 2023).

New Brunswick Research and Productivity Council (NB RPC). (2021). *Analysis of illicit and legal cannabis products for a suite of chemical and microbial contaminants*. Retrieved from https://www.rpc.ca/english/press/Comparison%20of%20Illicit%20and%20Legal%20Cannabis%20Samples.pdf Accessed September 8 2023.

Ontario Cannabis Store (OCS) and Ontario Provincial Police (OPP). (2022). *Ontario cannabis study shows illegal cannabis fails to deliver the goods*. Retrieved from https://cdn.shopify.com/s/files/1/2636/1928/files/Ontario_cannabis_study_shows_illegal_cannabis_fails_to_deliver_the_goods.pdf?v=1649256935 (Accessed 8 September 2023).

Rotermann, M. (2021). Looking back from 2020, how cannabis use and related behaviours changed in Canada. *Health Reports.* , Article 2021004. https://doi.org/10.25318/82-003-x202100400001-eng

Statistics Canada. (2015). *Prevalence and correlates of marijuana use in Canada, 2012*. Retrieved from https://www150.statcan.gc.ca/n1/pub/82-003-x/2015004/article/14158-eng.htm (Accessed 8 September 2023).

Statistics Canada. (2022). *The Canadian census: A rich portrait of the country's religious and ethnocultural diversity*. Retrieved from https://www150.statcan.gc.ca/n1/daily-quotidien/221026/dq221026b-eng.htm (Accessed 8 September 2023).

[dataset] Statistics Canada 2023a [dataset] Statistics Canada. (2023a). *Canadian Community Health Survey 2021. Public-use microdata file accessed through the Health Data Analysis and Dissemination Team (HDAD) of Health Canada's Health Care Strategies Directorate*.

Statistics Canada. (2023b). *Detailed household final consumption expenditure, Canada, quarterly (x 1,000,000)*. Table 36-10-0124-01Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610012401 (Accessed 8 September 2023).

Steeger, C. M., Hitchcock, L. N., Bryan, A. D., Hutchison, K. E., Hill, K. G., & Bidwell, L. C. (2021). Associations between self-reported cannabis use frequency, potency, and cannabis/health metrics. *International Journal of Drug Policy, 97*, Article 103278. https://doi.org/10.1016/j.drugpo.2021.103278

Strombotne, K., Sindelar, J., & Buckell, J. (2021). Who, me? Optimism bias about US teenagers' ability to quit vaping. *Addiction, 116*(11), 3180–3187. https://doi.org/10.1111/add.15525

Substance Abuse and Mental Health Services Administration (SAMHSA). (2021). *2021 National Survey of Drug Use and Health (NSDUH) releases. Table 1.1B – Types of illicit drug use in lifetime, past year, and past month: Among people aged 12 or older; Percentages, 2021*. Retrieved from https://www.samhsa.gov/data/sites/default/files/reports/rpt39441/NSDUHDetailedTabs2021/NSDUHDetailedTabs2021/NSDUHDetTabsSect1pe2021.htm (Accessed 8 September 2023).

U.S. News. (2023). *Where is marijuana legal? A guide to marijuana legalization*. Retrieved from https://www.usnews.com/news/best-states/articles/where-is-marijuana-legal-a-guide-to-marijuana-legalization (Accessed 8 September 2023).

UNICEF Office of Research. (2013). Child well-being in rich countries: a comparative overview. *Innocenti Report Card, 11*. Retrieved from https://www.unicef-irc.org/publications/pdf/rc11_eng.pdf (Accessed 8 September 2023).

Wadsworth, E., Driezen, P., Pacula, R. L., & Hammond, D. (2022). Cannabis flower prices and transitions to legal sources after legalization in Canada, 2019-2020. *Drug and Alcohol Dependence, 231*, Article 109262. https://doi.org/10.1016/j.drugalcdep.2021.109262

Weinstein, N., Marcus, S., & Moser, R. (2005). Smokers' unrealistic optimism about their risk. *Tobacco Control, 14*, 55–59. https://doi.org/10.1136/tc.2004.008375

Weinstein, N. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39*, 806–820. https://doi.org/10.1037/0022-3514.39.5.806