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Cannabis Consumption, Purchasing and Sources among Young Canadians: The Cannabis Purchase and Consumption Tool (CPCT)

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ABSTRACT

Background: Despite its extensive use, there is a paucity of research on consumption and purchasing patterns of cannabis, especially by modes of delivery. *Objective:* To assess the self-reported use and frequency of use of 12 different cannabis modes of delivery, their associated purchase sources, self-reported price, average consumption amount, and knowledge of THC and CBD levels. *Methods:* The Cannabis Purchase and Consumption Tool, an online survey, sampled Canadians 16-30 years old ($N=868$) in October 2017. Final sample included participants reporting use of any mode of cannabis within the past 30-days ($N=185$). *Results:* The most common modes of delivery were dried herb that was either smoked or vaporized, and cannabis edibles. Use of hashish, hash oil and other concentrates followed, while liquids, tinctures, topical ointments, and fresh flower/leaf were used less frequently. Average dried herb consumption was 17.8 g/month, 17.4 g/month, and 9.4 g/month among licensed medical, non-licensed medical, and non-medical cannabis users, respectively. At last time of purchase, participants paid an average of $17.97/gram for dried herb. 31.5% of current users reported knowing THC and 13.2% CBD levels of their cannabis. *Conclusions:* Youth and young adults report a wide diversity of cannabis products and modes of administration. Traditional measures that rely primarily on frequency of use may be inadequate to assess the rapidly evolving cannabis market, particularly given policy changes, including legalization of non-medical cannabis.

Introduction

Canada has among the highest rates of cannabis use among developed countries, with approximately 60% of Canadian adults reporting lifetime cannabis use, and 22% reporting use in the past 12 months (Government of Canada, 2018a). Prevalence of use is highest among Canadian youth and young adults: 36% and 44% of 16–19 and 20–24 year-olds, respectively, report past 12-month use (Government of Canada, 2018a). Patterns of cannabis use also vary provincially; for example, prevalence of edible use ranges from 16%–51% across provinces (Government of Canada, 2018a).

Cannabis can be delivered through various modes, including smoking, vaporizing, and orally through extracts, oils, foods, and drinks. Smoking remains the dominant form of administration, particularly among more frequent users (Deloitte, 2016; Government of Canada, 2017; 2018; Russell et al., 2018). However, many users report using multiple modes of administration, and the prevalence of non-smoked modes appears to be increasing, particularly among medical cannabis users (Government of Canada, 2016a; 2016b; Government of Canada, 2017; 2018; Russell et al., 2018; Shiplo et al., 2016). Among current non-medical cannabis consumers in Canada, 36% of monthly users vape, 29% smoked from a pipe or bong, 21% used joints and 13% consumed edibles (Deloitte, 2016). The 2017 Canadian Cannabis Survey, a survey of 3,395 respondents who used

cannabis in the past year, found that 34% consumed edibles, 20% vaporized using a vape pen, and 15% vaporized using a vaporizer (Government of Canada, 2017). While studies investigating consumption patterns by cannabis mode of delivery exist, there is no established standard on how to collect information on different modes of administration.

The price of cannabis in Canada varies, with lower prices in provinces where there is higher production and consumption, such as Québec and British Columbia (Aston et al., 2015; Clements, 2008; Kilmer et al., 2010; Ouellet et al., 2017; Statistics Canada, 2017; Stockwell et al., 2010; Werb et al., 2012). Using aggregated data from various websites where individuals were asked to anonymously report the price they paid at their latest purchase of cannabis, Statistics Canada reported a national price of average of $7.48/gram for both medical and non-medical users (Statistics Canada, 2017). Among non-medical past year cannabis users, almost $75/month was spent on cannabis products, while those who used in the past 30 days spent almost $88/month (Government of Canada, 2017). One Canadian study documented average retail price between October 2017 and March 2018 from online and storefront retails sources at $10.02/gram (Mahamad & Hammond, 2019).

There is relatively little data on the amount of cannabis consumed by users. According to the 2008-2009 British Columbia Alcohol and Other Drug Monitoring Project, High Risk Group Surveys, 72.3% who used cannabis at least monthly consume 0.1

to 3 joints per day (Zeisser et al., 2012). Among past year users, respondents of the 2017 Canadian Cannabis Survey used 0.9 grams/day of dried flower or leaf that was smoked or vaporized, 0.4 grams/day of hashish, and 1.1 servings of edibles (Government of Canada, 2017).

The main psychoactive component in cannabis, 9-tetrahydrocannabinol (THC), varies considerably across studies and over time, ranging from 1.0% to 25.0% (Freeman et al., 2014; Casajuana Kögel et al., 2017; van der Pol et al., 2013). Currently, the average THC concentration of commercially available dried herb is between 15% and 20% in both licit and illicit markets (Caulkins et al., 2018; Chandra et al., 2019; Ouellet et al., 2017). By volume, cannabidiol (CBD) is the secondary cannabinoid in cannabis, ranging from 0.2% to 5.5% (Freeman et al., 2014; Casajuana Kögel et al., 2017; van der Pol et al., 2013). At present, there is very little evidence on the extent to which cannabis users are aware of and can self-report THC and CBD levels.

The current study used a new survey instrument, the Cannabis Purchase and Consumption Tool (CPCT), to examine cannabis purchasing patterns and sources among youth and young adult cannabis users in Canada. Specifically, the study assessed the self-reported use and frequency of use of 12 different modes of delivery and their associated purchase sources. The study also examined self-reported price, average consumption amount, and knowledge of THC and CBD levels by mode. This study reflected the Canadian market prior to legalization of cannabis for recreational purposes, however medicinal cannabis has been legal in Canada since July 2001. These measures are critically important to examining potential changes in cannabis consumption following legalization of non-medical cannabis in Canada on the 17th of October 2018.

While there is considerable overlap in the CPCT and the Canadian Cannabis Survey (CCS), there are two key differences. The CPCT does not rely on an initial telephone call to screen participants, which has the potential to reduce nonresponse bias, and the CPCT uses images when assessing consumption amounts to help improve reporting accuracy.

Methods

Study design

A national sample of Canadians aged 16 to 30 years old were recruited online from a commercial sample between October 11 and October 23, 2017 using probability and non-probability recruitment techniques. A sub-sample of past-month users of any mode were selected for analysis as this group represents a higher-risk population based on their more frequent use, especially for the unconventional modes of delivery. The Cannabis Purchase and Consumption Tool (CPCT) sought to understand consumer patterns of use, purchasing patterns, retail access, medical cannabis use, health knowledge, problematic cannabis use, use in occupational settings, cannabis and driving, and cannabis marketing exposure. The CPCT was developed and validated using focus groups and cognitive interviewing in 10 participants (Goodman et al., 2019). This validation study found that participants were able to easily identify consumption amounts, purchase sources, purchase amount, modes of use, and frequency of use (Goodman et al., 2019).

Respondents were recruited *via* email through Leger's consumer panel for web surveys, which consists of approximately 400,000 active members, half of them sampled using probability-based methods (using the Canadian Census), along with other non-probability-based methods, including commercial surveys. Considering both probability and non-probability-based methods were used to recruit participants, the sample lacks conventional structure of strata and cluster, and may not be representative of all Canadian youth and young adults. Four follow-up reminders to complete the CPCT, as well as to fully complete the CPCT, were sent to eligible participants. Respondents aged 18–30 were recruited directly, while those aged 16–17 were recruited through their parents and parental consent was obtained prior to accessing the online survey. All respondents were provided with information about the study and asked to provide consent before participating. Respondents received remuneration from Leger in accordance with their usual incentive structure, which includes both points-based and monetary rewards (which can be cashed out or donated), as well as chances to win monthly prizes; the monetary incentive for this study was $2. The study was reviewed by and received ethics clearance from the Office of Research Ethics at the University of Waterloo (ORE# 22392).

Measures

The Cannabis Purchase and Consumption Tool (CPCT) consists of three primary sections: 1) frequency of use and cannabis forms, 2) consumption amounts, and 3) cannabis source and purchasing.

Frequency of use & cannabis forms

Participants were asked if they had 'ever' used cannabis and their frequency of use in the past 12 months. Participants who reported currently using cannabis in the past 30-days, were asked to identify each of 12 different forms of cannabis used in the past 12 months. Modes of cannabis delivery included smoked or vaporized dried herb, cannabis mixed or rolled with tobacco, vaporized liquid form, hashish, hash oil, concentrates, edibles, liquids, tinctures, topical ointments and fresh flower/leaf.

Consumption amounts

Respondents reported consumption amounts separately for each cannabis mode, either for a usual day, week, month, or past 12-months. For the analysis, all consumptions amounts were scaled to the past month. Respondents who reported using cannabis less than once a month were assumed to use once every 3 months. If participants reported using less than an eighth of an ounce of dried herb, a sixteenth of an ounce was used in statistical analysis. Due to a lack of established cannabis conversion factors, this study relied on expert opinion and websites such as https://www.leafly.ca/, https://honestmarijuana.com/ and https://mmj-doctoronline.com/. One hit/toke of hashish was defined as 0.1 grams of hashish, as one bowl of hashish contains about 0.5 grams which can be used for about 5 hits. The same conversion factor of 0.1 grams per hit/toke was used for hash oil. A hit/toke of cannabis concentrate was defined as 0.04 grams as there are about

25 hits/tokes per gram. For cannabis tinctures, 1 drop or capsule was defined as 2 mL. Participants could report topical ointment consumption in palmfuls, where the average palmful was defined as 2 ounces. For fresh raw cannabis flower/leaves about 30 grams of leaves (or 10-15 grams of cannabis buds) can be consumed daily.

Upper and lower limits were established to identify extreme consumption values for each mode. Considering there is a lack of previous research on appropriate consumption ranges, outliers were set using a "data-informed" approach as opposed to "data-driven". Traditional measures of central tendency (i.e. median, IQR, etc.) were examined, however, for most modes these measures were not appropriate as many valid responses would be omitted, even after extreme outliers were removed. In addition to examining traditional measures of central tendency, we considered a combination of expert opinion on what is logically/biologically plausible, and relied on sites like https://www.leafly.ca/. Participants reporting values that crossed thresholds were removed from analysis at the product level. Responses from nine respondents were excluded as their consumption amounts far exceeded typical use (>7.1 grams/¼ ounce per day, >14.2 grams per month, >7.1 grams in less than monthly users). These upper limits were established based on the assumption that it would be very unlikely for a participant to be a monthly user if they smoked/vaped 14.2 grams without being a weekly user. This same logic was used for the less than monthly users. Among those using vaporized liquid in the form of an e-cigarette, participants using more than 200 mL weekly were excluded (0.5% of the sample). Respondents who reported consuming 30 or more liquid beverages containing marijuana extract a week were excluded (0.5% of the sample). Subjects using 90 or more fluid ounces of tinctures who used less than once a month or 60.0 mL of tinctures used weekly were excluded (1.1% of the sample). Consuming 60 mL of tinctures weekly (but not daily), even six of the seven days of the week is 10 mL for each of those six days, is unrealistic. Participants using more than 850.5 grams weekly or 396.9 grams less than once a month of fresh flower/leaf were excluded (2.7% of the sample).

Cannabis source and purchasing

Cannabis source was measured for each cannabis form used by participants, a pre-coded checklist with 12 options. Participants were then asked if they had 'bought or paid for' each cannabis form, and could choose the time period for reporting their purchase amount in a typical day/week/month, or past 12-months. Images were used to assist participants when reporting purchase amounts (supplemental file). Respondents were then asked to report the total amount of money they spent on each form in the past day/week/month/past 12-months. The price at last purchase was assessed for dried herb.

THC and CBD knowledge

Participants were asked if they knew the level of THC and CBD in the modes they reported using; those that reported knowing were asked to report the usual level (either mg or percentage). Among participants who reported knowing the level of THC and CBD, we examined the proportion who could provide valid THC

and CBD levels. The THC content in fresh/dried herb and vaped liquid is usually less than 20%, however it is possible to obtain dried herb of 30% THC, therefore valid THC levels were considered ≤ 30% (Chandra et al., 2019; Cascini et al., 2012; Government of Canada, 2019). The THC concentration in edibles can vary depending on the amount of cannabis extract added, however because the question was asked as *"Do you know the THC level in the edible marijuana products you usually used?"*, it is possible participants are reporting the dose on the packaging label, and not the dose for a standard serving (usually about 10 mg THC) (Government of Canada, 2018b). An upper limit of 200 mg of THC was set based on examining common edibles like chocolate bars on retail websites. Retail beverages or liquids contain about 10 mg of THC per dose, however an upper limit of 100 mg was chosen as participants may have reported the total concentration of THC found on the packing label and some retail products such as Cannabis Quencher (https://vccbrands.com/consumer/cannabis-quencher/) report containing as much as 100 mg of THC (Government of Canada, 2018b). THC levels > 60% were considered invalid for hashish, while for hash oil and concentrates >90% were considered invalid (Government of Canada, 2019). An upper limit of 1000 mg THC was set for tinctures and topical ointments based on examination of dosage in several retail products available (i.e. Mota's Indica Tincture 900 mg THC, https://www.motacannabisproducts.ca/shop/mota-indica-thc-tincture/) (Government of Canada, 2018b). While CBD concentration is usually low in cannabis, concentrations can be as high as 15%, therefore CBD levels >15% were considered invalid for fresh/dried herb, vaped liquid, hashish, edibles, and beverages (Chandra et al., 2019; Ontario Cannabis Store, 2019). Hash oil and concentrates can have higher concentrations of CBD, for example, 240 mg CBD in topical ointment (https://www.motacannabisproducts.ca/shop/brio-4to1/).

Reason of use

Participants were asked if they use each cannabis form for medical purposes, non-medical purposes or for both medical and non-medical purposes.

Statistical analysis

Sample weights were created for 30 demographic groups (age group by sex by region) based on weighted National Health Survey population estimates. Postcensal estimates are based on the 2011 Census counts adjusted for census net undercoverage (CNU) (including adjustment for incompletely enumerated Indian reserves (IEIR)) and the components of demographic growth that occurred since that census. Intercensal estimates were produced using counts from two consecutive censuses adjusted for CNU (including (IEIR) and postcensal estimates (Statistics Canada, 2011). Weights ranged from 0.5 to 5.0.

Descriptive statistics were used across all measures and respondents were excluded from analyses on a case-wise basis for measures with missing data. All point estimates and descriptive analyses reported are weighted. Among those who reported a valid THC and CBD level for modes with adequate sample size, we examined if self-reported knowledge about THC and CBD

significantly differed based on either age, sex, and if the mode was used for medical reasons using weight chi-squared analysis (*proc surveyfreq*). Age was recoded into a binary classification: ≥ 19 years and < 19 years of age. Participants who reported "medical" and "both medical and non-medical" use were combined. Participants who reported knowing THC and CBD levels but did not provide a valid response or those who reported not knowing THC and CBD levels were combined to represent "no knowledge" group. All analysis was performed using SAS version 9.4 (SAS Institute Inc.). Data was analyzed November 2017 to February 2018.

Results

Of the 5,750 respondents contacted by Leger, a total of 1,045 respondents completed the survey (18.2%). Due to missing data on core measures of cannabis use, as well as the data integrity questions, 175 respondents were deleted. A total of 870 were retained for analysis, however this study examines a sub-sample of 185 current cannabis users who used in the past 30-days. The overall mean age of the sample was 23.9 ± 4.1 years, with 61.8% male (Table 1). Most participants resided in Ontario (50.0%), followed by The Prairies (23.9%) and British Columbia (9.4%) (Table 1). About a half of the sample had a university or post-graduate degree, finished technical school or community college. About a third of the sample had an annual income < $30,000.

Cannabis modes of use and polymodal use

Table 2 presents the frequency of use by mode of cannabis among participants who report using any mode of cannabis within the past 30-days. Only 6.6% of the sample reported using one mode of cannabis, whereas 26.4% reported using three modes and 54.6% reported using four or more modes. The average number of modes used was 4.3 ± 2.5.

Cannabis monthly consumption amount by mode

The average consumption amount of cannabis across the various modes is presented in Table 3. Among users of dried herb, 7.3% used for medical purposes, 48.9% use for non-medical purposes and 42.9% report using it for both medical and non-medical purposes. The average consumption amount was 17.8 ($SD = 27.3$) g/month, 9.4 ($SD = 16.8$) g/month and 17.4 ($SD = 24.6$) g/month for medical, non-medical and medical/non-medical users, respectively. Due to small sample sizes, means by medical, non-medical or both medical and non-medical users are not described for the other modes of cannabis use [Figure 1 near here].

Source of cannabis by mode

Overall, among past 30-day users of any mode of cannabis, the majority of participants received their cannabis from a family member or friend (53.9%), followed by from sharing in a group of friends (53.0%), or from a dealer in person (47.3%) (Figure 1). Table 4 presents source of cannabis by each mode. Among users of dried herb, most common sources were from a dealer in person (44.5%), shared with a group of friends (39.0%) or from a family member or friend (37.6%). Among users of vaporized liquid form in an e-cigarette, hashish, hash oil and concentrates, the majority received it by sharing with a group of friends (32.8–40.7%). Liquid forms of cannabis were commonly obtained from a friend or family member (25.7%), from a medical marijuana store like a dispensary (20.5%), made for the participant (20.4%), or self-made (19.9%).

Edibles were mostly obtained from a friend or family member (25.9%), self-made (20.5%), or shared with a group of friends (19.2%). Tinctures and topical ointments were obtained primarily from a friend or family member, and from a medical marijuana store. Fresh flowers/leaves were mainly self-grown (26.5%), followed by being obtained from someone else, or from family or friends (22.3% and 21.6%, respectively).

Price

Among all monthly users of cannabis who reported price ($n = 176$), 85.6% reported either buying or paying for their cannabis. Dried herb, vaporized liquid forms and edibles were the most common modes that were bought or paid for. About a third of those using topical ointments, liquids, and hashish bought or paid for their cannabis. Less than a quarter of respondents

Table 1. Sample characteristics of past 30-day cannabis users ($n = 185$).

	Weighted %	Unweighted % (sample size)
Sex		
Female	38.2	41.7 (75)
Mean age (SD)	23.9	23.9 (4.3)
Age group		
16 to 18 years old	11.8	17.2 (31)
19 to 24 years old	43.8	32.8 (59)
25 to 30 years old	44.4	50.0 (90)
Ethnicity		
Indigenous	9.2	8.9 (16)
White	66.3	67.2 (121)
South Asian, West Asian, Arab, South East Asian, Chinese[a]	9.6	11.1 (20)
Mixed, Black, Latin American[a]	14.9	12.8 (23)
Province		
Atlantic Canada[b]	22.9	8.3 (15)
Ontario	41.9	50.0 (90)
Québec	19.8	8.3 (15)
Prairies[c]	5.8	23.9 (43)
British Columbia	9.6	9.4 (17)
Education		
Less than high school degree	9.3	13.3 (24)
High school degree	23.1	22.8 (41)
Technical/trade school or community college	13.8	14.4 (26)
Some university, no degree	20.7	16.7 (30)
University degree or post-graduate degree	33.1	32.8 (59)
Annual income		
< $30,000	33.6	29.8 (50)
$30,000–$44,999	13.5	14.3 (24)
$45,000–$59,999	12.9	12.5 (21)
$60,000–74,999	15.9	14.3 (24)
>$75,000	24.1	29.2 (49)
Employed in the past 12 months		
Yes	88.1	88.3 (158)
No	11.9	11.7 (21)

[a]Ethnicities grouped together due to low sample size.
[b]Prince Edward Island, Nova Scotia, and Newfoundland and Labrador.
[c]Manitoba, Saskatchewan and Alberta.

Table 2. Cannabis frequency of use by mode among past 30-day cannabis users, weighted percent.

CANNABIS MODE[a]	Among all 30-day cannabis users		Among past-year users of each mode		
	Ever use % (SE)	Past-year use % (SE)	Monthly % (SE)[b]	Weekly % (SE)[c]	Daily % (SE)
Smoked dried herb $n = 185$	94.5 (1.6)	89.6 (2.3)	87.0 (3.9)	61.0 (4.8)	28.9 (3.9)
Vaporized dried herb $n = 180$	75.0 (3.8)	50.8 (4.5)	51.6 (6.3)	28.4 (5.2)	11.8 (3.4)
Mixed with or rolled in tobacco (e.g. blunt) $n = 181$	79.6 (3.1)	65.5 (4.2)	70.0 (5.0)	33.5 (5.5)	11.7 (3.4)
Vaporized liquid form in an e-cigarette $n = 182$	54.2 (4.4)	34.3 (3.9)	56.1 (7.7)	32.2 (7.5)	13.7 (6.4)
Hashish $n = 177$	61.3 (4.3)	39.1 (4.6)	39.4 (7.6)	12.9 (4.3)	1.3 (1.3)
Hash oil $n = 179$	50.7 (4.5)	24.0 (3.7)	42.8 (8.6)	11.4 (4.8)	4.9 (2.9)
Concentrate (e.g. shatter, budder, wax etc.) $n = 181$	49.5 (4.5)	34.9 (4.0)	44.6 (6.9)	24.5 (6.0)	7.5 (3.4)
Edibles (e.g. cookies) $n = 182$	75.6 (4.3)	60.4 (4.5)	42.2 (5.1)	12.1 (3.0)	0.6 (0.6)
Liquid (e.g. cola/tea) $n = 180$	27.3 (4.0)	14.3 (2.8)	51.8 (10.6)	19.1 (7.1)	–
Tinctures $n = 179$	25.0 (3.8)	14.2 (2.7)	54.0 (10.1)	25.6 (8.8)	8.8 (6.3)
Topical Ointments $n = 180$	24.0 (4.0)	13.3 (3.2)	62.5 (13.5)	11.6 (6.1)	–
Fresh flower/leaf (e.g. for juicing) $n = 178$	16.2 (3.6)	8.1 (2.7)	68.4 (20.5)	42.8 (16.0)	11.0 (8.2)

[a]Participants can report using more than one mode.
[b]Includes weekly and daily users.
[c]Includes daily users.

Table 3. Average monthly consumption amount among past 30-day cannabis users, weighted.

MODES[a]	Average (SD)	Range
Dried herb that was smoked or vaporized $n = 159$	13.7 (21.9) g	0.02 – 108.1 g
Vaporized liquid form in an e-cigarette $n = 32$	19.0 (40.5) mL	0.8 – 152.5 mL
Hashish $n = 51$	1.4 (2.4) g	0.1 – 8.7 g
Hash oil $n = 23$	2.0 (5.6) g	0.1 – 30.5 g
Concentrate (e.g. shatter, budder, wax etc.) $n = 41$	5.4 (11.6) g	0.03 – 61.0 g
Edibles (e.g. cookies) $n = 104$	3.3 (5.2) edible products	0.3 – 22.0 edible products
Liquid (e.g. cola/tea) $n = 17$	2.8 (5.2) beverages	0.3 – 21.8 beverages
Tinctures $n = 14$	22.1 (30.5) mL	0.8 – 91.5 mL
Topical Ointments $n = 15$	53.7 (56.5) g	2.0 – 170.1 g
Fresh flower/leaf (e.g. for juicing) $n = 4$	480.6 (377.1) g	10.0 – 864.7 g

SD = standard deviation.
[a]Participants can report using more than one mode.

reported buying or paying for hash oil, concentrates, tinctures or fresh flower/leaf. The mean amount at last purchase of dried herb was 10.8 ($SD = 3.5$) grams, with a mean price of $67.17 ($SD = 14.32$) ($N = 140$). Overall, an average of $17.97/gram was paid for dried herb the last time it was purchased.

THC and CBD knowledge

Among all current users who answered the question regarding knowing THC or CBD ($N = 180$), 31.5% reported knowing the THC level and 13.2% the CBD level of their cannabis. Among those who reported knowing THC and CBC levels, not all participants reported valid responses (Figure 2). In general, respondents were more likely to report valid ranges of THC and CBD for liquids, concentrates, tinctures, and edibles than for dried herb, vaporized liquid form of cannabis, hash oil, and hashish [Figure 2 near here]. For dried herb knowledge ($n = 172$), 17.2% reported knowing THC levels and provided valid amounts. There was no differences between participants who knew levels and those who did not based on age ≥ 19 compared to < 19 years old ($p = 0.17$), by sex ($p = 0.09$), or by medical user status ($p = 0.09$).

As for CBD, 7.0% could validly report it, with no differences by age ($p = 0.11$) or sex ($p = 0.05$) between participants with and without valid CBD knowledge. Medical users were more likely to report valid levels ($p = 0.002$), where 92.1% of the 7.0% were medical users.

Among participants who vaped marijuana liquid ($n = 62$), 10.1% could validly report levels. Knowledge did not differ based on older age ($p = 0.20$) or sex ($p = 0.94$), but was different based on medical use status ($p = 0.04$), where medical users were more likely to report valid responses (of the 10.1% who could report levels, 88.9% were medical users). CBD knowledge was not compared due to low sample size. Knowledge of valid THC and CBD levels was not compared by age, sex or medical use for the remaining modes based on small sample size.

Discussion

The current study is one of few studies that provides a detailed assessment of the consumption and purchasing patterns of various modes of cannabis among regular users. The results highlight the increasing variety of cannabis products and modes of administration among young people (Deloitte, 2016; Government of Canada,

Table 4. Source of cannabis among past 30-day cannabis users, weighted percent.

MODES	SOCIAL weighted % (SE)			DEALER weighted % (SE)		RETAIL weighted % (SE)				GROWN OR MADE weighted % (SE)	
	Shared around a group of friends	From a family member or friend	From someone else I know	In person	Mail delivery	Medical marijuana from a store (e.g. dispensary or compassion club)	Medical marijuana mailed from a licensed producer	Non-medical marijuana from a store	Ordered it online (not from a licensed producer)	On my own	For me
All modes N=180	53.0 (4.4)	53.9 (4.5)	32.6 (4.0)	47.3 (4.5)	9.2 (2.1)	29.1 (4.2)	14.0 (3.0)	9.0 (2.2)	8.3 (2.1)	20.9 (3.8)	20.5 (3.2)
Dried herb that was smoked or vaporized n=174	39.0 (4.6)	37.6 (4.4)	24.2 (3.8)	44.5 (4.7)	6.6 (1.8)	23.9 (4.0)	9.8 (2.7)	7.0 (1.9)	5.6 (1.8)	6.5 (3.1)	5.4 (1.8)
Vaporized liquid form in e-cigarette n=63	40.7 (8.1)	17.3 (5.0)	14.1 (4.5)	5.8 (3.0)	2.5 (1.8)	13.0 (5.2)	8.4 (3.8)	2.1 (2.1)	4.6 (2.8)	3.2 (2.3)	6.3 (3.2)
Hashish n=70	35.6 (8.0)	30.8 (7.1)	16.7 (5.4)	15.7 (5.3)	1.0 (1.0)	1.0 (1.1)	7.6 (3.5)	3.8 (2.3)	–	3.7 (2.1)	2.9 (2.1)
Hash oil n=43	32.8 (8.9)	14.3 (5.7)	20.9 (6.5)	8.5 (3.9)	3.1 (3.1)	10.0 (6.0)	5.3 (3.1)	1.6 (1.6)	2.1 (2.1)	11.4 (4.7)	8.8 (4.5)
Concentrate (e.g. shatter, wax etc.) n=61	32.8 (6.7)	25.0 (6.0)	4.8 (2.8)	12.6 ()	2.0 (2.0)	8.3 (3.8)	5.2 (3.2)	4.6 (2.7)	9.2 (4.0)	6.4 (3.2)	3.6 (2.1)
Edibles n=111	19.2 (4.1)	25.9 (4.3)	8.5 (3.3)	12.1 (3.6)	3.6 (1.7)	13.0 (3.6)	6.3 (2.6)	2.7 (1.6)	5.5 (2.3)	20.5 (4.7)	18.0 (3.8)
Other (e.g. liquid, tinctures, topicals, fresh flower) n=46	14.2 (5.1)	28.0 (7.2)	12.4 (5.1)	9.9 (4.6)	6.2 (3.7)	33.2 (9.1)	10.2 (4.6)	2.0 (2.0)	6.6 (3.4)	12.5 (5.2)	15.5 (5.8)
Liquid (e.g. cola/tea) n=26	7.8 (4.6)	25.7 (9.5)	16.2 (7.8)	2.3 (2.3)	–	20.5 (9.9)	4.7 (4.7)	–	6.6 (4.7)	19.9 (8.6)	20.4 (8.7)
Tinctures n=26	12.9 (7.1)	38.7 (9.8)	12.2 (7.0)	11.6 (6.7)	9.4 (6.4)	18.4 (7.8)	14.5 (7.2)	–	–	–	–
Topical Ointments n=24	10.0 (5.9)	10.0 (7.0)	–	9.0 (6.4)	–	34.5 (14.7)	–	3.9 (4.0)	9.5 (5.7)	3.7 (3.7)	4.1 (4.1)
Fresh flower/leaf n=15	4.8 (4.8)	21.6 (12.7)	22.3 (12.0)	19.0 (11.6)	12.4 (9.5)	–	–	–	–	26.5 (21.2)	14.6 (10.5)

2016a; Government of Canada, 2017; Russell et al., 2018; Shiplo et al., 2016). Moreover, the results highlight the popularity of polymodal use, where only 6.6% of past 30-day users reported using one mode, while 81% reported using 3 or more modes. Consistent with existing literature, the most common mode was dried herb: 87% of users in the past month reported smoking or vaping dried herb (Deloitte, 2016; Government of Canada, 2016a; Government of Canada, 2017; 2018; Russell et al., 2018). Cannabis edibles were also prevalent among users, with more than 42% of youth and young adults consuming an edible in the past month (Government of Canada, 2017; Russell et al., 2018). The popularity of cannabis edibles may warrant dedicated public education efforts: although edibles have the potential to minimize harm associated with smoke inhalation, they are associated with greater accidental ingestion and 'excess' consumption given that the THC dose may be less intuitive than dried herb, along with a greater time lag between ingestion and absorption (Barrus et al. 2016; Russell et al., 2018).

Vaping cannabis was popular, with over half of these participants reporting using it monthly and almost 14% daily. Some studies suggest that rates of vaporizer use among cannabis users is comparable to cannabis smoking rates, especially among males and medical users (Russell et al., 2018; Shiplo et al., 2016). The current findings support research that finds that the use of concentrated extracts, such as hashish, hash oil and other concentrates have become more widespread (Russell et al., 2018). Overall, the findings indicate a diversity and polymodal use of cannabis products on the market, which appears to be increasing alongside the emergence of medical and non-medical cannabis industries. There is a need for greater evidence on consumer patterns of use for emergent modes, such as concentrated extracts, given that most of the existing evidence on problematic use has focused on traditional forms of consumption.

To date, few studies have estimated consumption amounts among cannabis users, especially by mode of administration. In a recent survey conducted by Health Canada, the Canadian Cannabis Survey (CCS), the average amount of dried herb used on a typical day by past-year users was approximately 1 gram (Government of Canada, 2017). This varied from the monthly average of 13.7 grams (about 0.5 grams daily) of dried herb among past 30-day users in our sample. Differences in amounts may reflect methodological differences as the CCS sampled past-year users aged 16 and older, assumed that all joints contained the same quantity of cannabis, and asked about consumption on a typical day (Government of Canada, 2017). Additionally, it is important to consider that the modes of administration can be quantified using varying units. For example, the CCS used milliliters when asking about consumption of liquids, whereas our study used number of beverages. The accuracy of self-reporting consumption amounts has yet to be established across different product forms. While some respondents may be able to report the number of products, such as the number of beverages or capsules, more validly than the number of mL's consumed, converting products into a volume or size represents a challenge. Future work is required to standardize units within modes and to
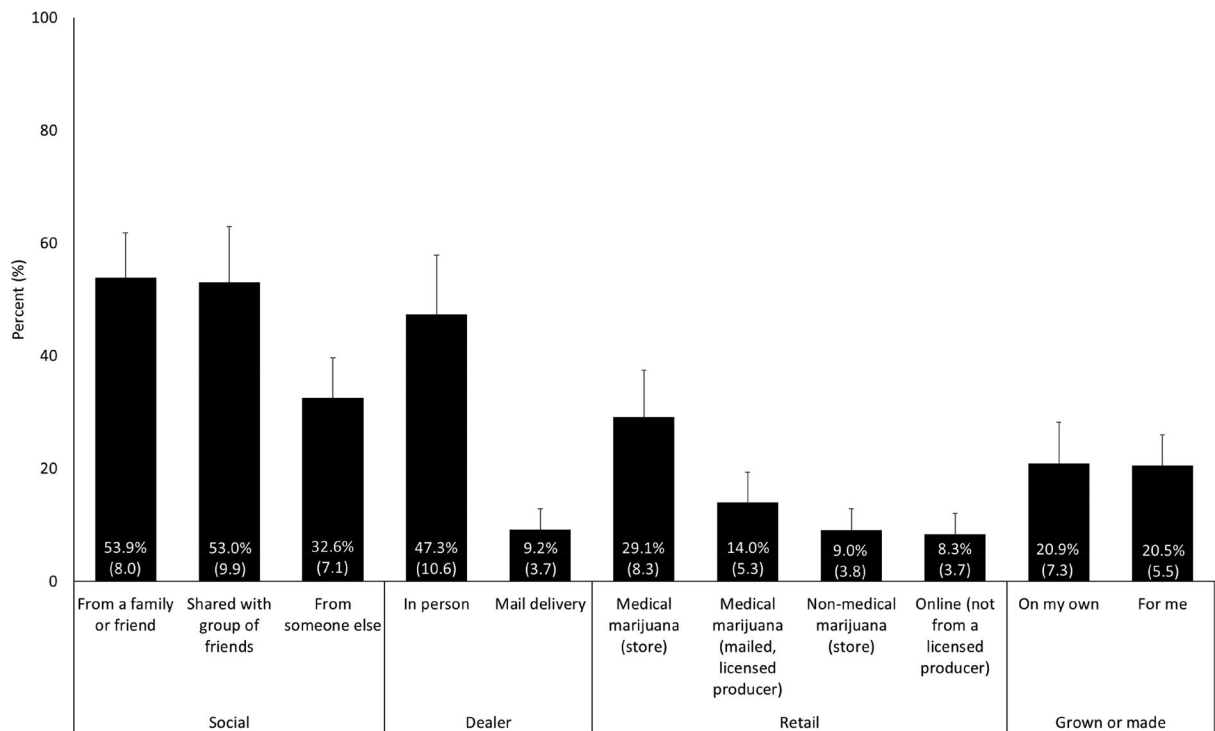
Figure 1. Source of cannabis among past 30-day cannabis users, weighted percent (SE).
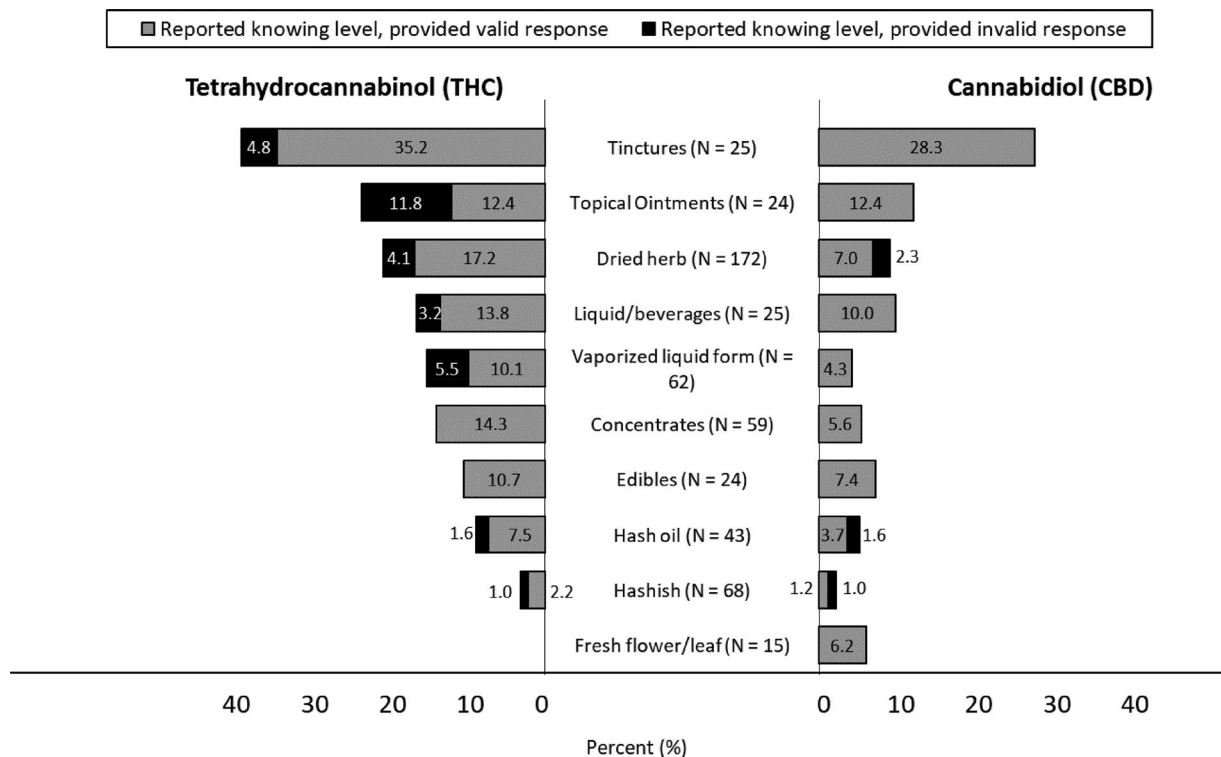

Figure 2. Participant knowledge of tetrahydrocannabinol levels and cannabidiol (% and mg) among past 30-day cannabis user, weighted percent.

examine if participants can validly self-report consumption amounts (e.g. by examining urinary and plasma THC and CBD concentrations) across the spectrum of cannabis products. The current study suggests that most participants were able to report valid consumption amounts that did not deviate from expected values.

Most participants sourced their cannabis from a family or friend, followed by sharing with a group of friends or from a dealer in person, consistent with previous research (Government of Canada, 2017; Ouellet et al., 2017; Reinarman, 2009). However, the source for cannabis products depends upon the product type. For example, topical ointments and beverages containing

cannabis are more commonly obtained from medical cannabis stores. The source of cannabis products is likely to vary depending upon the legal status of medical and non-medical cannabis.

Cannabis users reported low levels of knowledge of cannabinoid levels in their products. Only about one third of participants reported knowing THC levels and approximately 13% reported knowing CBD levels. Although the study did not have 'objective' information on the actual THC and CBD levels of products, some participants who reported knowing these levels provided responses outside of a valid range. Valid responses were more common for products that are often prepackaged, such as tinctures and topical ointments. Medical users of dried herb and vaporized cannabis liquid were more likely to report valid CBD levels compared to non-medical users. Medical users of vaporized cannabis liquid were also more likely to report valid THC concentrations. This may reflect different labeling practices or self-selection in terms of the type of consumers (i.e. medical users) using these products. One would expect higher levels of THC and CBD knowledge in 'legal' markets, where THC and CBD labeling are often required on products.

Strengths and limitations

Participants were recruited from a commercial sample that used probability and non-probability based techniques for recruitment; thus, the sample may not be representative of all Canadian youth and young adults. Due to low sample size, the weighting scheme substantially changes the sample characteristics. For instance, while relatively few people from Atlantic Canada and Quebec responded to the survey, they receive substantial weight. Results should be interpreted in consideration of the low sample size, which decreases the precision of estimates. Additional validity and reliability analyses of the CPCT are warranted. Nevertheless, a diverse sample with similar measures of patterns of cannabis use and sociodemographic characteristics was recruited. While the response rate was low (18.2%), one review of 81 national surveys examining response rates between 5 to 54%, found that lower response rates did not markedly decrease demographic representativeness (Holbrook et al., 2008). The current sample included 16 to 30 year olds; while this age group has the highest rates of cannabis use in Canada, it is unclear to what extent the current findings generalize to older adults. A major strength of the study was the use of images in ascertaining consumption amounts, as well as allowing participants to report amounts for the time period of their choice (i.e. daily, weekly, or monthly). This has the potential to increase reporting accuracy across different frequencies of use.

Conclusions

The current findings highlight the importance of more detailed surveillance measures to examine cannabis use. Standard surveillance metrics for cannabis use (e.g. use in the past 30 days) may be inadequate to assess the rapidly evolving cannabis market, particularly with respect to policy changes including legalization of non-medical cannabis. The use of pictorial representations of cannabis consumption amounts in relation to commonly known objects (e.g. beer bottle cap) may help improve the validity of self-reported consumption amounts (Goodman et al., 2019; van

der Pol et al., 2013). Additional research investigating methodological advancements to improve accuracy of self-report quantities of cannabis consumed and purchased is warranted.

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