Drug and Alcohol Dependence 225 (2021) 108794

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

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

Retail availability and legal purchases of dried flower in Canada post-legalization

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ARTICLE INFO

Keywords:
Cannabis
Marijuana
Retail availability
Legalization
Proximity
Purchasing

ABSTRACT

Objective: Retail availability of cannabis has the potential to influence demand for both legal and illegal cannabis. The aims of the study were to: 1) estimate the percentage of consumers who report purchasing dried flower legally; and 2) examine the association between purchasing dried flower legally and retail availability, where retail availability was represented as: a) Canadian province; b) 'objective' retail proximity; and c) self-reported retail proximity.

Methods: Data come from Canadian respondents in Wave 2 of the International Cannabis Policy Study (ICPS) conducted one year after non-medical cannabis legalization in September-October 2019. Respondents were 18+ years in Alberta/Quebec and 19+ years elsewhere and had purchased any dried flower in the past year (n = 2506). Respondents were recruited through commercial online panels. Weighted binary logistic regression models examined likelihood of purchasing dried flower legally.

Results: Overall, 47.7 % of past-year dried flower purchasers reported last purchasing dried flower legally, with variation across provinces (range = 40.5 %–81.2 %). Likelihood of purchasing dried flower legally was greater among those who lived closer to a legal retail store based on Euclidean distance (<3 km vs. > 10 km: AOR = 1.56, 95 % CI: 1.20,2.02), and who had shorter self-reported travel time to a retail store (<5 min. vs. > 15 min.: AOR = 2.24, 95 % CI: 1.56,3.21).

Conclusion: One year after legalization, retail availability was associated with last purchasing dried flower legally among past-year dried flower purchasers. To our knowledge, the current study is among the first to examine the legality of purchase source used for dried flower and retail availability of cannabis in Canada post-legalization.

1. Introduction

In October 2018, Canada legalized non-medical ('recreational') cannabis. In the first year, only dried flower and some oils were available to purchase legally, whereas all other products were available in December 2019 (Government of Canada, 2019a). Canada has among the highest global rates of cannabis use, with approximately 25 % of adults reporting past 12-month cannabis use (Government of Canada, 2019b). One of the primary objectives of legalization is to protect public health by establishing a legal retail framework (Government of Canada, 2018). Transitioning consumers into the legal market is critical to achieve this public health objective (McLellan et al., 2016). Before legalization, illegal cannabis was widely available in Canada and could be accessed through street dealers, 'dispensaries' and online retail sources (Mahamad and Hammond, 2019; Statistics Canada, 2018). Therefore, the well-developed illegal market in Canada is not expected to disappear immediately. Indeed, 30 % of past 12-month cannabis consumers reported to "always", "mostly" or "sometimes" purchase cannabis from illegal sources in 2020 (Government of Canada, 2020a).

Self-reported data on the legality of purchase sources used by Canadians post-legalization are limited. In the annual 2019 Canadian Cannabis Survey (CCS), over half of past 12-month cannabis consumers reported purchasing cannabis from a legal source since legalization (Government of Canada, 2019b). In the 2019 third quarter National Cannabis Survey (NCS), 28 % of cannabis consumers reported receiving their cannabis products exclusively from legal sources (Statistics Canada, 2019a).

The retail availability of cannabis has the potential to influence demand for both legal and illegal cannabis. Research on other legal substances has shown that retail availability is associated with demand for

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https://doi.org/10.1016/j.drugalcdep.2021.108794
Received 3 March 2021; Received in revised form 6 April 2021; Accepted 9 April 2021
Available online 29 May 2021

illegal and legal substances. Indeed, differences in retail availability is a main reason for the regional differences in illegal tobacco sales across Canada (Driezen et al., 2020; Guindon et al., 2016; Tilson, 2011). Retail availability of cannabis captures many aspects of availability within the retail market such as availability of specific cannabis product, proximity to a cannabis retail store, or the number of retail stores in an area. In the alcohol literature, retail availability can be measured by retail store density, distance to the nearest store, minimum legal age, and retail store trading hours and days (Popova et al., 2009; Bryden et al., 2012). Under federal law, provinces have jurisdiction over retail policies (Government of Canada, 2018). Four provinces opted for a hybrid model of private and government-run retail sales (physical and online stores), four opted for a government-run only model, and two opted for a private-only model (Canadian Centre for Substance Use and Addiction, 2020). The implementation of legal cannabis stores was not immediate, and both stores and websites experienced shortages in the initial months of legalization (Armstrong, 2019). After the first year of legalization, Statistics Canada reported more than 400 legal physical retail stores (Statistics Canada, 2019b); however, the number of legal cannabis stores varied widely across the provinces, ranging from one store for 2375 past 3-month cannabis consumers in Alberta, to one store for 84,288 past 3-month consumers in Ontario (Alberta Gaming Liquor and Cannabis, 2020; Alcohol and Gaming Commission of Ontario, 2020; Statistics Canada, 2019a). In addition, the average distance to a physical legal retail store was estimated at 66 km for adults in March 2019, which decreased to 34 km in July 2019 as additional stores opened, with considerable variation across the provinces (Statistics Canada, 2019b). Proximity to legal stores will change over time as the legal retail market becomes more established.

Provinces and municipalities also implemented other retail policies that may affect availability. For example, some municipalities may prohibit stores altogether and some impose restrictions on proximity to schools (CCSA, 2020). Therefore, availability of stores may be dependent on policy rather than demand. This may influence who lives close to areas where retail stores are able to open. For example, research examining equity in the locations of illegal and legal retail cannabis stores in California concluded that vulnerable populations were disproportionately exposed to illegal retail stores (Unger et al., 2020). Similar research exploring equity in location of retail stores in Portland, Oregon and Washington State concluded that retail stores were more likely to be located in poorer census tracts (Amiri et al., 2019; Firth et al., 2002; Tabb et al., 2018).

Previous literature has explored the associations between availability of cannabis stores and cannabis use, with mixed conclusions (Palali and van Ours, 2015; Pedersen et al., 2020; Rusby et al., 2018; Shi et al., 2018; Wouters et al., 2012). However, retail availability can be defined and measured in various ways such as through retail density, retail proximity, or retail store opening times. For example, research in the Netherlands did not find a relationship between proximity to non-medical retail stores and cannabis use (Wouters et al., 2012). Research in Washington State observed a positive association between current cannabis use and access to non-medical retail stores, and research in Los Angeles observed an association between heavy cannabis use and greater retail density of medical and non-medical retail stores (Everson et al., 2019; Pedersen et al., 2020).

To our knowledge, the current study is among the first to examine the legality of purchase source used for dried flower and retail availability of legal cannabis among dried flower purchasers in Canada post-legalization. The aims of the study were to 1) estimate the percentage of dried flower purchasers who report last purchasing dried flower legally overall and by province; and 2) examine the association between last purchasing dried flower at a legal source and the retail availability of cannabis at a provincial and individual level. In this study, retail availability will be represented in three ways: a) province of residence; b) 'objective' retail proximity; and c) self-reported retail proximity. This study offers a unique and timely look at the relationship of retail availability in the transition to the legal cannabis market in Canada, one year after legalization.

2. Methods

Data are cross-sectional findings from the 2019 International Cannabis Policy Study (ICPS) conducted in Canada and the US. Data were collected via self-completed web-based surveys conducted in fall 2019 with respondents aged 16−65. A non-probability sample of respondents was recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations with a unique link were sent to a random sample of panelists (after targeting for age and country criteria); panelists known to be ineligible were not invited. Surveys were conducted in English in the US and English or French in Canada. Median survey time was 25 min. Respondents provided consent prior to completing the survey. Respondents received remuneration in accordance with their panel's usual incentive structure. In total, 81,263 respondents accessed the survey link, of whom 51,087 completed the entire survey for an AAPOR cooperation rate of 62.9 % (American Association for Public Opinion Research, 2016). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#31,330). A full description of the study methods is described in the ICPS 2019 Technical Report and methodology paper (Hammond et al., 2020). The current study reports Canadian data.

2.1. Measures

2.1.1. Socio-demographic measures

Sex at birth, age (beginning at minimum legal age to purchase cannabis), ethnicity/race, highest education level, perceived income adequacy, suspected device type used to complete survey, province of residence, and cannabis use frequency. Cannabis use frequency was assessed through questions, "How often do you use cannabis?" and "When was the last time you used cannabis?" Responses were categorized into: ("Less than monthly user", "At least monthly user", "At least weekly user", "Daily or almost daily user"). Minimum legal age was taken from provincial laws in September 2019: 18 years in Alberta and Quebec, and 19 years elsewhere. See Table 1 for full coding of response options.

2.1.2. Legality of purchase source used at last purchase

Respondents who purchased dried flower in the past 12 months were asked "The last time you bought dried flower, where did you buy it", with answers: "From a family member or friend", "From a dealer (in person)", "Internet delivery service or mail order", "From a store, co-operative or dispensary (in person)", "Other". Illegal and legal physical stores and online stores were determined by follow-up questions: "What type of physical store or dispensary did you buy the dried herb from?" with answers: "A legal/authorized store", "An illegal or unauthorized store/dispensary", "Other" and "Where did you buy the dried herb online?" with answers: "An authorized/legal website", "An unauthorized/illegal website, private delivery service or dealer", "Other". "Other" responses were re-categorized according to answers provided. All other sources were categorized according to Canadian regulations in September 2019 (Supplementary Table 1).

2.1.3. Provincial retail density (stores per 100,000 residents aged 15 and over)

Legal retailers in each province were identified and downloaded from provincial websites in September 2019 (i.e., Alberta Gaming Liquor and Cannabis, 2020) and cross-checked with lists displayed on Leafly, a website dedicated to cannabis and legal cannabis stores (www.leafly.ca). The number of stores in each province was divided by the provincial population aged 15 and over for 2019 and multiplied by 100,000 (Statistics Canada, 2020a). Illegal retail stores were not included.

Table 1
Sample characteristics of past 12-month cannabis consumers who purchased dried flower in the past 12 months (n = 2506).

	Unweighted % (n)	Weighted % (n)
Age group		
MLA-25*	14.4 (361)	14.0 (352)
26–35	28.7 (720)	33.5 (839)
36–45	23.5 (590)	22.2 (556)
46–55	17.4 (435)	17.6 (440)
56–65	16.0 (400)	12.7 (319)
Sex at birth		
Female	53.6 (1343)	40.2 (1008)
Male	46.4 (1163)	59.8 (1498)
Ethnicity/Race		
Black	2.6 (66)	3.3 (83)
East/Southeast Asian	4.2 (105)	4.4 (111)
Indigenous	4.2 (104)	4.4 (109)
Latino	1.5 (38)	2.1 (52)
Middle Eastern	0.6 (16)	0.5 (13)
South Asian	2.2 (55)	2.6 (66)
White	78.5 (1966)	76.0 (1905)
Mixed/Other	6.2 (156)	6.7 (167)
Highest level of Education		
Less than high school	6.9 (171)	13.0 (324)
High school diploma	19.4 (484)	31.4 (783)
Some college or technical vocation	47.8 (1192)	35.4 (882)
Bachelor's degree or higher	25.9 (647)	20.2 (503)
Income adequacy		
Very difficult	12.0 (301)	12.1 (302)
Difficult	25.5 (640)	26.1 (653)
Neither easy nor difficult	33.5 (840)	33.7 (845)
Easy	18.5 (464)	17.9 (449)
Very easy	8.4 (211)	7.6 (191)
Not specified	2.0 (50)	2.6 (66)
Province		
British Columbia	14.5 (363)	13.9 (347)
Alberta	16.4 (412)	13.8 (346)
Saskatchewan	5.4 (135)	3.3 (83)
Manitoba	6.3 (158)	4.1 (103)
Ontario	22.4 (562)	40.1 (1005)
Quebec	17.9 (448)	17.2 (430)
New Brunswick	5.3 (132)	2.4 (60)
Nova Scotia	6.7 (169)	2.9 (73)
Prince Edward Island	1.0 (24)	0.5 (13)
Newfoundland and Labrador	4.1 (103)	1.8 (46)
Cannabis Use Frequency		
Past year, but less than monthly consumer	17.3 (433)	15.4 (386)
Monthly consumer	18.4 (461)	17.4 (436)
Weekly consumer	20.5 (513)	20.8 (521)
Daily/almost daily consumer	43.9 (1099)	46.4 (1162)
Device used		
Smartphone	49.1 (1230)	48.7 (1220)
Tablet	7.0 (176)	6.7 (169)
Computer	43.9 (1100)	44.6 (1117)

* MLA = minimum legal age. Minimum legal age (MLA) was taken from provincial laws in September 2019: 18 years in Alberta and Quebec, and 19 years in all other provinces.

2.1.4. Retail proximity (Euclidean distance)

Respondents were asked "Please provide the postal code where you live for most of the year". If respondents did not provide their postal code (n = 2900), they were asked "Please name the 2 cross-streets of this intersection". Of those who provided their intersection (n = 1081), Google Maps was used to obtain postal codes, cross-referencing with the respondents' city and province. All intersections where Google Maps could not find a postal code were left blank (n = 272). The postal codes of legal retailers were identified as described above. The Canadian respondents' postal codes and postal codes of legal retail stores were then linked to the Postal Code Conversion File Plus (PCCF+) version 7B, to obtain latitude and longitudes (Statistics Canada, 2020b). An open-source geographic information system (GIS) application (QGIS v3.6) was used to geocode the latitudes and longitudes of legal retail stores and respondents' postal codes. For respondents in urban areas, Canadian postal codes can cover a single house/apartment building, whereas postal codes in rural areas cover a larger landmass. In the current study, 86 % of respondents live in urban areas and so a certain degree of accuracy can be assumed from postal codes as a proxy for Canadian respondent locations (Bow et al., 2004; Pinault et al., 2020). The North American Equidistant Conic Projection (EPSG:102010) was used to minimize distance distortions. The Euclidean distance (in kilometers) between the postal code of the retail store and each respondent's address was computed. Distances were categorized into: "Under 3 km", "3–4.99 km", "5–9.99 km", "Over 10 km" to mimic categories used by Statistics Canada (2019b). A sensitivity analysis was conducted to examine the effect of distance as a categorical measure using breaks at the quartiles as well as a continuous measure (Supplemental Table 2).

2.1.5. Retail proximity (self-reported time to retail store)

Respondents were asked "How long would it take you to get to the nearest store that sells cannabis using your usual mode of transportation?" Responses began at "Less than five minutes" and increased in five-minute increments up to one hour and ended with "More than an hour" and "I don't know any store near to where I live". Responses were categorized into: "Under 5 min", "5–15 mins", "Over 15 min", "I don't know any stores where I live". To approximately match the time taken to travel 3 km and 10 km by car at 40–60 km per hour. This variable included both legal and illegal retail stores.

The full questionnaire is available in the ICPS 2019 survey (www.cannabisproject.ca/methods). All questions included "Don't know" and "Refuse to answer" options. Except "perceived income adequacy", all "Refuse to answer" options were set to missing. Except "perceived income adequacy" and "self-reported time to nearest retail store", all "Don't know" options were set to missing.

2.2. Statistical analysis

After exclusions due to poor data quality, such as speeding, dishonesty, or duplicate entries (n = 1228), the 2019 Canadian sample comprised 15,256 respondents. See 2019 Technical Report for more detail on exclusions (Goodman et al., 2019)(www.cannabisproject.ca/methods).

The current analysis was based on the sub-sample of 2506 Canadian respondents who were of legal age to purchase cannabis and had consumed and purchased dried flower in the past 12-months. A total of 101 respondents were excluded where the legality of purchase source was unknown, and 355 were excluded where respondents did not provide a postal code or intersection.

Post-stratification sample weights were constructed based on the Canadian census estimates. Respondents were classified into age-by-sex-by-province, education, and age-by-smoking status groups. A raking algorithm was applied to the cross-sectional analytic sample to compute weights that were calibrated to these groupings and rescaled to the sample size for Canada. Statistical models were conducted with and without weights and similar patterns emerged. All estimates are weighted unless otherwise specified.

Descriptive statistics were used to describe legality of last purchase source, number of retail stores, and retail proximity across province. Binary logistic regression models were fitted to examine the association between the legality of last purchase source (1=Illegal vs. 2=Legal) and retail availability, where retail availability was represented in three ways: 1) province of residence; 2) objective retail proximity using the Euclidean distance to legal retail stores from a respondent's residence; and 3) self-reported retail proximity using time taken to nearest retail store. All models were adjusted for age, sex, education level, ethnicity/race, income adequacy, survey device type, and cannabis use frequency. Adjusted odds ratios (AORs) are reported with 95 % confidence intervals (95 % CI). Analyses were conducted using survey procedures in SAS (SAS version 9.4, SAS Institute Inc., Cary, NC, USA).

3. Results

Table 1 displays the weighted and unweighted sample characteristics among Canadian respondents who were of legal age to purchase legal cannabis and had consumed and purchased dried flower in the past 12 months.

Table 2 displays the percentage of dried flower purchasers who last purchased dried flower from a legal source, the number of stores per 100,000 residents aged 15 and over in September 2019, and retail proximity to the nearest store as an objective and self-reported measure in each province. As Table 2 shows, 47.7 % of dried flower purchasers reported to last purchase dried flower from a legal source (range = 40.5 %–81.2 % across the provinces). On average, there were 1.61 stores per 100,000 residents aged 15 and over in all provinces in September 2019 (range = 0.20–7.87 stores per 100,000 residents aged 15 and over across the provinces). A total of 31.3 % of dried flower purchasers live under 3 km from a legal retail store (range = 12.2 %–74.0 % across the provinces). A total of 8.4 % of dried flower purchasers reported living within five minutes from a retail store using their usual mode of transport (range = 2.1 %–20.7 % across the provinces). Of those who reported their usual mode of transport, 66.8 % (n = 1625) drove (car/taxi), 16.9 % (n = 372) used active transport (bike/walk), and 16.3 % (n = 325) used public transport (bus/train).

3.1. Province of residence

Three binary logistic regression models were used to examine the association of the legality of last purchase source used to purchase dried flower and retail availability (Table 3). In Model 1, province of residence was associated with legality of purchase source, adjusting for sociodemographic covariates. Dried flower purchasers residing in Prince Edward Island, Newfoundland and Labrador, Alberta, Nova Scotia, New Brunswick, Saskatchewan, and Quebec were more likely to last purchase dried flower from a legal source than residents of Ontario. No differences were found in the odds of last purchasing from a legal source between those residing in Manitoba or British Columbia and residents of Ontario.

3.2. Retail proximity (Euclidean distance)

In Model 2, objective retail proximity to the nearest legal retail store was associated with legality of purchase source, adjusting for sociodemographic covariates. Dried flower purchasers who lived under 3 km from a legal retail cannabis store were more likely to last purchase dried flower from a legal source than those who lived over 10 km away. No differences were found in the odds of last purchasing from a legal source between dried flower purchasers who lived between 3 km and 4.9 km and 5 km and 9.9 km from a legal retail cannabis store and those who lived over 10 km away.

3.3. Retail proximity (self-reported time taken to nearest retail store)

In Model 3, self-reported retail proximity to the nearest retail store was associated with legality of purchase source, adjusting for sociodemographic covariates. Dried flower purchasers who reported living over 15 min from their nearest retail store were less likely to last purchase dried flower from a legal source than those who reported living under five minutes, between five and 15 min, and those who did not know any stores near to where they lived.

3.4. Secondary covariates

After adjusting for retail availability and sociodemographic covariates, across all three models, daily cannabis consumers were less likely to last purchase dried flower at a legal source than less than monthly users (all contrasts $p < 0.001$). Dried flower purchasers with less than a high school diploma were less likely to last purchase dried flower at a legal source than those with a higher level of education, (all contrasts $p < 0.05$). Dried flower purchasers who found making ends meet neither

Table 2
Legality of purchase source, the number of residents per store, and retail proximity across the provinces in Canada.

	Legal source used at last purchase (n = 2405)	Number of stores per 100,000 people aged 15+ in September 2019	Objective retail proximity: Euclidean distance between postal code of respondents' residence and postal code of nearest legal retail store (km) (n = 2151)				Self-reported retail proximity: Time taken to get to the nearest retail store in the town/city near to where you live (n = 2487)			
			Under 3 km	3–4.9 km	5–9.9 km	Over 10 km	Under 5 minutes	5–15 min	Over 15 min	I don't know any stores near to where I live
All 10 provinces	47.7 (1278)	1.61	31.3 (831)	10.8 (259)	16.4 (336)	41.5 (725)	8.4 (282)	35.8 (1004)	47.9 (1056)	7.9 (145)
Province										
Prince Edward Island	81.2 (20)	3.01	23.9 (7)*	43.3 (7)*	0.0 (0)	32.8 (7)*	9.4 (2)*	65.5 (17)	25.1 (5)*	0.0 (0)
Newfoundland and Labrador	73.8 (77)	5.53	66.3 (58)	10.7 (7)*	4.9 (5)*	18.2 (18)	18.2 (20)	58.0 (56)	22.8 (26)	1.0 (1)*
Nova Scotia	66.6 (105)	1.44	28.3 (38)	13.3 (25)	14.7 (25)	43.6 (58)	17.5 (26)	40.9 (71)	40.4 (68)	1.1 (3)*
Alberta	61.6 (251)	7.87	74.0 (262)	8.7 (33)	9.0 (29)	8.3 (34)	20.3 (91)	54.0 (208)	22.3 (97)	3.4 (14)*
New Brunswick	58.0 (72)	3.01	46.1 (45)	11.5 (18)	24.3 (23)	18.1 (22)	20.7 (21)	51.1 (67)	25.6 (40)	2.6 (2)*
Saskatchewan	54.8 (78)	3.71	64.9 (75)	7.9 (12)*	7.6 (10)*	19.7 (23)	12.9 (20)	47.3 (69)	36.5 (40)	3.4 (4)*
Quebec	48.7 (223)	0.27	23.6 (102)	15.4 (64)	24.6 (89)	36.4 (133)	2.1 (12)*	32.7 (150)	57.8 (253)	7.4 (30)
Manitoba	47.0 (79)	2.07	49.4 (72)	14.1 (18)	13.4 (19)	23.2 (26)	13.0 (28)	49.9 (79)	33.5 (45)	3.6 (5)*
British Columbia	41.2 (154)	1.53	33.7 (106)	11.5 (35)	16.3 (54)	38.6 (119)	11.6 (42)	39.1 (143)	45.4 (161)	4.0 (16)
Ontario	40.5 (219)	0.20	12.2 (66)	8.6 (40)	16.9 (82)	62.3 (285)	3.2 (20)	24.7 (144)	59.2 (321)	13.0 (70)

Data are % (n). Weighted %, unweighted n. Missing values for legality of purchase source (n = 101); Euclidean distance (n = 355); and time taken to nearest store (n = 19) are excluded (removed from the denominator). *High sampling variability – coefficient of variation is >.30 %.

Table 3
Weighted binary logistic regression analysis for outcome variables by legality of purchase source at last purchase of dried flower (n = 2,506).

	% Legal (n)	MODEL 1 (n=2,368) Legal (vs. illegal) AOR (95% CI)	p-value	MODEL 2 (n=2,057) Legal (vs. illegal) AOR (95% CI)	p-value	MODEL 3 (n=2,356) Legal (vs. illegal) AOR (95% CI)	p-value
Province of residence							
Prince Edward Island	81.2 (20)	**5.66 (1.77, 18.13)**	.004	–		–	
Newfoundland and Labrador	73.8 (77)	**4.25 (2.21, 8.19)**	<.001	–		–	
Nova Scotia	66.6 (105)	**2.82 (1.85, 4.31)**	<.001	–		–	
Alberta	61.6 (251)	**2.74 (1.98, 3.78)**	<.001	–		–	
New Brunswick	58.0 (72)	**2.26 (1.32, 3.88)**	.003	–		–	
Saskatchewan	54.8 (78)	**1.83 (1.14, 2.94)**	.013	–		–	
Manitoba	47.0 (79)	1.47 (0.94, 2.31)		–		–	
Quebec	48.7 (223)	**1.41 (1.03, 1.92)**	.032	–		–	
British Columbia	41.2 (154)	1.04 (0.76, 1.43)		–		–	
Ontario	40.5 (219)	REF		–		–	
Euclidean distance to legal retail store (km)							
Under 3 km	53.9 (462)			**1.56 (1.20, 2.02)**	.001	–	
3 km – 4.9 km	48.6 (133)			1.17 (0.80, 1.70)			
5 km – 9.9 km	43.5 (164)	–		0.97 (0.70, 1.34)		–	
Over 10 km	43.9 (337)	–		REF		–	
Time taken to nearest retail store							
Under 5 minutes	63.0 (173)	–		–		**2.24 (1.56, 3.21)**	<.001
5 – 15 minutes	53.5 (574)	–		–		**1.39 (1.11, 1.74)**	.005
Over 15 minutes	44.1 (491)	–		–		REF	
I don't know any stores near to where I live	29.9 (35)	–		–		**0.49 (0.30, 0.83)**	.007
Cannabis Use Frequency							
Past year, but less than monthly consumer	57.6 (283)	REF		REF		REF	
Monthly consumer	58.9 (276)	1.11 (0.78, 1.58)		1.19 (0.82, 1.72)		1.02 (0.72, 1.45)	
Weekly consumer	51.5 (283)	0.93 (0.67, 1.31)		0.96 (0.67, 1.38)		0.85 (0.60, 1.19)	
Daily/almost daily consumer	38.3 (436)	**0.51 (0.38, 0.70)**	<.001	**0.49 (0.35, 0.68)**	<.001	**0.47 (0.35, 0.64)**	<.001
Income adequacy							
Very difficult/Difficult	42.1 (435)	REF		REF		REF	
Neither difficult nor easy	53.4 (465)	**1.54 (1.19, 2.00)**	.001	**1.45 (1.11, 1.91)**	.007	**1.51 (1.61, 1.95)**	.002
Easy/Very easy	48.2 (357)	1.21 (0.93, 1.59)		1.14 (0.86, 1.52)		1.09 (0.83, 1.43)	
Not specified	49.1 (21)	1.84 (0.62, 5.44)		3.20 (0.57, 17.92)		2.51 (0.84, 7.53)	
Age group							
MLA-25	47.4 (190)	0.93 (0.61, 1.41)		1.14 (0.74, 1.76)		0.98 (0.65, 1.47)	
26–35	51.2 (396)	1.20 (0.84, 1.72)		1.27 (0.88, 1.85)		1.17 (0.81, 1.67)	
36–45	47.8 (302)	1.04 (0.72, 1.50)		1.14 (0.78, 1.67)		1.05 (0.73, 1.50)	
46–55	41.9 (195)	0.79 (0.54, 1.15)		0.79 (0.54, 1.17)		0.80 (0.55, 1.17)	
56–65	46.5 (195)	REF		REF		REF	
Sex at birth							
Female	50.2 (707)	**1.27 (1.02, 1.58)**	.003	1.15 (0.92, 1.45)		**1.26 (1.02, 1.57)**	.035
Male	46.0 (571)	REF		REF		REF	
Ethnicity/Race							
Black	38.9 (29)	0.74 (0.40, 1.37)		0.72 (0.36, 1.46)		0.66 (0.37, 1.20)	
East/Southeast Asian	61.0 (58)	1.47 (0.87, 2.49)		1.08 (0.60, 1.95)		1.23 (0.73, 2.08)	
Indigenous	41.6 (45)	0.76 (0.46, 1.27)		0.68 (0.39, 1.18)		0.85 (0.51, 1.43)	
Latino	42.3 (20)	0.68 (0.27, 1.75)		0.60 (0.23, 1.56)		0.60 (0.23, 1.54)	
Middle Eastern	75.1 (11)	2.93 (0.75, 11.48)		4.87 (0.73, 32.65)		2.27 (0.72, 10.85)	
South Asian	43.6 (24)	0.65 (0.34, 1.25)		0.59 (0.30, 1.18)		0.58 (0.30, 1.10)	
White	48.2 (1013)	REF		REF		REF	
Other/Mixed	44.9 (64)	0.96 (0.59, 1.57)		0.77 (0.46, 1.30)		0.88 (0.54, 1.44)	
Highest level of Education							
Less than high school	32.9 (55)	REF		REF		REF	
High school diploma	47.3 (230)	**1.80 (1.15, 2.81)**	.011	**2.06 (1.27, 3.33)**	.003	**1.74 (1.11, 2.73)**	.017
Some college or technical vocation	49.0 (607)	**1.78 (1.18, 2.00)**	.006	**2.01 (1.29, 3.14)**	.002	**1.65 (1.08, 2.51)**	.019
Bachelor's degree or higher	55.0 (380)	**1.97 (1.25, 3.11)**	.004	**2.20 (1.35, 3.60)**	.002	**1.84 (1.16, 2.91)**	.010
Device used							
Computer	47.7 (557)	REF		REF		REF	
Smartphone	47.7 (631)	1.05 (0.83, 1.33)		1.12 (0.88, 1.44)		1.08 (0.86, 1.36)	
Tablet	48.0 (90)	1.06 (0.68, 1.67)		0.99 (0.62, 1.58)		1.04 (0.66, 1.63)	

Weighted %, unweighted n. *MLA=minimum legal age. Minimum legal age (MLA) was taken from provincial laws in September 2019: 18 years in Alberta and Quebec, and 19 years in all other provinces. Missing values for legality of purchase source (n=101); Euclidean distance (n=355); time taken to nearest store (n=19); ethnicity/race (n=35); and education (n=12) are excluded.

difficult nor easy were more likely to last purchase dried flower at a legal source than those who found it difficult, (all contrasts $p < 0.05$).

After adjusting for retail availability and sociodemographic covariates, female dried flower purchasers were more likely to last purchase dried flower at a legal source than male purchasers in Models 1 and 3 (all contrasts $p < 0.05$), with no association in Model 2. Age, ethnicity/race, and device used to complete survey were not associated with legality of last purchase source.

4. Discussion

The findings suggest that retail availability of legal cannabis is associated with purchasing dried flower from legal sources compared to illegal sources among Canadians who had consumed and purchased dried flower in the past 12-months; however, there is important variation across provinces. The proportion of Canadian dried flower purchasers who last purchased dried flower from a legal source varied from 41 % in Ontario to 81 % in Prince Edward Island. Indeed, residents in most provinces were more likely to purchase dried flower at a legal source than residents of Ontario. These results are consistent with a study using government data from federal and provincial agencies, which found a similar range of legal market share across the provinces, with Prince Edward Island having the greatest legal market share (70 %) and Ontario having the smallest (13 %) (Armstrong, 2020).

In the annual 2019 Canadian Cannabis Survey (CCS), 52 % of consumers reported purchasing any cannabis legally in the past 12-months (Government of Canada, 2019b). In addition, twice as many consumers reported their usual source to be legal physical stores (29 %) than legal online stores (14 %) (Government of Canada, 2019b). In the current study, 48 % of all dried flower purchasers purchased dried flower legally at their last purchase. The proportion of those purchasing legally may be slightly lower in the current study due to potentially fewer people answering honestly about illegal purchases to a government survey. Moreover, the current survey removed respondents who reported being 'dishonest' in their answers.

The findings highlight marked discrepancies in retail availability in the first year after cannabis legalization. In September 2019, most dried flower purchasers in Alberta lived under 10 km from a legal cannabis store (92 %), compared to only a third of those from Ontario (38 %). Slightly lower proportions were reported by Statistics Canada in July 2019: 70 % in Alberta lived within 10 km from a legal store and 33 % in Ontario lived within 10 km (Statistics Canada, 2019b). The percentages from the current study across all provinces were slightly higher than those reported by Statistics Canada, potentially resulting from additional stores opening between July and September 2019 (Statistics Canada, 2019b). The number of stores varied across the provinces in the first year of legalization and clear differences in physical availability of legal retail stores were seen across the provinces (Myran et al., 2019). In the current study, Ontario – Canada's most populated province - had the lowest number of stores per 100,000 residents aged 15 and over. After a change of provincial government prior to legalization, Ontario's cannabis retail structure for physical stores changed from government-run to private; therefore, Ontario had no stores until April 2019. Comparatively, Alberta had a private retail structure for physical stores, and had 86 stores by April 2019. Ontario since increased its number of legal retail cannabis stores and therefore these patterns may change in the future as the legal market becomes more established. Documenting the evolution of the legal retail market is important for interpreting studies examining legalization in Canada and evaluating the impact of legalization in Canada.

The current study demonstrated a positive relationship between retail proximity, both objective and self-reported, and last purchasing dried flower from a legal source. Dried flower purchasers who lived under 3 km to a legal retail store were more likely to last purchase legally than those over 10 km away. Self-reported time taken to get to the nearest store demonstrated a similar relationship, whereby those who reported living under 15 min from a store were more likely to purchase legally than those over 15 min. The relationship indicates that not only the distance to stores but the perceived time it takes to travel to stores is correlated to whether dried flower purchasers purchase from physical retail stores. Moreover, the self-reported measure considers travel time and reflects the awareness of retail stores in the local area. However, the importance of physical proximity and access may depend on the availability of delivery services (Berg et al., 2018; Freisthler and Gruenewald, 2014). Unlike most US states that have legalized non-medical cannabis, online sales are available in all Canadian provinces. The importance of physical access may also depend on access to the internet, access to a credit card, and patience for delivery. Indeed, although delivery times were longer than expected after legalization (Loriggio, 2018), the government-run online retail store (Ontario Cannabis Store) now provides same-day delivery in some regions of Ontario (Leafly Canada Staff, 2019). Furthermore, since the COVID-19 pandemic and resulting reduced mobility, physical access to cannabis stores may matter less than before the pandemic.

Daily and almost daily cannabis consumers account for a significant proportion of the cannabis market share; therefore, they represent a priority group from transitioning to legal sources (Callaghan et al., 2019; Midgette et al., 2019). After adjusting for retail availability and sociodemographic covariates, daily cannabis consumers were less likely to last purchase dried flower from a legal source than less than monthly consumers. The legal purchase limit in Canada for dried flower is 30 g. Daily consumers may purchase in larger quantities; therefore, making illegal sources more desirable for bulk purchases. Indeed, quantity discounts are common in illegal drug markets (Caulkins and Padman, 1993; Caulkins, 2007; Clements, 2019). Substantial quantity discounts were observed in a retail scan of objective prices in the Canadian illicit cannabis market (Mahamad and Hammond, 2019). Quantity discounts are present in the legal markets; although with smaller reductions (Mahamad et al., 2020; Ontario Cannabis Store, 2020). Daily consumers may be retained in the illegal market due to the quantity discounts and the more generous purchase limits.

4.1. Limitations

This study is subject to limitations common to survey research. Respondents were recruited using non-probability-based sampling; therefore, the findings do not provide nationally representative estimates. The data were weighted by age group, sex, region, education, and smoking status. Cannabis use estimates were within the range of national estimates for young adults, whereas estimates among the entire ICPS sample were generally higher than national surveys in Canada. This is likely because the ICPS sampled individuals aged 16–65, whereas national surveys included older adults, who are known to have lower rates of cannabis use. In addition, a greater percentage of ICPS respondents reported poor self-rated general health than the national population, which is a feature of many non-probability samples (Fahimi et al., 2018) and may be partly due to the use of web surveys, which provide greater perceived anonymity than in-person or telephone-assisted interviews often used in national surveys (Hays et al., 2015).

To measure self-reported time taken to retail store, respondents were asked how long it would take them (in minutes) to get to their nearest store that sells cannabis. This question did not specify the legality of the retail store. In addition, self-reported time taken to retail store could vary by mode of transport; however, of those who reported their usual mode of transport, most used personal vehicle such as a taxi or car (66.8 %). Sensitivity analyses examined the association of 'usual mode of transport' as a covariate in the regression model, but comparable patterns emerged.

Euclidean distance to legal retail cannabis stores was treated as a categorical variable in the regression models, which assumes there are similar break points in distance travelled among respondents. A

continuous measure would assume a monotonic linear relationship between distance and the likelihood of purchasing their dried flower at an illegal or legal source. Moreover, the geometric mean revealed skewness in the data and so a continuous measure was deemed inappropriate. A sensitivity analysis was conducted to examine the effect of distance as a categorical measure using different classification schemes as well as a continuous measure and similar patterns emerged (Supplementary Table 2).

Price of dried flower was not included in the current study. There are several estimates of legal prices for dried flower after the first year of legalization; however, provincial estimates are inconsistent, and the reliability is unclear (Mahamad et al., 2020; Ontario Cannabis Store, 2020; Martin, 2019; Statistics Canada, 2020c). Finally, the current study focused on dried flower only and therefore the findings may not be representative of all cannabis products in Canada. However, dried flower is the most used product among Canadians and so would capture a large proportion of expenditures in the legal market (Goodman et al., 2020; Government of Canada, 2019b, b). In addition, only dried flower and some oils were available in the legal market at the time of the survey; therefore, most products were only available in the illegal market (Government of Canada, 2019a). Further research is needed on the association between proximity to legal stores and the legality of purchase source across different cannabis products, which are increasing in market share.

4.2. Conclusions

The findings demonstrate a strong association between retail availability and the proportion of past 12-month dried flower purchasers who reported purchasing dried flower from a legal source, where retail availability was represented by province of residence, 'objective' proximity to legal stores, and self-reported proximity to retail stores. This association was demonstrated both at the provincial level in terms of residence, as well as the individual level with respect to distance to legal stores and consumers' own perception of travel time to the nearest store. Achieving optimal retail availability, where consumers are encouraged to transition to the legal market without promoting increased initiation or problematic use, is paramount in a regulated market. The current study would suggest that more legal stores and accessible legal stores would increase legal purchases; however, too many stores may not only increase consumption but if stores are unequally distributed, may increase consumption in some populations over others, such as vulnerable populations or those in low-income areas (Amiri et al., 2019; Tabb et al., 2018; Unger et al., 2020). A balance must be achieved in the Canadian market to achieve the public health objectives set out in the Cannabis Act. Future research is needed on how retail proximity changes over time and its association with legal purchases as the market continues to stabilize post-legalization.

Role of funding source

Funding for this study was provided by a Canadian Institutes of Health Research Project Bridge Grant (PJT-153342) and a Canadian Institutes of Health Research Project Grant. Additional support was provided by a Public Health Agency of Canada-Canadian Institutes of Health Research Chair in Applied Public Health (DH) and a Vanier Canada Graduate Scholarship (EW). The funders had no role in study design, collection, analysis or interpretation of the data, report writing, or decision to submit the report for publication.

6. Contributors

EW and DH conceptualized and designed the study. All authors assisted with analyses. EW drafted the initial manuscript. All authors reviewed and revised the manuscript. All authors approved the final manuscript as submitted.

Declaration of Competing Interest

DH has served as a paid expert witness on behalf of governments in legal challenges to public health laws and regulations initiated by cannabis and tobacco companies. The other authors have indicated they have no potential conflicts of interest to declare.

Acknowledgements

We thank Beau Kilmer for his helpful comments and suggestions.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.drugalcdep.2021.108794.

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