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Cannabis flower prices and transitions to legal sources after legalization in Canada, 2019–2020

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ABSTRACT

Background: The post-tax price of legal cannabis has the potential to influence whether consumers transition from the illegal to legal cannabis market. The aims of the study were to: 1) estimate the percentage who report purchasing dried flower at different sources; 2) estimate the unit price of dried flower; and 3) examine the association between price and legality of purchase source.
Methods: Repeat cross-sectional survey data come from Canadian respondents from the International Cannabis Policy Study conducted in 2019 and 2020. Respondents were recruited through online commercial panels, of legal age to purchase cannabis (up to 65 years), and purchased dried flower in the past 12-months (n = 4923). Weighted binary logistic regression models examined the association between price and legality of source.
Results: The proportion of consumers last purchasing dried flower from legal sources increased from 2019 to 2020 (45.7% vs 58.1%) and in the past 12-months, the average percent of dried flower consumers reported purchasing from legal sources increased from 2019 to 2020 (55.7% vs 67.5%). The mean price of legal dried flower decreased in 2020 ($12.63 vs $11.16; $p < 0.001$), but remained more expensive than illegal dried flower in both years ($12.63 vs $9.04 in 2019; $p < 0.001$, $11.16 vs $9.41 in 2020; $p < 0.001$).
Conclusions: Two years after legalization in Canada, the price of dried flower from legal sources decreased, along with a greater percentage of consumers purchasing from legal sources than after one year. Price and retail policies must continue to encourage the transition to the legal market in Canada.

1. Introduction

Canada legalized non-medical ("recreational") cannabis in October 2018. At the time of legalization, only dried flower and some oils were available to purchase from the non-medical market, whereas all other products (e.g., edibles, vape pens) were available from December 2019. In the non-medical market, Canadians are permitted to purchase up to 30 g of dried flower in a single transaction (Government of Canada, 2018a). Indeed, quantity discounts are considerable in illegal markets, where purchasing in larger quantities tend to be cheaper per gram than smaller quantities (Ben Lakhdar et al., 2016; Caulkins, 2007; Caulkins and Padman, 1993; Červený and van Ours, 2019; Clements, 2006; Wadsworth et al., 2020).

Canada had an established illegal and medical cannabis market prior to legalization (Mahamad and Hammond, 2019; Capler et al., 2017). Transitioning consumers from illegal to legal (medical or non-medical) sources is a primary objective of legalization; however, the timeline and the extent to which consumers shift to legal retail sources remains unclear. Indeed, Canada's national survey found that just under half of consumers reported using the illegal market two years after legalization (Government of Canada, 2020). Price is among the primary reasons cited by cannabis consumers that influences where they sourced their cannabis (Government of Canada, 2019a, 2020). This suggests that if the legal market is superior to the illegal market on price then consumers may choose the legal market to source their cannabis.

The post-tax price of legal cannabis has the potential to influence whether consumers transition from the illegal to legal cannabis market (Amlung et al., 2019; Amlung and MacKillop, 2019; Childs and Stevens, 2019). Since legalization, studies have consistently reported illegal cannabis to be cheaper than legal cannabis in Canada. In a study using

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prices collected from illegal and legal retailers, legal cannabis was 19% more expensive than illegal cannabis at all quantities examined in the two months after legalization in Canada (Mahamad et al., 2020). Crowdsourced data from Statistics Canada found a slightly greater price differential, where legal cannabis was 50% more expensive than illegal cannabis two months after legalization; however, results were not split by quantity purchased (Statistics Canada, 2020a). Moreover, in a self-reported study conducted pre-legalization, dried flower purchased from a legal source – government licensed medical retailers – was more expensive than dried flower purchased from an illegal source (Wadsworth et al., 2020). Canada's national cannabis survey reported a drop in the price-per-gram of dried flower prior to legalization among cannabis consumers, but an increase since legalization ($11.40/g, $8.62/g, $9.83/g, and $10.48/g in 2017, 2018, 2019, and 2020, respectively) (Government of Canada, 2017, 2018b, 2019a, 2020). However, the Canadian Cannabis Survey did not separate price-per-gram by quantity purchased nor legality of source.

To our knowledge, the current study is among the first to examine the self-reported price-per-gram (hereafter: unit price) of dried flower and its relationship with purchase source used among cannabis dried flower purchasers in Canada post-legalization. The aims of the study were to 1) estimate the percentage of dried flower purchasers who report purchasing dried flower from legal and illegal sources; 2) the quantities purchased; 3) estimate the unit price of dried flower by source and cannabis use status and; 4) examine the association between unit price of dried flower and legality of purchase source. We hypothesized more consumers would purchase in the legal market and the average price paid would be lower in 2020 than 2019. We also hypothesized that it would be more expensive to purchase in the legal market than the illegal market. This study offers a timely exploration at the association of price of dried flower and legal purchases in a newly legal non-medical cannabis market in Canada.

2. Methods

Data are from Waves 2 and 3 of the International Cannabis Policy Study (ICPS), repeat cross-sectional surveys conducted in Canada and the United States. Data were collected via self-completed web-based surveys in September-October 2019 and 2020 from respondents aged 16–65. Respondents were recruited using non-probability sampling methods through the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations with a unique link were sent to panelists; ineligible panelists were not invited. Surveys were conducted in English or French in Canada. Median survey time was 25 min in 2019 and 21 min in 2020. Respondents provided consent prior to completing the survey. Respondents received remuneration in accordance with their panel's usual incentive structure. In 2019, 81,263 respondents accessed the survey link, of whom 51,087 completed the entire survey for an AAPOR cooperation rate of 63% (American Association for Public Opinion Research, 2016). In 2020, 78,438 respondents accessed the survey link, of whom 48,633 completed the entire survey (62%). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#31330). A full description of the study methods can be found in the ICPS Technical Reports and methodology paper (Goodman et al., 2020a,b, 2021; Hammond et al., 2020).

The current study reports data on Canadian respondents who had consumed and purchased dried flower in the past 12-months and were of legal age to purchase cannabis. Minimum legal age to purchase cannabis (MLA) was taken from provincial laws in September 2019 and 2020. In 2019, MLA was 18 years in Alberta and Quebec, and 19 years elsewhere. In 2020, Quebec raised their MLA to 21 years.

2.1. Measures

2.1.1. Socio-demographic measures

Sex at birth, age, ethnicity/race, education, perceived income adequacy, suspected device type used to complete survey, and province of residence. See Table 1 for full coding of response options.

2.1.2. 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 consumer", "Monthly consumer", "Weekly consumer", "Daily/almost daily consumer".

2.1.3. Legal purchases of dried flower in past 12-months

Respondents who consumed dried flower in the past 12-months were asked "Overall, about what percentage of the dried flower that you used in the past 12-months came from legal/authorized sources?". Answers were open-ended from 0% to 100%. Respondents were able to report both medical and non-medical legal/authorized sources.

2.1.4. Source used to purchase dried flower 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 (delivered to me)", "From a store, co-operative or dispensary (in person/curbside pickup)", "Other". "Other" responses were re-categorized according to answers provided.

2.1.5. Legality of last purchase source

Respondents who purchased dried flower from a physical or online store were asked: "What type of physical store or dispensary did you buy the dried flower from?" with answers: "A legal/authorized store", "An illegal or unauthorized store/dispensary", "Other", and "Where did you buy the dried flower 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. "Don't know" responses were categorized into "Unknown". All other sources were categorized according to Canadian regulations in September 2019 and 2020 to "Illegal" and "Legal" (Table S1).

2.1.6. Unit price of dried flower at last purchase

Respondent's unit price was calculated from two questions. First, respondents were asked, "The last time you purchased dried flower, how much did you buy…?" with answers "1/8 g or less", "1/4 g", "1/2 g", "3/4 g", "1 g", "2 g", "3 g", "1/8 ounce", "1/4 ounce", "1/2 ounce", "3/4 ounce", "1 ounce" and "More than 1 ounce". Respondents also could answer in the number of joints and choose the weight that is closest to the size they purchased. Units were standardized into grams (g) and responses were treated as continuous. Second, participants were asked, "How much did you spend the last time you bought dried flower?" and respondents could provide numeric responses in an open-ended field. To account for extreme values, unit prices above the 95th percentile were excluded (n_{2019} =100; n_{2020} =88) and values below the 1st percentile were winsorized to the 1st percentile (n_{2019} =20; n_{2020} =22). All prices were in Canadian dollars ($CAD). Prices in 2019 were inflated to 2020

Table 1
Sample characteristics of Canadian cannabis consumers who were of legal age to purchase cannabis and had reported purchasing dried flower in the past 12 months in 2019 and 2020 (n = 4923).

	Unweighted % (n)		Weighted % (n)	
	2019 n = 2506	2020 n = 2417	2019 n = 2481	2020 n = 2442
Age group				
MLA-25	14.4 (361)	12.3 (298)	14.0 (348)	10.3 (250)
26–35	28.7 (720)	26.2 (632)	33.5 (831)	32.2 (785)
36–45	23.5 (590)	24.9 (602)	22.2 (551)	26.2 (640)
46–55	17.4 (435)	18.8 (455)	17.6 (436)	18.8 (458)
56–65	16.0 (400)	17.8 (430)	12.7 (316)	12.7 (309)
Sex				
Female	53.6 (1343)	56.0 (1354)	40.2 (998)	42.1 (1029)
Male	46.4 (1163)	44.0 (1063)	59.8 (1483)	57.9 (1413)
Ethnicity				
Black	2.7 (66)	2.5 (65)	3.4 (83)	3.2 (77)
East/Southeast Asian	4.3 (105)	3.3 (85)	4.5 (110)	4.0 (96)
Indigenous	4.2 (104)	3.7 (94)	4.4 (108)	3.2 (78)
Latinx	1.5 (38)	1.5 (39)	2.1 (52)	1.8 (43)
Middle Eastern	0.7 (16)	1.1 (28)	0.5 (13)	1.3 (32)
South Asian	2.2 (55)	2.5 (63)	2.7 (65)	3.1 (73)
White	79.6 (1966)	78.4 (2006)	77.2 (1885)	78.0 (1877)
Other/Mixed	4.9 (121)	7.0 (180)	5.2 (127)	5.4 (129)
Education				
Less than high school	6.9 (171)	6.6 (158)	13.0 (321)	9.7 (236)
High school diploma	19.4 (484)	18.2 (437)	31.4 (775)	31.9 (775)
Some college or technical vocation	47.8 (1192)	46.1 (1106)	35.4 (873)	36.8 (893)
Bachelor's degree or higher	25.9 (647)	29.2 (700)	20.2 (498)	21.6 (524)
Income adequacy				
Very difficult	12.0 (301)	10.3 (248)	12.1 (299)	10.2 (249)
Difficult	25.5 (640)	23.1 (558)	26.1 (647)	21.7 (529)
Neither easy nor difficult	33.5 (840)	35.0 (846)	33.7 (836)	35.9 (877)
Easy	18.5 (464)	20.9 (506)	17.9 (444)	21.2 (517)
Very Easy	8.4 (211)	8.9 (214)	7.6 (189)	9.4 (228)
Not stated	2.0 (50)	1.9 (45)	2.6 (65)	1.7 (43)
Cannabis use frequency				
Past-year but less than monthly	17.3 (433)	18.0 (436)	15.4 (382)	15.4 (376)
Monthly	18.4 (461)	16.8 (406)	17.4 (432)	15.9 (388)
Weekly	20.5 (513)	19.4 (469)	20.8 (516)	19.8 (483)
Daily/almost daily	43.9 (1099)	45.8 (1106)	46.4 (1150)	48.9 (1194)
Province of residence				
British Columbia	14.5 (363)	16.5 (398)	13.9 (344)	15.2 (371)
Alberta	16.4 (412)	16.6 (402)	13.8 (343)	13.6 (333)
Saskatchewan	5.4 (135)	6.8 (165)	3.3 (82)	4.1 (101)
Manitoba	6.3 (158)	5.8 (141)	4.1 (102)	3.7 (89)
Ontario	22.4 (562)	19.2 (464)	40.1 (995)	38.1 (931)
Quebec	17.9 (448)	13.8 (334)	17.2 (426)	17.9 (438)
New Brunswick	5.3 (132)	7.1 (171)	2.4 (59)	2.4 (57)
Nova Scotia	6.7 (169)	7.1 (172)	2.9 (72)	3.0 (73)
Prince Edward Island	1.0 (24)	1.2 (28)	0.5 (12)	0.4 (11)
Newfoundland & Labrador	4.1 (103)	5.9 (142)	1.8 (46)	1.6 (39)
Device used				
Smartphone	49.1 (1230)	51.8 (1252)	48.7 (1208)	50.8 (1240)
Tablet	7.0 (176)	4.5 (109)	6.7 (167)	5.1 (124)
Computer	43.9 (1100)	43.7 (1056)	44.6 (1106)	44.1 (1078)

Income adequacy is assessed by the question: "Thinking about your family's income, how difficult or easy is it to make ends meet?", where 'making ends meet' means having enough money to pay for the things your family needs.
MLA = minimum legal age. Minimum legal age to purchase cannabis (MLA) was taken from provincial laws in September 2019 and 2020. In 2019, MLA was 18 years in Alberta and Quebec, and 19 years elsewhere. In 2020, Quebec raised their MLA to 21 years.

prices using the 12-month change in Consumer Price Index from September 2019 to September 2020 (0.5%) (Statistics Canada, 2020b).

2.1.7. Market price

An overall estimate of the market price of dried flower was calculated, similar to the average retail prices that are often reported based on sales data (Ontario Cannabis Store, 2020a). The average market price takes into account the price and quantity purchased among consumers, such that larger purchases are weighted more heavily than smaller purchases. The market price is estimated as the ratio:

$$\text{Market price} = \sum (P_r * Q_r) / \sum (Q_r))$$

where P_r is the respondents' unit price and Q_r is the respondent's quantity purchased.

The full questionnaire is available in the ICPS 2019 and 2020 surveys. All questions included "Don't know" and "Refuse to answer"

options. Except "perceived income adequacy", all "Refuse to answer" responses were set to missing. Except "perceived income adequacy" and "legality of last purchase source" all "Don't know" responses were set to missing.

2.2. Statistical analysis

After exclusions due to poor data quality or duplicate entries (n_{2019} = 1228; n_{2020} = 1221), the Canadian samples comprised 15,256 and 15,780 respondents in 2019 and 2020, respectively. See Technical Reports for more detail on exclusions (Goodman et al., 2020, 2021). The current analysis was based on the sub-sample of 4923 (n_{2019} = 2506; n_{2020} = 2417) Canadian respondents who were of legal age to purchase cannabis, and had consumed and purchased dried flower in the past 12-months. Respondents who received dried flower for free or through non-monetary exchange were not included in the analysis. Missing data were removed using case-wise deletion for variables in regression analyses for: legality of purchase source at last purchase (n = 188 [3.8%]); education (n = 28 [0.6%]); ethnicity/race (n = 71 [1.4%]); and unit price, either not providing a price or quantity variable to calculate a unit price (n = 995 [20.2%]) or an invalid value (n = 188 [3.8%]). The proportion of cannabis consumers who did not provide or had an invalid unit price were more likely to be female in 2020 ($\chi^2 = 9.9$, p = 0.002), to be better educated in 2019 ($\chi^2 = 7.9$, p = 0.048), report Black, East/-Southeast Asian or Middle Eastern ethnicity/race in 2019 ($\chi^2 = 16.2$, p = 0.023), report it was difficult to make ends meet in 2019 ($\chi^2 = 13.6$, p = 0.018), and be less frequent cannabis consumers (2019: $\chi^2 = 27.6$, p < 0.001; 2020: χ^2 =22.1, p < 0.001).

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 for each year (Goodman et al., 2020, 2021). All estimates are weighted unless otherwise specified.

First, descriptive statistics were used to describe purchase sources and quantity purchased of dried flower at last purchase across province. Second, the percentage of legal purchases of dried flower in the past 12-months was examined among dried flower purchasers. Third, the mean unit price with standard errors of the mean (SEM) and market price with standard errors (SE) were estimated. Fourth, a binary logistic regression model was fitted to examine the relationship between the legality of last purchase source and unit price, and tested a two-way interaction for survey wave and unit price. Sensitivity analyses were conducted where: 1) unit price of dried flower was removed as a covariate due to the bidirectionality of price also being dependent on purchase source and; 2) quantity purchased was included as a covariate as a categorical variable (<1 g, 1–3.49 g, 3.5–27.9 g, 28 g+) due to its relationship with purchase source, unit price, and cannabis use frequency. Models were adjusted for age, sex at birth, education, race/ethnicity, income adequacy, 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 of Canadian respondents who were of legal age to purchase cannabis and had consumed and purchased dried flower in the past 12 months in 2019 and 2020. Over half the sample were male, over three-quarters were White, and close to half were daily/almost daily cannabis consumers.

3.1. Legal dried flower purchases in the past 12-months

Fig. 1a displays the average reported percentage of dried flower purchased from legal sources in the past 12-months in 2019 and 2020 overall and across the provinces. On average, consumers of legal age reported purchasing 55.7% and 67.5% of dried flower from legal sources in 2019 and 2020, respectively. Fig. 1b displays the average reported

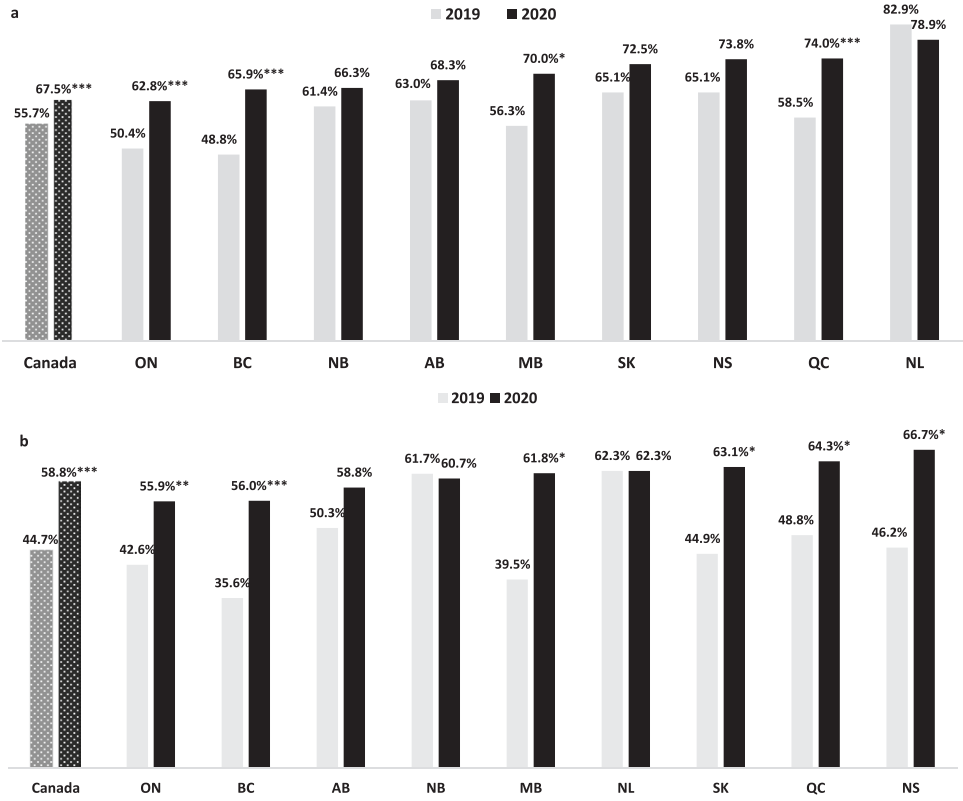

Fig. 1. a: Average percentage of dried flower purchased from legal sources in the past 12-months by province in 2019 and 2020 (n=4923) T-test between years: *<0.05; **<0.01; ***<0.001. ON=Ontario; NB=New Brunswick; BC=British Columbia; MB=Manitoba; AB=Alberta; NS=Nova Scotia; QC=Quebec; SK=Saskatchewan; NL=Newfoundland and Labrador. Respondents from Prince Edward Island are not included due to low sample size (n 2019=24; n2020=28). b: Average percentage of dried flower purchased from legal sources in the past 12-months by province among daily/almost daily consumers in 2019 and 2020 (n=1867) T-test between years: *<0.05; **<0.01; ***<0.001. ON=Ontario; NB=New Brunswick; BC=British Columbia; MB=Manitoba; AB=Alberta; NS=Nova Scotia; QC=Quebec; SK=Saskatchewan; NL=Newfoundland and Labrador. Respondents from Prince Edward Island are not included due to low sample size (n2019 =4; n2020 =14).

percentage of dried flower purchased from legal sources among daily cannabis consumers. On average, daily cannabis consumers of legal age reported purchasing 44.7% and 58.8% of dried flower from legal sources in 2019 and 2020, respectively.

3.2. Purchase source and quantity of dried flower at last purchase

Table 2 displays the characteristics of consumers' last purchase of dried flower by province, in 2019 and 2020. As Table 2 shows, stores/dispensaries were the most commonly reported purchase source last used in both years. The percentage of dried flower purchasers who reported last purchasing dried flower online/mail order and in stores/dispensaries was greater in 2020. The mean quantity last purchased was greater in 2020 (10.3 g) than 2019 (8.7 g), although the median quantity last purchased was 3.4 g in both years. In both years, most consumers last purchased between 3.5 g and 27.9 g of dried flower. The percentage of those purchasing 28 g and over was greater in 2020.

Supplemental Fig. 1a displays the percentage of consumers purchasing different quantities of dried flower at last purchase. On average, a greater percentage of consumers purchased greater quantities of illegal dried flower than legal (e.g., 18.9% purchased 28 g or more illegally vs 5.1% legally in 2019). Supplemental Fig. 1b displays the percentage of daily consumers purchasing quantities of dried flower at last purchase. On average, a greater percentage of daily consumers purchased 28 g or more in 2020 than 2019 illegally and legally (e.g., 13.0% purchased 28 g or more legally in 2019 vs 23.2% in 2020).

3.3. Unit price of dried flower at last purchase

Fig. 2 displays the market price of dried flower last purchased from illegal and legal sources in 2019 and 2020 by quantity purchased. On average, dried flower purchasers paid a higher unit price at all quantities from a legal source in both years.

Table 3 displays the mean and market price of dried flower by cannabis frequency, purchase source, and quantity purchased. The mean unit price of dried flower was $10.64 in 2019 and $10.41 in 2020 ($t(3739) = 0.8$, $p = 0.436$), and the market price was $7.09 in 2019 and $6.83 in 2020. In general, the mean unit price of dried flower decreased as frequency of use increased (i.e., less than monthly consumers = $14.01 in 2019, daily consumers = $8.47 in 2019, $t(1928) = -9.5$, $p < 0.001$). In both years, purchases from stores/dispensaries had the highest mean and market price at last purchase. In both years, legal dried flower was more expensive than illegal dried flower ($12.63 vs $9.04 in 2019 [$t(1869) = 8.9$, $p < 0.001$]; $11.16 vs $9.41 in 2020 [$t(1755) = 3.8$, $p < 0.001$]). Legal dried flower decreased in 2020 ($12.63 vs $11.16, $t(2085) = -3.6$, $p < 0.001$). As Table 3 indicates, the unit price of dried flower decreased as quantity purchased increased.

3.4. Legality of purchase source at last purchase

As Table 2 shows, 45.7% of consumers last purchased dried flower from legal sources in 2019 and increased to 58.1% in 2020. A total of 50.1% last purchased dried flower from illegal sources in 2019 and decreased to 38.2% in 2020.

A binary logistic regression model examined the correlates of the legality of last purchase source of dried flower (Table 4). An interaction test between unit price paid and survey year was significant ($F_{1,3579} = 4.3$, $p = 0.039$). Each additional dollar paid per gram in 2019 was associated with a 3% increase in the odds of purchasing legally and a 7% increase in 2020.

Consumers from Ontario were less likely to report last purchase of dried flower from a legal source than consumers from all provinces except Manitoba. Daily cannabis consumers were less likely to make their last purchase from a legal source than infrequent (i.e. less than monthly) users. Purchasing from legal sources was lower among those with less than a high school diploma. Respondents who reported finding it neither easy nor difficult or easy to make ends meet were more likely to make their last purchase from a legal source than those who reported finding it difficult. When unit price was removed as a primary covariate, respondents in 2020 were more likely to purchase legally than respondents in 2019. All other patterns remained largely similar, except sex at birth, which after adjusting for covariates was associated with last purchasing from a legal source.

As a sensitivity analysis, quantity purchased was included as a covariate. Similar patterns emerged in all variables, except the association between cannabis use frequency and legality of purchase source was attenuated. Respondents who purchased between 1 g and 3.49 g (AOR = 2.60, 95%CI: 1.85, 3.65) and 3.5 g and 27.9 g (AOR = 2.18, 95%CI: 1.62, 2.94) were more likely to purchase legally than respondents who purchased 28 g or more.

4. Discussion

The current study demonstrated a modest shift in purchase sources used to purchase dried flower between 12 and 24-months after cannabis legalization in Canada. Purchase sources typically used in the illegal market (i.e., friends and family, dealers) decreased from 2019 to 2020. Conversely, more typical purchase sources used in a legal market (i.e., stores or online) increased from 2019 to 2020. The Canadian Cannabis Survey reported a similar increase in the use of legal retail stores among past 12-month consumers from 2019 to 2020 (29–41%, respectively), but no increase in the use of legal online services from 2019 to 2020 (14–13%) (Government of Canada, 2019a, 2020). The lower percentage of consumers reporting use of legal physical and online stores could be explained by the discrepancy in the questions: whereas the current study asked for last purchase, the Canadian Cannabis Survey asked for usual purchase. Furthermore, greater use of online purchasing in the current study may be reflective of the COVID-19 pandemic and increased online purchasing due to provincial lockdowns. The Canadian Cannabis Survey began in April 2020, only one month after all provinces declared a state of emergency.

Legal purchases of dried flower were greater in 2020 than 2019. At last purchase, 46% of consumers purchased dried flower from legal sources in 2019 and increased to 58% in 2020. Comparable increases were found in the past 12-months: cannabis consumers reported purchasing 56% of dried flower from legal sources in the past 12-months in 2019, which increased to 68% in 2020. Similar percentages were reported in Canada's national cannabis survey, where 52% of past 12-month consumers reported purchasing from a legal source in 2019 and 79% in 2020 (Government of Canada, 2019a, 2020).

Legal dried flower purchases varied across the provinces. Ontarians were less likely to purchase dried flower from a legal source than dried flower purchasers of all provinces except Manitoba, after adjusting for price and other covariates. Ontario was slower to open a physical retail market due to a new provincial government that changed the proposed public retail structure to private months before legalization. Indeed, by September 2019 the legal non-medical market had only 13% of the total cannabis market share in Ontario, the lowest across the provinces (Armstrong, 2021). However, by February 2021, Ontario authorized 30 store applications per week, so Ontarians could see a change to legal retail access over the years (Alcohol and Gaming Commission of Ontario, 2021; CBC News, 2019). Newfoundland and Labrador was the

Table 2
Purchase source and quantity of dried flower among past 12-month cannabis consumers in Canada and the provinces: 2019 and 2020 (n = 4923).

	Canada		British Columbia		Alberta		Saskatchewan		Manitoba
	2019 n = 2506	2020 n = 2417	2019 n = 363	2020 n = 398	2019 n = 412	2020 n = 402	2019 n = 135	2020 n = 165	2019 n = 158
Purchase source used at last purchase									
Friends or family member	15.5% (377)	14.8% (327)	19.0% (73)	15.0% (63)	11.0% (49)	8.4% (33)	13.7% (20)	6.5% (12)	11.7% (25)
Dealer (in person)	25.4% (561)	16.0% (343)	25.0% (75)	18.4% (57)	21.3% (81)	20.4% (81)	25.3% (24)	17.7% (22)	37.3% (45)
Online/mail order	18.8% (400)	22.9% (463)	13.0% (43)	16.4% (73)	13.3% (56)	13.1% (57)	12.4% (23)	16.2% (30)	11.7% (18)
Store/dispensary (in person)	38.5% (1126)	44.6% (1243)	41.8% (166)	48.2% (199)	51.8% (218)	57.0% (226)	48.6% (68)	57.5% (97)	36.7% (69)
Unknown	1.8% (42)	1.8% (41)	1.2% (6)	2.0% (6)	2.7% (8)	1.1% (5)	0.0% (0)	2.0% (4)	2.6% (1)
Legality of purchase source used at last purchase									
Legal	45.7% (1278)	58.1% (1503)	39.2% (154)	53.1% (223)	59.6% (251)	66.4% (267)	52.0% (78)	68.6% (115)	44.5% (79)
Illegal	50.1% (1127)	38.2% (827)	56.0% (188)	42.3% (158)	37.1% (149)	31.2% (124)	42.9% (52)	27.7% (43)	50.2% (73)
Unknown	4.2% (101)	3.6% (87)	4.8% (21)	4.6% (17)	3.3% (12)	2.4% (11)	5.1% (5)	3.7% (7)	5.3% (6)
Quantity purchased at last purchase									
Mean grams (SEM)	8.7 g (0.4)	10.3 g (0.6)	9.1 g (0.7)	12.2 g (1.0)	8.0 g (0.6)	10.9 g (1.3)	8.9 g (2.5)	8.7 g (1.4)	6.8 g (0.7)
Geometric mean grams (SE)	4.2 g (0.1)	5.0 g (0.2)	4.6 g (0.3)	5.7 g (0.4)	4.4 g (0.3)	5.3 g (0.4)	3.2 g (0.4)	4.1 g (0.5)	3.9 g (0.4)
Median grams (SE)	3.4 g (0.1)	3.4 g (0.1)	3.4 g (0.2)	3.4 g (0.2)	3.5 g (0.2)	3.5 g (0.1)	3.0 g (0.3)	3.0 g (0.3)	3.5 g (0.3)
< 1 g	7.8% (200)	6.2% (139)	4.5% (20)	5.4% (25)	5.3% (23)	3.7% (16)	10.8% (13)	3.2% (8)	8.8% (10)
1–3.49 g	35.5% (884)	32.1% (796)	34.7% (125)	28.6% (119)	32.5% (123)	28.2% (111)	37.9% (50)	44.7% (63)	27.2% (49)
3.5–27.9 g	44.4% (1071)	44.3% (1026)	43.8% (146)	43.0% (164)	51.6% (200)	51.4% (201)	41.9% (56)	38.1% (65)	57.1% (82)
= >28 g	12.2% (265)	17.4% (380)	17.0% (59)	23.0% (77)	10.6% (45)	16.7% (60)	9.4% (11)	14.1% (25)	6.9% (10)

Data are among consumers who were of legal age to purchase cannabis and who reported purchasing dried flower in the past 12-months.
Data are % (n). Weighted %, unweighted n. Respondents from Prince Edward Island are not included due to low sample size ($n_{2019} = 24$; $n_{2020} = 28$).

only province where a lower percentage of dried flower purchased legally was reported in 2020 than 2019; however, this could be due to the temporary closure of 10 legal cannabis stores before and during the time of the current survey in 2020 (Israel, 2020).

The price of dried flower remained stable in 2019 and 2020. The mean unit price of dried flower was $10.64 in 2019 and $10.41 in 2020. These estimates are similar to the Canadian Cannabis Survey's estimates of dried flower among past 30-day consumers in 2019 ($9.83) and 2020 ($10.48), where the change in price was not statistically significant (Government of Canada, 2020). In the current study, the price paid by consumers was also presented by a 'market' price, which accounted for how much cannabis each consumer purchased: $7.09 in 2019 and $6.83 in 2020. The two approaches yield markedly different estimates of price due to quantity discounts. Researchers using self-reported data from population surveys should clarify which approach is being used to calculate price estimates, recognizing that the market approach is likely to show better correspondence with actual data from retailers.

Study findings suggest that a higher unit price was associated with a higher likelihood of purchasing from a legal source in 2019 and to a greater extent in 2020. However, it is plausible that the relationship between price and legality of source is bidirectional: purchase source may determine the price paid, and the price may determine the purchase source chosen to obtain dried flower. Since legalization, reports demonstrate the price of legal cannabis has been more expensive than illegal cannabis, and the price differential is growing (Mahamad et al., 2020; Statistics Canada, 2020a). Indeed, legal dried flower was more expensive than illegal at all quantities in the current study; however, the price differential seems to be converging. In 2019, legal dried flower was 12%–41% more expensive than illegal, whereas in 2020, legal dried flower was only 5%–10% more expensive than illegal. In a legal market, the price of cannabis is expected to reduce over time, and reductions have already been observed in US states that have legalized non-medical cannabis (Caulkins et al., 2018; Oregon Liquor Control Commission, 2019, 2021; Pacula et al., 2014; Smart et al., 2017). It is argued that in order to transition consumers to the legal market, the price of legal cannabis needs to be competitive with illegal cannabis (Childs and Stevens, 2019). However, behavioral economic literature suggests that the price of legal cannabis may not need to be lower than illegal cannabis to encourage transition (Amlung et al., 2019; Amlung and MacKillop, 2019).

Purchasing from legal sources increased between 2019 and 2020 among dried flower purchasers; however, more frequent consumers are transitioning slower than others. After adjusting for price and other covariates, daily cannabis consumers were less likely to purchase dried flower from a legal source than infrequent consumers; however, when quantity purchased was included in the model as a sensitivity analysis, the association of cannabis use frequency was attenuated. Most of the relationship between cannabis use frequency and legality of purchase source was mediated by quantity purchased. Quantity discounts are frequent in both illegal and legal markets, but unlike the illegal market, the Canadian legal non-medical market has a purchase limit of 30 g for dried flower (Caulkins and Padman, 1993; Caulkins, 2007; Clements, 2006; Mahamad and Hammond, 2019; Mahamad et al., 2020). In the current study, more consumers purchased greater quantities of illegal dried flower than legal dried flower in 2019 and 2020. Moreover, compared to all consumers, higher percentages of daily consumers purchased quantities of 28 g or more. If more frequent consumers purchase in greater quantities, it would suggest remaining in the illegal market may be financially beneficial due to quantity discounts (Caulkins and Padman, 1993; Caulkins, 2007; Clements, 2006; Mahamad and Hammond, 2019). Indeed, sensitivity analyses found consumers purchasing in quantities over an ounce were less likely to purchase legally than quantities between 1 g and 28 g. Daily consumers represent an important group of people to transition to the legal market due to their significant proportion of the cannabis market share (Caulkins et al., 2020; Callaghan et al., 2019; Chan and Hall, 2020; Midgette et al., 2019).

4.1. Limitations

This study is subject to limitations common to survey research. Respondents were recruited using non-probability-based sampling;

Manitoba	Ontario		Quebec		New Brunswick		Nova Scotia		Newfoundland and Labrador	
2020 n = 141	2019 n = 562	2020 n = 464	2019 n = 448	2020 n = 334	2019 n = 132	2020 n = 171	2019 n = 169	2020 n = 172	2019 n = 103	2020 n = 142
Purchase source used at last purchase										
19.0% (24)	18.3% (102)	17.9% (88)	13.2% (59)	15.4% (52)	14.2% (18)	12.9% (19)	11.4% (23)	12.8% (21)	5.8% (6)	5.4% (12)
17.7% (20)	25.1% (144)	14.1% (61)	31.3% (130)	15.8% (51)	18.9% (25)	12.0% (21)	13.3% (21)	9.7% (13)	18.1% (15)	13.6% (16)
16.3% (26)	26.9% (148)	35.0% (154)	15.8% (64)	16.8% (52)	7.7% (12)	6.9% (13)	14.5% (25)	14.8% (28)	6.5% (9)	15.5% (21)
42.2% (67)	27.5% (156)	31.3% (153)	39.0% (191)	50.9% (175)	53.5% (70)	64.8% (115)	59.8% (97)	60.3% (104)	68.3% (72)	64.2% (92)
4.8% (4)	2.2% (12)	1.8% (8)	0.8% (4)	1.2% (4)	5.7% (7)	3.5% (3)	0.9% (3)	2.5% (6)	1.3% (1)	1.3% (1)
Legality of purchase source used at last purchase										
49.5% (81)	38.7% (219)	52.2% (247)	46.8% (223)	65.0% (219)	54.3% (72)	63.4% (115)	65.1% (105)	62.3% (110)	71.5% (77)	72.3% (104)
44.5% (54)	56.8% (318)	43.5% (197)	49.4% (211)	33.5% (109)	39.3% (51)	30.6% (50)	32.7% (59)	32.6% (51)	25.5% (22)	24.8% (35)
6.0% (6)	4.5% (25)	4.3% (20)	3.8% (14)	1.5% (6)	6.4% (9)	6.0% (6)	2.2% (5)	5.0% (11)	3.1% (4)	2.8% (3)
Quantity purchased at last purchase										
11.7 g (2.5)	10.2 g (0.8)	10.5 g (0.6)	6.6 g (0.7)	8.1 g (0.9)	7.6 g (1.1)	9.7 g (1.0)	6.8 g (0.8)	11.5 g (1.2)	5.1 g (0.6)	7.2 g (0.9)
5.0 g (0.7)	4.8 g (0.3)	5.3 g (0.4)	3.3 g (0.2)	3.9 g (0.3)	3.4 g (0.4)	5.0 g (0.6)	3.6 g (0.4)	5.8 g (0.6)	3.0 g (0.3)	4.1 g (0.4)
3.5 g (0.3)	3.5 g (0.4)	3.5 g (0.4)	2.9 g (0.2)	2.9 g (0.2)	2.9 g (0.4)	2.9 g (0.4)	2.9 g (0.2)	2.9 g (0.2)	3.2 g (0.2)	3.2 g (0.3)
5.9% (9)	7.4% (47)	7.3% (28)	11.5% (51)	7.9% (29)	11.8% (13)	7.6% (9)	8.0% (11)	2.5% (5)	7.2% (9)	3.5% (7)
29.7% (46)	32.5% (182)	28.3% (134)	44.3% (188)	42.1% (142)	39.4% (43)	31.4% (55)	45.3% (71)	33.7% (61)	41.1% (42)	47.7% (56)
46.9% (60)	45.7% (256)	45.2% (212)	36.3% (163)	41.2% (126)	37.2% (54)	41.0% (63)	37.0% (64)	39.2% (63)	48.0% (43)	36.2% (60)
17.5% (20)	14.4% (64)	19.2% (77)	8.0% (32)	8.8% (31)	11.7% (18)	20.0% (34)	9.7% (18)	24.6% (36)	3.7% (6)	12.6% (16)

therefore, the findings do not provide nationally representative estimates. The data were weighted by age group, sex, region, education and smoking status in Canada. Cannabis use estimates were generally lower than national estimates for young adults, and 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.

The current study is cross-sectional and cannot determine causality or direction; however, it is plausible that the relationship between unit price and the legality of purchase source used is bi-directional.

Respondents were asked to report their last purchase of dried flower, rather than their 'usual' purchase. While a respondent's last purchase may not be representative of their usual purchase or if respondents varietize their sources, last purchase should provide a more representative estimate at the population level. Indeed, research examining the comparison between consumers most recent cannabis purchase and all cannabis purchases demonstrated little difference between the two (Bond et al., 2014). Moreover, we did not account for the resale of dried flower, i.e., purchasing to sell at a different price, not to consume.

Respondents could include pre-rolls when reporting dried flower purchases. While pre-rolls contain dried flower, they are a premium product and would be priced as such (Ontario Cannabis Store, 2020b). Prices of dried flower in the current study could change if pre-roll and loose dried flower were separated. Future research should examine prices of dried flower and pre-rolls in Canada separately.

Implausible unit prices were excluded or modified, and so price estimates could vary if alternative cleaning methods were conducted. The Cannabis Retail Scan conducted in March 2020 was used as guidance for a minimum and maximum unit price in the illegal and legal retail markets (Mahamad et al., 2020). The distribution of prices was also used to guide implausible values as physical and online retail stores do not cover all sources where respondents could purchase their dried flower (i.e., friends, dealers).

The potency, or tetrahydrocannabinol (THC) content, of dried flower was not included in the analysis. Research has shown positive associations between perceived potency and price (Ben Lakhdar et al., 2016; Smart et al., 2017). Indeed, the potency of a product may contribute to both the price of the product and the purchase source used (Caulkins et al., 2018; Government of Canada, 2020; Smart et al., 2017). However, potency information is limited in the illegal market (Freeman et al., 2019). Moreover, research suggests that consumers typically lack understanding of potency, which promotes caution in using self-reported

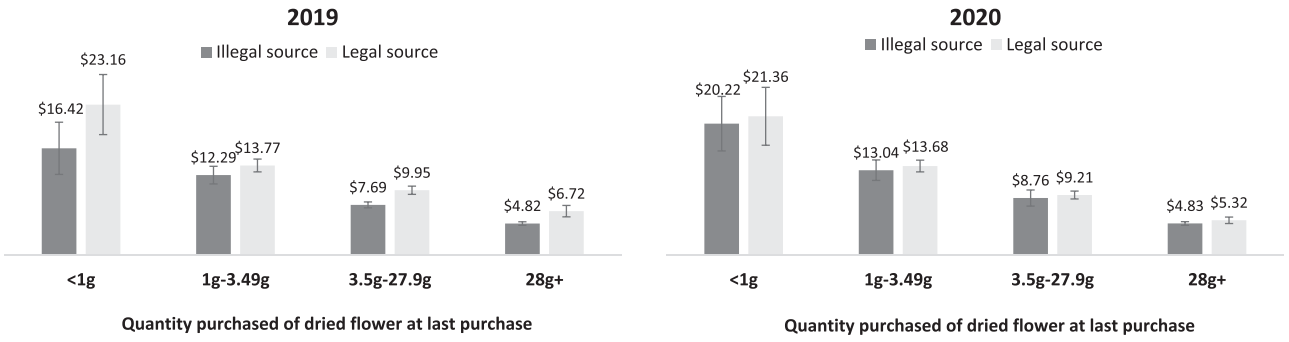

Fig. 2. Market price of dried flower purchased from illegal and legal sources in 2019 and 2020 by quantity purchased at last purchase (n = 3740). Values with cell counts below n = 30 were suppressed.

Table 3
Unit price and market price of dried flower at last purchase by cannabis use frequency, purchase source, and quantity purchased (n = 3740).

	Mean $/g (SEM)		Market price (SE)	
	2019 n = 1929	2020 n = 1811	2019 n = 1929	2020 n = 1811
All participants	$10.64 (0.2)	$10.41 (0.2)	$7.09 (0.2)	$6.83 (0.2)
Cannabis use frequency				
Past year, but less than monthly	$14.01 (0.5)	$14.13 (0.7)	$10.98 (0.7)	$9.73 (1.0)
Monthly	$13.78 (0.7)	$12.75 (0.6)	$10.76 (0.6)	$8.77 (0.7)
Weekly	$11.15 (0.4)	$10.60 (0.3)	$8.06 (0.7)	$7.96 (0.5)
Daily	$8.47 (0.2)	$8.68 (0.3)	$6.29 (0.1)	$6.28 (0.2)
Purchase source				
Friends or family	$9.73 (0.5)	$9.60 (0.6)	$6.60 (0.3)	$5.93 (0.3)
Dealer (in person)	$9.10 (0.4)	$10.07 (0.6)	$6.34 (0.2)	$6.91 (0.5)
Online/mail order	$10.14 (0.5)	$9.73 (0.5)	$6.46 (0.3)	$6.50 (0.3)
Store/dispensary	$12.34 (0.3)	$11.16 (0.3)	$9.37 (0.4)	$7.66 (0.2)
Legality of purchase source				
Illegal	$9.04 (0.3)	$9.41 (0.4)	$6.07 (0.2)	$6.16 (0.2)
Legal	$12.63 (0.3)	$11.16 (0.3)	$9.59 (0.3)	$7.70 (0.2)
Unknown	$9.44 (0.7)	$9.15 (0.9)	$7.61 (0.6)	$6.75 (0.4)
Quantity purchased				
< 1 g	$20.40 (1.6)	$21.27 (1.3)	$20.27 (1.6)	$20.99 (1.5)
1–3.49 g	$13.37 (0.4)	$14.02 (0.4)	$13.02 (0.4)	$13.45 (0.4)
3.5–27.9 g	$9.48 (0.2)	$9.76 (0.2)	$8.63 (0.2)	$8.97 (0.3)
≥ 28 g	$5.25 (0.1)	$5.19 (0.1)	$5.11 (0.1)	$5.08 (0.1)

Values suppressed for "Other" category of purchase source due to cell counts below n = 30.

measures (Leos-Toro et al., 2020; Ouellet et al., 2017; Hammond and Goodman, 2020).

Finally, the current study focused on dried flower and so the findings reported may not translate to other cannabis products. However, dried flower and some oils were the only products available until December 2019; therefore, other products would only have been available to purchase from the illegal market for the majority of the study period (Government of Canada, 2019b). Furthermore, although the use of non-flower cannabis products is increasing among Canadians, dried flower is still the most used product and so would capture a large proportion of purchased cannabis (Government of Canada, 2017, 2018b, 2019a, 2020; Goodman et al., 2020).

4.2. Conclusion

Findings indicate that the price of dried flower from legal sources decreased, along with an increasing percentage of consumers purchasing from legal cannabis retailers in the first two years after legalization in Canada. The most frequent consumers have transitioned to the legal market more slowly; however, purchasing from legal retail sources increased between 2019 and 2020 for all dried flower purchasers. Future research should examine price and purchase sources for cannabis products other than dried flower, which represent an increasing market share.

Table 4
Weighted binary logistic regression analysis for correlates of legality of purchase source used at last purchase among dried flower purchasers with and without unit price.

	Odds of purchasing dried flower from a legal source (vs. illegal) *With unit price* n = 3580 AOR (95% CI)	Odds of purchasing dried flower from a legal source (vs. illegal) *Without unit price* n = 4657 AOR (95% CI)
Unit price x Survey year		
Unit price x 2019	**1.03 (1.01, 1.05)**	–
Unit price x 2020	**1.07 (1.04, 1.09)**	–
Survey year		
2019	–	REF
2020	–	**1.66 (1.42, 1.95)**
Province of residence		
NL	**4.13 (2.56, 6.70)**	**3.25 (2.11, 4.99)**
PEI	**2.77 (1.24, 6.22)**	**3.91 (1.75, 8.74)**
AB	**2.60 (1.97, 3.43)**	**2.29 (1.81, 2.90)**
SK	**2.54 (1.66, 3.87)**	**2.04 (1.43, 2.92)**
NB	**2.78 (1.82, 4.24)**	**2.06 (1.43, 2.97)**
NS	**2.41 (1.68, 3.46)**	**2.15 (1.56, 2.96)**
QC	**1.93 (1.46, 2.54)**	**1.51 (1.20, 1.91)**
BC	**1.31 (1.00, 1.71)**	1.07 (0.85, 1.34)
MB	1.25 (0.86, 1.82)	1.14 (0.82, 1.58)
ON	REF	REF
Cannabis use frequency		
Past year, but less than monthly	REF	REF
Monthly	1.03 (0.75, 1.42)	1.04 (0.80, 1.35)
Weekly	1.04 (0.77, 1.41)	0.99 (0.77, 1.27)
Daily	**0.64 (0.49, 0.84)**	**0.56 (0.45, 0.70)**
Sex		
Male	REF	REF
Female	1.05 (0.88, 1.26)	**1.18 (1.01, 1.38)**
Age		
MLA-25	1.21 (0.86, 1.71)	1.15 (0.85, 1.55)
26–35	1.06 (0.78, 1.42)	1.23 (0.95, 1.59)
36–45	0.97 (0.72, 1.31)	1.07 (0.83, 1.39)
46–55	0.79 (0.58, 1.08)	0.88 (0.67, 1.16)
56–65	REF	REF
Ethnicity/race		
Black	0.67 (0.39, 1.14)	0.75 (0.48, 1.17)
East/Southeast Asian	0.90 (0.54, 1.50)	1.05 (0.70, 1.59)
Indigenous	0.66 (0.42, 1.03)	0.69 (0.47, 1.02)
Latinx	0.80 (0.40, 1.59)	0.76 (0.41, 1.41)
Middle Eastern	2.35 (0.80, 6.90)	1.16 (0.54, 2.51)
South Asian	0.60 (0.35, 1.09)	0.64 (0.40, 1.01)
White	REF	REF
Other/Mixed	0.94 (0.63, 1.40)	0.87 (0.61, 1.23)
Education		
Less than high school	REF	REF
High school diploma	1.38 (0.96, 1.98)	**1.40 (1.01, 1.93)**
Some college or technical vocation	**1.67 (1.20, 2.33)**	**1.55 (1.15, 2.10)**
Bachelor's degree or higher	**1.58 (1.09, 2.29)**	**1.63 (1.17, 2.27)**
Income adequacy		
Very difficult/ Difficult	REF	REF
Neither easy nor difficult	**1.54 (1.24, 1.92)**	**1.37 (1.13, 1.65)**
Easy/Very easy	**1.39 (1.09, 1.76)**	**1.26 (1.03, 1.54)**
Not stated	1.69 (0.60, 4.72)	1.15 (0.51, 2.57)
Device used		
Computer	REF	REF
Smartphone	1.14 (0.94, 1.40)	1.10 (0.93, 1.31)
Tablet	0.96 (0.64, 1.44)	1.16 (0.81, 1.65)

Bolded values = significant at the $p < 0.05$ level.
AOR = Adjusted Odds Ratio; 95% CI = 95% Confidence Interval; REF = Reference category.

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Contributors

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

Conflict of 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.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2021.109262.

References

Alcohol and Gaming Commission of Ontario, 2021. The AGCO Now Issuing 30 Cannabis Retail Store Authorizations Per Week 2021. ⟨https://www.agco.ca/blog/cannabis/feb-2021/agco-now-issuing-30-cannabis-retail-store-authorizations-week⟩.

American Association for Public Opinion Research, 2016. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. ⟨https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf⟩.

Amlung, M., MacKillop, J., 2019. Availability of legalized cannabis reduces demand for illegal cannabis among Canadian cannabis users: evidence from a behavioural economic substitution paradigm. Can. J. Public Health 110, 216–221. https://doi.org/10.17269/s41997-018-0160-4.

Amlung, M., Reed, D.D., Morris, V., Aston, E.R., Metrik, J., MacKillop, J., 2019. Price elasticity of illegal versus legal cannabis: a behavioral economic substitutability analysis. Addiction 114, 112–118. https://doi.org/10.1111/add.14437.

Armstrong, M.J., 2021. Legal cannabis market shares during Canada's first year of recreational legalisation. Int. J. Drug Policy 88, 103028. https://doi.org/10.1016/j.drugpo.2020.103028.

Ben Lakhdar, C.G., Vaillant, N., Wolff, F.C., 2016. Price elasticity of demand for cannabis: does potency matter? Addict. Res. Theory 24, 300–312. https://doi.org/10.3109/16066359.2016.1139699.

Bond, B., Caulkins, J.P., Scott, N., Kilmer, B., Dietze, P., 2014. Are users' most recent drug purchases representative? Drug Alcohol Depend. 142, 133–138.

Callaghan, R.C., Sanches, M., Benny, C., Stockwell, T., Sherk, A., Kish, S.J., 2019. Who consumes most of the cannabis in Canada? Profiles of cannabis consumption by quantity. Drug Alcohol Depend. 205, 107587 https://doi.org/10.1016/j.drugalcdep.2019.107587.

Capler, R., Walsh, Z., Crosby, K., Belle-Isle, L., Holtzman, S., Lucas, P., Callaway, R., 2017. Are dispensaries indispensable? Patient experiences of access to cannabis from medical cannabis dispensaries in Canada. Int. J. Drug Policy 47, 1–8. https://doi.org/10.1016/j.drugpo.2017.05.046.

Caulkins, J.P., 2007. Price and purity analysis for illicit drug: data and conceptual issues. Drug Alcohol Depend. 90 (Suppl. 1), S61–S68. https://doi.org/10.1016/j.drugalcdep.2006.08.014.

Caulkins, J.P., Padman, R., 1993. Quantity discounts and quality premia for illicit drugs. J. Am. Stat. Assoc. 88, 748–757. https://doi.org/10.2307/2290759.

Caulkins, J.P., Bao, Y., Davenport, S., Fahli, I., Guo, Y., Kinnard, K., Najewicz, M., Renaud, L., Kilmer, B., 2018. Big data on a big new market: Insights from Washington State's legal cannabis market. Int. J. Drug Policy 57, 86–94. https://doi.org/10.1016/j.drugpo.2018.03.031.

Caulkins, J.P., Pardo, B., Kilmer, B., 2020. Intensity of cannabis use: findings from three online surveys. Int. J. Drug Policy 79, 102740. https://doi.org/10.1016/j.drugpo.2020.102740.

CBC News, 2019. Ontario Removing Cap on Number of Pot Shops, Opening up Market for Retailers. CBC News. 12 December 2019. ⟨https://www.cbc.ca/news/canada/toronto/cannibis-store-cap-1.5394662⟩.

Červený, J., van Ours, J.C., 2019. Cannabis prices on the dark web. Eur. Econ. Rev. 120, 103306 https://doi.org/10.1016/j.euroecorev.2019.103306.

Chan, G., Hall, W., 2020. Estimation of the proportion of population cannabis consumption accounted for by daily users using Monte Carlo simulation. Addiction 115, 1182–1186. https://doi.org/10.1111/add.14909.

Childs, J., Stevens, J., 2019. The state must compete: optimal pricing of legal cannabis. Can. Public Adm. 64, 656–673. https://doi.org/10.1111/capa.12352.

Clements, K.W., 2006. Pricing and packaging: the case of marijuana. J. Bus. 79, 2019–2044. https://doi.org/10.1086/503655.

Freeman, T.P., Groshkova, T., Cunningham, A., Sedefov, R., Griffiths, P., Lynskey, M.T., 2019. Increasing potency and price of cannabis in Europe, 2006-16. Addiction 114, 1015–1023. https://doi.org/10.1111/add.14525.

Goodman, S., Wadsworth, E., Leos-Toro, C., Hammond, D., 2020a. Prevalence and forms of cannabis use in legal vs. illegal recreational cannabis markets. Int. J. Drug Policy 76, 102658. https://doi.org/10.1016/j.drugpo.2019.102658.

Goodman, S., Burkhalter, R., Hammond, D., 2020b. International Cannabis Policy Study Technical Report – Wave 2 (2019). University of Waterloo, Waterloo, ON, Canada.

Goodman, S., Burkhalter, R., Hammond, D., 2021. International Cannabis Policy Study Technical Report – Wave 3 (2020). University of Waterloo; Waterloo, ON, Canada.

Government of Canada, 2017. Canadian Cannabis Survey 2017 Summary. ⟨https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2017-summary.html⟩.

Government of Canada, 2018a. Justice Laws Website: Cannabis Act (S.C. 2018, c.16).

Government of Canada, 2018b. Canadian Cannabis Survey 2018 Summary. ⟨https://www.canada.ca/en/services/health/publications/drugs-health-products/canadian-cannabis-survey-2018-summary.html⟩.

Government of Canada, 2019a. Canadian Cannabis Survey 2019 – Summary. ⟨https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2019-summary.html⟩.

Government of Canada, 2019b. Backgrounder: Final Regulations on New Cannabis Products. ⟨https://www.canada.ca/en/health-canada/news/2019/06/backgrounder-final-regulations-on-new-cannabis-products.html⟩.

Government of Canada, 2020. Canadian Cannabis Survey 2020: Summary. ⟨https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/research-data/canadian-cannabis-survey-2020-summary.html⟩.

Hammond, D., Goodman, S., 2020. Knowledge of tetrahydrocannabinol and cannabidiol levels among cannabis consumers in the United States and Canada. Cannabis Cannabinoid Res. https://doi.org/10.1089/can.2020.0092.

Hammond, D., Goodman, S., Wadsworth, E., Rynard, V., Boudreau, C., Hall, W., 2020. Evaluating the impacts of cannabis legalization: the International Cannabis Policy Study. Int. J. Drug Policy 77, 102698. https://doi.org/10.1016/j.drugpo.2020.102698.

Israel, S., 2020. Strike Shutters Many Newfoundland Cannabis Stores, Prompts Online Surge. MJBizDaily. 27 August, p. 20. ⟨https://mjbizdaily.com/strike-shutters-one-third-of-newfoundland-cannabis-stores-prompting-online-sales-surge/⟩.

Leos-Toro, C., Fong, G.T., Meyer, S.B., Hammond, D., 2020. Cannabis labelling and consumer understanding of THC levels and serving sizes. Drug Alcohol Depend. 208, 107843 https://doi.org/10.1016/j.drugalcdep.2020.107843.

Mahamad, S., Hammond, D., 2019. Retail price and availability of illicit cannabis in Canada. Addict. Behav. 90, 402–408. https://doi.org/10.1016/j.addbeh.2018.12.001.

Mahamad, S., Wadsworth, E., Rynard, V., Goodman, S., Hammond, D., 2020. Availability, retail price and potency of legal and illegal cannabis in Canada after recreational cannabis legalisation. Drug Alcohol Rev. 39, 337–346. https://doi.org/10.1111/dar.13069.

Midgette, G., Davenport, S., Caulkins, J.P., Kilmer, B., 2019. What America's Users Spend on Illegal Drugs, 2006-2016. RAND Corporation, Santa Monica, California, USA. https://doi.org/10.7249/RR3140.

Ontario Cannabis Store, 2020a. A Quarterly Review: April 1–June 30, 2020. ⟨https://cannabislaw.report/wp-content/uploads/2020/10/OCS-InsightsReport_Q1-2020-FINAL.pdf⟩.

Ontario Cannabis Store, 2020b. A Year in Review: 2019–2020. ⟨https://cdn.shopify.com/s/files/1/2636/1928/files/OCS-InsightsReport_2019-2020_8f607a7b-21b0-4718-adb3-7cd60a2f08ea.pdf?v=1608224707⟩.

Oregon Liquor Control Commission, 2019. 2019 Recreational Marijuana Supply and Demand Legislative Report. ⟨https://www.oregon.gov/olcc/marijuana/Documents/Bulletins/2019%20Supply%20and%20Demand%20Legislative%20Report%20FINAL%20for%20Publication(PDFA).pdf⟩.

Oregon Liquor Control Commission, 2021. 2021 Recreational Marijuana Supply and Demand Legislative Report. ⟨https://www.oregon.gov/olcc/Docs/Legislative_docs/2021-Supply-and-Demand-Report.pdf⟩.

Ouellet, M.L., Macdonald, M., Bouchard, M., Morselli, C., Frank, R., 2017. The Price of Cannabis in Canada. Public Safety Canada Sécurité publique Canada, Ottawa, ON, Canada.

Pacula, R.L., Kilmer, B., Wagenaar, A.C., Chaloupka, F.J., Caulkins, J.P., 2014. Developing public health regulations for marijuana: lessons from alcohol and tobacco. Am. J. Public Health 104, 1021–1028. https://doi.org/10.2105/AJPH.2013.301766.

Smart, R., Caulkins, J.P., Kilmer, B., Davenport, S., Midgette, G., 2017. Variation in cannabis potency and prices in a newly legal market: evidence from 30 million cannabis sales in Washington state. Addiction 112, 2167–2177. https://doi.org/10.1111/add.13886.

Statistics Canada, 2020a. StatsCannabis Data Availability: Crowdsourced Cannabis Prices, Fourth Quarter 2019. ⟨https://www150.statcan.gc.ca/n1/daily-quotidien/200123/dq200123c-eng.htm⟩.

Statistics Canada, 2020b. Consumer Price Index, September 2020. ⟨https://www150.statcan.gc.ca/n1/daily-quotidien/201021/dq201021a-eng.htm⟩.

Wadsworth, E., Driezen, P., Goodman, S., Hammond, D., 2020. Differences in self-reported cannabis prices across purchase source and quantity purchased among Canadians. Addict. Res. Theory 28, 474–483. https://doi.org/10.1080/16066359.2019.1689961.