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3 **1 Characteristics of Canadians likely to try or increase cannabis use following legalization**
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5 **2 for recreational purposes: A cross-sectional study**
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3 **1 ABSTRACT**

4
5 **2 Background:** The Government of Canada legalized recreational use of cannabis in October
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8 **3** 2018.

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10 **4 Methods:** We used data from the 2018 National Cannabis Survey to investigate factors
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12 associated with intent to try or increase cannabis use post–legalization among Canadians using
13
14 multivariable logistic regression. Respondents’ data were weighted and bootstrapped. We report
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16
17 relative measures of association as adjusted odds ratios (aORs) and absolute measure of
18
19 association as adjusted risk increases (ARIs).
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21
22 **9 Results:** An estimated 18.5% (95%CI: 17.6–19.5) of the study population indicated that they
23
24 intended to try (15.7%) or increase (2.8%) cannabis use following legalization. Our weighted
25
26 analysis represented 27,808,081 Canadians 15 years of age or older (unweighted n = 17,089). In
27
28 our adjusted regression model, being more likely to try or increase cannabis use was associated
29
30 with younger age (15–24 years versus ≥ 65 ; aOR 3.8, 95%CI: 2.6–5.6; ARI 20.1%, 95%CI: 13.9–
31
32 26.2), cannabis use in the past three months versus not (aOR 3.3, 95%CI: 2.8–3.9; ARI 20.4%,
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34 95%CI: 17.1–23.6), higher income ($\geq \$80,000$ versus $< \$40,000$; aOR 1.5, 95%CI: 1.3–1.9; ARI
35
36 6.1%, 95%CI: 3.2–9.0), and poor or fair mental health compared to good or excellent mental
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38 health (aOR 2.0, 95%CI: 1.6–2.6; ARI 11.5%, 95%CI: 6.7–16.2).
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42 **18 Interpretation:** Nearly 1 in 5 respondents reported their intention to try or increase cannabis use
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44 post–legalization. Efforts to promote responsible use of cannabis should be a priority for
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52 **22 Keywords:** Cannabis; Marijuana; Health behavior; Canada; Health policy; Public health
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1 Introduction

2 Cannabis refers to products of the dried leaves and flowers of the *Cannabis sativa* plant which is
3 consumed for medical and recreational purposes.(1) Although recreational use of cannabis was
4 illegal in Canada prior to October 2018, Canadians were the leading consumers of cannabis in
5 the developed world.(2) According to the 2012 Canadian Community Health Survey (CCHS),
6 12.2% of Canadians aged 15 or older reported using cannabis in the past year.(3) Daily use was
7 reported by 1.8% and was more common in males (2.4%) versus females (1.2%), and among
8 those who were 18–24 years of age (4.9%).(3) A long–term trends study confirmed greater
9 cannabis use among younger males and also showed that, from 2004 to 2015, past–year cannabis
10 use increased among Canadians aged 25 and older.(4)

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12 Observational studies have shown that cannabis users are more likely to be involved in motor
13 vehicle collisions, with a systematic review finding double the odds of being involved in a
14 collision while under the influence of cannabis compared to unimpaired driving (OR 1.92,
15 95%CI: 1.35–2.73).(5) Cannabis use is also associated with anxiety, psychotic symptoms,
16 chronic bronchitis, impaired respiratory function, and cannabis use disorder.(6–11) The lifetime
17 risk of addiction among Canadians who used cannabis was estimated to be 6.8% in 2012 and an
18 estimated 1.3% met criteria for cannabis abuse or dependence in the past year.(12) Moreover, the
19 potency of illicit cannabis has increased from 4% in 1995, to 12% in 2014, in the United States
20 (US)(13), and higher potency has been shown to be associated with adverse health outcomes
21 such as greater emergency department visits involving drug use.(10,11,14,15)

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3 1 In an effort to promote responsible use, deter criminal activity, and protect public health and
4
5 2 safety, the federal government legalized the use of recreational cannabis on October 17th,
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7 3 2018.(16) This is in addition to medical cannabis which has been legal in Canada since 2001.(17)
8
9 4 There are concerns that recreational cannabis may increase use and subsequent harm.(18) The
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11 5 impact of legalization based on evidence from US States is mixed with some studies showing
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13 6 increased rates of use and other showing no change.(19–22) Moreover, a 2016 narrative review
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15 7 found inconsistent evidence for an association between policy change and increased uptake of
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17 8 cannabis among youth.(23)
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24 10 Monitoring cannabis use prevalence, patterns of use, and modes of use are crucial to determining
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26 11 the impact of policy change.(24) Statistics Canada, the national statistics agency, developed and
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28 12 implemented the 2018 National Cannabis Survey (NCS), a novel cross-sectional survey which
29
30 13 aims to better understand the frequency of cannabis use and to monitor changes in attitudes and
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32 14 behavior as a result of legalization.(25) Our objectives were to: (1) determine the prevalence of
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34 15 Canadians (aged 15 years or older) likely to try or increase cannabis use after legalization for
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36 16 recreational purposes; and (2) explore characteristics associated with intent to try or increase use.
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42 18 **Methods**

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45 19 We followed standards set by the “Strengthening the Reporting of Observational Studies in
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47 20 Epidemiology” (STROBE) statement for reporting our study.(26)
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3 1 *Study design & respondents*
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5 2 This is a cross-sectional study involving analysis of the 2018 NCS master file.(25,27) The NCS
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7 3 was developed by Statistics Canada in consultation with the Public Health Agency of Canada,
8
9 4 Department of Justice of Canada, and Public Safety Canada.(25) Cognitive testing of
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11 5 questionnaire content was conducted and validation of estimates was done through cross-
12
13 6 tabulations of other data and consultation with Statistics Canada stakeholders.(25) The data used
14
15 7 in this study were collected just prior to legalization of recreational cannabis, from February to
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17 8 September 2018 (waves 1–3).(25) Data from the three waves were independent of each other,
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19 9 and were combined and analyzed together. Participation in the NCS was voluntary and data were
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21 10 collected through an electronic questionnaire or computer-assisted telephone interview.(25) The
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23 11 study population consisted of non-institutionalized Canadians, aged 15 years or older, residing in
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25 12 Canada’s 10 provinces and three territory capital cities.(25) The sampling method was two-stage
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27 13 (dwelling and person) stratified by province or territory, and a simple random sample of
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29 14 dwellings which aimed to represent the Canadian population.(25) The NCS master file was
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31 15 accessed through the McMaster University Statistics Canada Research Data Centre.(28)
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40 17 *Measures*
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42 18 Our primary outcome measure was derived from an NCS question that asked when cannabis
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44 19 consumption becomes legal for recreational purposes, would respondents be more likely to try
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46 20 cannabis or increase their consumption?(27) Response options included: “Yes”, “Maybe”, or
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48 21 “No”. We also summarized whether respondents would be more likely to try different types of
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50 22 cannabis products or acquire cannabis from another source after legalization. Information on
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52 23 gender, age, cannabis use in the past three months, education and income level, main activity
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1 during the previous week, and self-reported mental health were also collected and analyzed for
2 association with intention to try or increase cannabis use. Categories for age, education level,
3 income level, main activity, and self-reported mental health were collapsed to ensure adequate
4 cell size and simplify analysis and subsequent interpretation. The full questionnaire is available
5 through Statistics Canada.(27)

6 7 *Statistical analysis*

8 Descriptive statistics were used to summarize the data. We constructed univariable and
9 multivariable logistic regression models to explore factors associated with the intent to try or
10 increase cannabis use following legalization (those who responded “Yes or Maybe” compared to
11 those who answered “No”). Of the individuals that endorsed the intent to try or increase cannabis
12 use after legalization, we considered those who had not used cannabis in the past three months to
13 be new users. Our independent variables were: (1) gender; (2) age; (3) cannabis use in past three
14 months; (4) education level; (5) income level; (6) main activity during the previous week; and
15 (7) self-reported mental health. We also adjusted our multivariable regression model for survey
16 wave and province or territory of residence. Results are presented as aORs along with 95%
17 confidence intervals (95% CIs). All analyses were two-tailed and statistical significance was
18 defined as $p < 0.05$.

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20 Prior to analysis, we reviewed unweighted frequencies of the independent variables to ensure
21 adequate cell sizes (at least 10 events per variable).(29) Bootstrap weights provided by Statistics
22 Canada were applied to convert unweighted frequencies to represent the Canadian population
23 and adjust for biases in the survey sampling design.(30) Missing data were excluded from our

1 regression analysis using listwise deletion. For all statistically significant associations in our
2 adjusted model, we calculated adjusted risk increases (ARI) by subtracting the risk of the
3 outcome in the referent group (e.g. age ≥ 65) from the risk in the comparator group (e.g. age 15-
4 24), while holding all other variables constant.(31) The likelihood ratio test was performed to
5 determine if the multivariable logistic regression model fit significantly better than a model with
6 no predictors and the Wald test determined significance of individual predictors in the model. A
7 Hosmer–Lemeshow test was performed to assess goodness–of–fit of our adjusted model.(32) All
8 analyses were performed using Stata/SE 15 software.(33)

9 10 *Ethics consideration*

11 As per the Tri–Council Policy Statement: Ethical Conduct for Research Involving Humans
12 Article 2.2 (a), research is exempt from research ethics board review if it relies exclusively on
13 publicly available information that is legally accessible to the public and appropriately protected
14 by law.(34) Our results were reviewed by a Statistics Canada Research Data Centre Analyst prior
15 to release to ensure confidentiality of survey respondents.

16 17 **Results**

18 Of 39,000 households selected for recruitment of NCS waves 1–3, 17,089 respondents had
19 provided complete data and were included in our multivariable logistic regression analysis
20 (survey completion rate = 43.8%).(25) There was an equal distribution of males and females,
21 most were employed (59.2%), the majority (93.8%) reported good to excellent mental health,
22 and 15.2% reported use of cannabis in the past three months (Table 1). The “please specify”
23 category of gender was removed from analysis and not reported due to very low response ($n <$

10). Overall, 18.5% (95%CI: 17.6–19.5) of individuals were likely to try or increase their recreational use of cannabis following legalization with an estimated 15.7% being new users. Almost a quarter of respondents (22.6%, 95%CI: 21.7–23.6) were likely to try different types of cannabis products and 16.7% (95%CI: 15.8–17.6) were likely to acquire cannabis from a new source (see Figure 1).

In our adjusted model, younger age (15–24 years OR 3.8, 95%CI: 2.6–5.6; ARI 20.1%, 95%CI: 13.9–26.2), cannabis use in past three months (OR 3.3, 95%CI: 2.8–3.9; ARI 20.4%, 95%CI: 17.1–23.6), higher income (\geq \$80,000 OR 1.5, 95%CI: 1.3–1.9; ARI 6.1%, 95%CI: 3.2–9.0), and poor or fair mental health (OR: 2.0, 95%CI: 1.6–2.6; ARI 11.5%, 95%CI: 6.7–16.2) were associated with a greater likelihood of trying or increasing cannabis use following legalization compared to referent categories (Table 2). The Hosmer-Lemeshow ($p = 0.46$) and likelihood ratio ($p < 0.05$) tests suggested good fit of our adjusted model.

15 Interpretation

The NCS data collected prior to legalization suggests that nearly 1 in 5 Canadians intend on trying or increasing cannabis use following legalization for recreational purposes with a majority being new users. Those who are younger, used cannabis in the past three months, report higher income and poorer mental health were significantly more likely to try or increase cannabis use following legalization. Furthermore, we found that almost 1 in 4 Canadians were likely to try consuming different types of cannabis products, which will become legally available in October 2019.(35) A 2017 survey of 1,087 Canadians found that up to 46% are willing to try cannabis-infused food products.(36) In addition, a 2018 Deloitte survey found that 58% Canadian

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3 1 cannabis users prefer edible products.(37) We also found that 1 in 6 respondents intended to
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5 2 obtain cannabis from alternate sources after legalization and the Deloitte survey found that
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7 3 Canadian cannabis users will shift up to 63% of their purchases towards legal channels.(37)
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12 5 Further complementing our findings, a 2014 survey of 3,532 US adults aged 18 to 34 found that
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14 6 13.5% reported they would use cannabis more frequently if it were legalized.(38) This may be
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16 7 cause for concern as younger individuals are at a higher risk of experiencing harms associated
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18 8 with cannabis use;(7,10,11,39–41) however, intent may or may not translate into action.
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20 9 Consistent with our findings, the 2014 US study also found that cannabis non–users experiencing
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22 10 anxiety were more likely to endorse interest in trying cannabis if it were legal.(38) Although
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24 11 some studies have reported an association between cannabis use and mental illness (e.g. early
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26 12 onset psychosis among those who are predisposed, depression, anxiety, substance use disorder),
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28 13 management of psychiatric disorders is also one of the top cited reasons for cannabis use.(41–45)
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30 14 The association may therefore be bi–directional. The Canadian Psychiatric Association released
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32 15 a position statement in 2018 highlighting concerns over the impact of increased access to
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34 16 cannabis and mental health, particularly for youth.(46) Healthcare incidences involving cannabis
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36 17 increased following legalization in Colorado(47), and cannabis–related hospitalizations have
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38 18 been shown to be associated with higher rates of mental illness.(48,49)
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46 20 There is also evidence to suggest that the general public may underestimate harms associated
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48 21 with cannabis. A 2017 national survey of 16,280 US adults found 22.4% believe cannabis is not
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50 22 addictive and 9% believe there are no risks associated with cannabis use.(50) A 2013 qualitative
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52 23 study of 76 Canadian youth (aged 14–19 years) found that many were unaware of the potential
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1 harms associated with cannabis use, highlighting a potential area for further education.(51)
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1 harms associated with cannabis use, highlighting a potential area for further education.(51)
2 Continued national–level monitoring of changing attitudes and behaviours regarding cannabis
3 use through surveys like the NCS will help assess the public health impact of cannabis
4 legalization.(4,21,52)

6 *Limitations*

7 Self-reported use of cannabis and intention to try or increase use may be subject to measurement
8 error and bias. It is possible that prevalence of cannabis use may have been underreported,
9 although a number of studies have found self–reported cannabis use to be as reliable as other
10 self–reported behaviors.(7,53,54) There is a potential for non–response bias due to sampling
11 design and the completion rate, however bootstrap weighting by Statistics Canada attempts to
12 addresses this by adjusting the representation of the data to be closer to the intended sample.
13 Furthermore, the NCS did not collect information on institutionalized persons and our findings
14 may not be generalizable to this population. Finally, the NCS data used for our study only
15 measured intentions to use cannabis, not actual changes in behaviour, and only associations are
16 reported.

18 *Conclusion*

19 Almost 1 in 5 Canadians intend to try or increase cannabis use following legalization for
20 recreational purposes; particularly those who are younger, have used cannabis in the past three
21 months, have higher income, and self–report their mental health as poor or fair. Clinicians,
22 public health officials, and policymakers should pay special attention to these higher–risk
23 populations to ensure informed decision–making and responsible use. Continued monitoring

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3 1 through national-level surveys, such as the NCS, will be crucial in establishing rates and patterns
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5 2 of cannabis use among Canadians after recreational use becomes legal.
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9
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17
18 8 Methods, Evidence, and Impact, McMaster University) for review of our manuscript.
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24 10 **Data access:** The 2018 National Cannabis Survey master file can be accessed through a
25
26 11 Statistics Canada Research Data Centre. The analysis code can be accessed by contacting the
27
28 12 corresponding author.
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FIGURES & TABLES

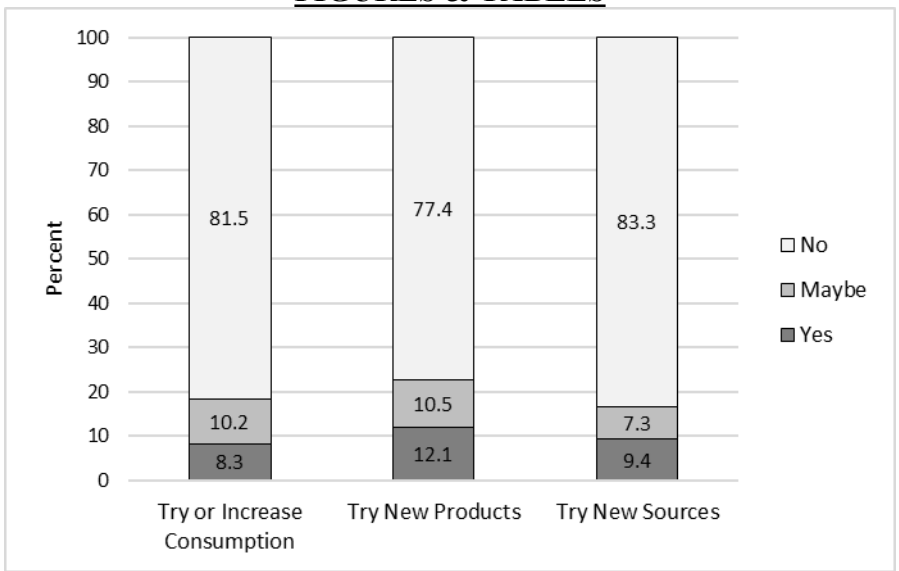


Figure 1: Full responses to whether respondents would (1) try or increase their cannabis consumption (n = 29,928,424); (2) try or consume different types of cannabis products (n = 29,607,064); and (3) obtain or purchase cannabis from another source (n = 29,300,593), following legalization for recreational purposes.

1 **Table 1:** Weighted table of respondent characteristics (n = 27,808,08).

Variable	Level	Percent (95%CI)
Gender	Female	50.3% (50.0–50.6)
	Male	49.7% (49.4–50.0)
Age (Years)	65 or older	18.5% (18.2–18.7)
	45–64	32.6% (32.3–32.9)
	35–44	16.6% (16.4–16.8)
	25–34	19.5% (18.7–20.4)
	15–24	12.9% (12.0–13.7)
Cannabis use in past 3 months	No	84.8% (84.0–85.7)
	Yes	15.2% (14.3–16.0)
Education Level	Bachelor’s or higher	32.7% (31.7–33.8)
	College or Diploma	33.7% (32.6–34.7)
	Less than HS or HS only	33.6% (32.6–34.7)
Income Level	Less than \$40,000	49.7% (48.7–50.8)
	\$40,000–79,999	32.0% (31.0–33.1)
	\$80,000 or more	18.3% (17.5–19.0)
Main Activity	Employed	59.2% (58.1–60.2)
	Student	6.8% (6.1–7.5)
	Caregiving or Housework	8.4% (7.8–9.1)
	Retired or LTI	20.6% (20.0–21.2)
	Other	5.0% (4.4–5.6)
Mental Health	Good to Excellent	93.8% (93.2–94.4)
	Fair or Poor	6.2% (5.6–6.8)
Provinces (Grouped)	Atlantic Provinces	6.5% (6.4–6.6)
	Quebec	22.9% (22.7–23.2)
	Ontario	39.4% (39.1–39.7)
	Manitoba	3.4% (3.3–3.4)
	Saskatchewan	3.0% (2.9–3.0)
	Alberta	11.5% (11.3–11.6)
	British Columbia Territorial Capital Cities	13.3% (13.1–13.5) 0.05% (0.049–0.051)
Survey wave	1	32.9% (32.6–33.2)
	2	33.5% (33.2–33.8)
	3	33.7% (33.4–34.0)

2 Percentage totals for ages and provinces do not add up to 100% exactly due to bootstrapping and
3 rounding. HS = high school, LTI = long-term illness.

1 **Table 2:** Variables associated with intent to try or increase cannabis use post-legalization (n =
 2 27,808,081).
 3

Variable	Levels	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted risk increase percent (95%CI)
Gender	Female	Ref.	Ref.	Ref.
	Male	1.3* (1.15–1.45)	1.1 (1.0–1.3)	N/a
Age (years)	65 or older	Ref.	Ref.	Ref.
	45–64	1.7* (1.4–2.1)	1.3 (1.0–1.6)	N/a
	35–44	2.8* (2.3–3.3)	1.8* (1.3–2.4)	6.8% (3.5–10.1)
	25–34	4.2* (3.5–5.1)	2.6* (1.9–3.4)	12.6% (8.8–16.4)
	15–24	5.3* (4.2–6.8)	3.8* (2.6–5.6)	20.1% (13.9–26.2)
Cannabis use in past 3 months	No	Ref.	Ref.	Ref.
	Yes	4.3* (3.7–5.0)	3.3* (2.8–3.9)	20.4% (17.1–23.6)
Education Level	≥ Bachelor's	Ref.	Ref.	Ref.
	College or diploma	0.8* (0.7–0.9)	0.9 (0.7–1.0)	N/a
	≤ HS	0.9 (0.8–1.1)	0.9 (0.8–1.1)	N/a
Income Level	< \$40,000	Ref.	Ref.	Ref.
	\$40–79,999	1.0 (0.8–1.1)	1.2* (1.0–1.4)	2.5% (0.3–4.7)
	≥ \$80,000	1.2* (1.1–1.4)	1.5* (1.3–1.9)	6.1% (3.2–9.0)
Main Activity	Employed	Ref.	Ref.	Ref.
	Student	1.4* (1.1–1.9)	0.9 (0.6–1.3)	N/a
	Caregiving or housework	0.8 (0.7–1.0)	1.0 (0.8–1.3)	N/a
	Retired or LTI	0.4* (0.4–0.5)	0.9 (0.7–1.1)	N/a
	Other	1.1 (0.8–1.4)	0.8 (0.6–1.1)	N/a
Mental Health	Good to excellent	Ref.	Ref.	Ref.
	Poor or fair	2.6* (2.1–3.2)	2.0* (1.6–2.6)	11.5% (6.7–16.2)

4 * = Wald test for predictors being significant in model at $p < 0.05$.

5 Adjusted model included province/territory and survey wave.

6 N/a = an adjusted risk difference was not calculated for adjusted odd ratios that were not significant.