CHARACTERISTICS OF CANADIANS INTENDING TO INITIATE OR INCREASE CANNABIS USE FOLLOWING LEGALIZATION: A CROSS-SECTIONAL STUDY

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CHARACTERISTICS OF CANADIANS INTENDING TO INITIATE OR INCREASE CANNABIS USE FOLLOWING LEGALIZATION: A CROSS-SECTIONAL STUDY

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TITLE: Characteristics of Canadians Intending to Initiate or Increase Cannabis Use Following Legalization: A Cross-Sectional Study

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ABSTRACT:

OBJECTIVES: The Government of Canada legalized the recreational use of cannabis on October 17th, 2018. Our objectives were to determine the prevalence of Canadians (aged 15 years or older) intending to try or increase their cannabis use following legalization and explore characteristics associated with the intent to try or increase use.

METHODS & DATA ANALYSIS: A secondary data analysis was conducted of cross-sectional data from Waves 1–3 of the National Cannabis Survey collected from February to September 2018. All respondents' data were weighted and bootstrapped multivariable logistic and multinomial regression models were developed. Relative measures of association were reported as adjusted odds ratios (aORs) and relative risk ratios (RRRs), and absolute measures of association as adjusted risk differences (ARDs).

RESULTS: Response rates were 51.2% (Wave 1), 51.3% (Wave 2), and 51.6% (Wave 3). An estimated 18.5% (95%CI: 17.6–19.5) of the study population indicated that they intended to try (12.3%) or increase (6.2%) cannabis use following legalization. Our weighted analysis represented 27,808,081 Canadians 15 years of age or older (unweighted n = 17,089). In our adjusted logistic model, being more likely to try or increase cannabis use was associated with younger age (15–24 years versus ≥65; aOR 3.8, 95%CI: 2.6–5.6; ARD 20.1%, 95%CI: 13.9–26.2), cannabis use in the past three months versus not (aOR 3.3, 95%CI: 2.8–3.9; ARD 20.4%, 95%CI: 17.1–23.6),

higher income (≥$80,000 versus <$40,000; aOR 1.5, 95%CI: 1.3–1.9; ARD 6.1%, 95%CI: 3.2–9.0), and poor or fair mental health compared to good or excellent mental health (aOR 2.0, 95%CI: 1.6–2.6; ARD 11.5%, 95%CI: 6.7–16.2).

CONCLUSIONS: Nearly 1 in 5 respondents reported their intention to try or increase cannabis use post–legalization. Intentions may not lead to actual changes in behaviour and further surveillance of cannabis use can help determine impact of policy change.

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I would like to thank my supervisor Dr. Jason W. Busse for his ongoing support of all my thesis work. He helped me develop an area of research and gave me the autonomy to pursue the topics I found interesting while guiding my study design, methods, and interpretation of the results.

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Finally, I want to thank my colleagues, friends, and family for supporting my work, always engaging in conversations about my thesis, and encouraging me to continue improving my research skills through this thesis project.

PREFACE:

This thesis contains a manuscript submitted to a journal for publication and is formatted as a "sandwich" thesis, which includes an introduction, the manuscript, additional analyses, and a conclusion. At the time of submission of this thesis, the manuscript has been submitted to a peer-reviewed journal and is undergoing review for publication. A full table of contents is on the following page.

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LIST OF ALL ABBREVIATIONS

aOR   Adjusted Odds Ratio

ARI   Adjusted Risk Increase

CCHS   Canadian Community Health Survey

CI   Confidence Interval

CTADS   Canadian Tobacco, Alcohol and Drugs Survey

HL   Hosmer-Lemeshow

LR   Likelihood Ratio

NCS   National Cannabis Survey

RRR   Relative Risk Ratio

US   United States

DECLARATION OF ACADEMIC ACHIEVEMENT:

I, Harman Sandhu, declare this thesis work to be my own. I proposed the study design, obtained access to the data, performed the analysis, led the writing of the manuscript, and wrote this thesis document.

My supervisor, Dr. Busse, and thesis committee members Dr. Anderson and Dr. Guindon provided guidance and feedback for my thesis development, the manuscript and this document. Dr. Busse and Dr. Anderson provided in-depth feedback on multiple versions of the manuscript that was prepared and contributed to writing certain parts of the manuscript, and thus are listed as co-authors for Chapter 2.

Chapter 1: Introduction

1.1 Context and Cannabis Policy Change

The Government of Canada legalized the recreational (or non-medical) use of cannabis on October 17th, 2018.[1] This marked a drastic policy change with potentially wide-ranging impacts, especially as Canada has one of the highest rates of cannabis use in the world.[2] According to the 2017 Canadian Tobacco, Alcohol, and Drugs Survey, 15% of Canadians aged 15 and older used cannabis in the past year.[3] Estimates from Ontario, the most populous province in Canada, show that past year cannabis use increased from 15.7% in 2016 to 19.4% in 2017, just a year before legalization.[4] Medical cannabis was legalized in Canada in 2001 and the legislation was revised in 2014 to allow select healthcare providers to authorize access to cannabis for medical purposes.[5] The Government of Canada legalized the recreational use of cannabis in order to promote responsible use, deter criminal activity, and protect public health and safety.[1]

1.2 Review of Cannabis Use and Health Impacts

Observational studies have shown the association between acute cannabis use and motor vehicle collisions, with a systematic review finding almost double the odds of being involved in a collision while under the influence of cannabis compared to unimpaired driving (OR 1.92, 95%CI: 1.35–2.73).[6] Cannabis use during pregnancy has also been

(1)

shown to be associated with adverse health outcomes. A meta-analysis demonstrated that there was in increase in odds of anemia (OR 1.36, 95%CI: 1.10–1.69) in women who used cannabis during pregnancy compared to those who did not.[7] Furthermore, infants who had been exposed to cannabis in utero were more likely to have a decreased birth weight compared to infants who had not been exposed (OR 1.77, 95%CI: 1.04–3.01).[7] It is important to note that cannabis use does not result in fatal overdoses.[8]

Long-term use of cannabis can result in different outcomes. For example, a meta-analysis found that using cannabis weekly or more increased the odds of individuals having non-seminoma testicular cancer compared to those who had never used cannabis (OR 2.59, 95%CI: 1.60–4.19).[9] A cross-sectional study from the US showed that adults who smoked cannabis, the most common form of consumption[10], were more likely to have increased respiratory symptoms such as chronic bronchitis (OR 2.17, 95%CI: 1.11–4.26), cough on most days (OR 2.00, 95%CI: 1.32–3.01), phlegm (OR 1.89, 95%CI: 1.35–2.66), and wheezing (OR 2.98, 95%CI: 2.05–4.34), compared to those who did not.[11] Verbal learning, memory, attention, and psychomotor function have also been shown to be impaired following both acute and long-term cannabis use.[12] A meta-analysis of three cohort studies showed that the earlier the age of fist cannabis use was associated with lower likelihood of completing school and pursuing post-secondary education.[13] An estimated 17% of the rate of school incompletion could be contributed to early use of

cannabis.[13] Similarly, a cohort study demonstrated that increasing rates of cannabis use from ages 14–21 were associated with lower income at age 25.[14]

Among those who had ever used cannabis, a meta-analysis reported an increased risk of experiencing a psychotic symptom or disorder (OR 1.41, 95%CI: 1.20–1.65) with a greater risk on those who used more frequently (OR 2.09, 95%CI: 1.54–2.84).[15] The lifetime risk of addiction among Canadians who used cannabis was estimated to be 6.8% in 2012 and an estimated 1.3% met criteria for cannabis abuse or dependence in the past year.[16] Moreover, the potency of illicit cannabis has increased from 4% in 1995, to 12% in 2014, in the US[17], and higher potency has been shown to be associated with adverse health outcomes such as greater emergency department visits involving drug use.[8,18–20] It is important to note that those who are younger and use more frequently are at a higher risk of harms related to cannabis use.[21] More detailed information summarizing the literature on adverse health effects of recreational cannabis use can be found in the referenced systematic and overview reviews.[8,21]

Cannabis is also used for its medical or therapeutic effects.[22] An observational study evaluated patients with fibromyalgia before and 2 hours after using cannabis and found significant relief of stiffness and pain.[23] A US survey study of self-reported reasons for

using cannabis noted that top responses included chronic pain (97% of sample), stress/anxiety (50%), and insomnia (45%).[22] A 2015 clinical review concluded that the strongest evidence exists for using medical cannabis for chronic pain, neuropathic pain, and spasticity due to multiple sclerosis.[24] Furthermore, a randomized controlled crossover trial studied adults with post-traumatic or post-surgical neuropathic pain who were given 9.4% tetrahydrocannabinol (active chemical in cannabis) reported significant improvements in sleep.[25] An interview study with 50 self-identified medical cannabis users noted that 37 (74%) also used it recreationally and that the distinction between medical and recreational use may be blurred.[26] Finally, although patients report relief from stress/anxiety as one of the reasons they use medical cannabis[27], a 2017 systematic review noted the need to further study and create more evidence of using medical cannabis for various psychiatric disorders.[28]

1.3 Studying the Impact of Legalization

Fischer and colleagues (2018) have proposed 10 indicators for evaluating the impact of cannabis legalization in Canada.[29] These include: (1) cannabis use prevalence; (2) patterns of use, (3) modes of use; (4) cannabis potency; (5) cannabis product sourcing; (6) cannabis-impaired driving and injuries; (7) hospitalizations; (8) cannabis use disorders; (9) other substance use; and (10) cannabis-related "harm to others".[29] Careful monitoring

of these indicators will help assess the public health impact of cannabis legalization. Prior

to legalization, Statistics Canada conducted the National Cannabis Survey in 2018.[30] The

questionnaire asked respondents whether they are intending to try or increase their

cannabis use following recreational legalization.[31] Any intentions which translate into

action may change the rates of cannabis use and are important to further study. This is

the focus of this thesis project.

1.4 Evidence from Other Jurisdictions

The most relevant literature regarding impact of legalization on rates of use comes from

the United States (US) where 8 states and 1 district have legalized recreational use of

cannabis: Colorado and Washington in 2012; Alaska, Oregon, and the District of

Columbia in 2014; and California, Massachusetts, Nevada, and Maine in 2016, with the

legal–age being 21 years.[32] The impact of legalization on rates of use in these regions are

mixed with some showing increases in rates of use and others showing no change among

various sub-populations.[33–36] One study examined past 30-day cannabis use among adults

and youth in Colorado in the years prior to legalization and one-year afterwards and

found that there was no significant change in rates of use.[35] A study of 262 adolescents

(aged 13-19 years) from Washington showed that cannabis use among this population did

not increase and instead there was increase in negative perceptions of use.[36] A study with

a larger sample size (n = 5509) showed that among 8th and 10th grade adolescents in

Washington, cannabis use increased following legalization compared to other states;

however, rates did not change among 12th graders.[33] Among college students in Oregon,

students aged 18-26 years showed increased rates of cannabis use (OR 1.29, 95%CI:

1.13–1.48) and decreased tobacco use rates (OR 0.71, 95%CI: 0.60–0.85) following

legalization compared to other states.[34] It has been noted that changes in use, when found,

are similar between those who are legal-age (21 years or older) and those who are not

(<21 years).[32,34] One study from the US examined the intentions to try or increase

cannabis use due to legalization among 18 to 34 year old's in the US.[37] They found that

about 13.5% reported they would use more frequently and this intention was associated

with presence of mental health issues, being male, having support for legalization, lower

perception of risk, and a history of cannabis use.[37] Ultimately, changes in rates may vary

based on sample sizes, study methods, and target populations. Large sample national

surveys could help monitor potential changes in rates of use at the population level.

There are two common factors that are suggested to have an impact of whether the rates

of use will change or not: history of medical legalization and price/accessibility of

cannabis.[36,38] There is no published research into the impact of medical legalization on

recreational rates of use and related outcomes in Canada. Research from

the US suggests that medical legalization may alter perceptions of risk and states that have medical legalization typically have higher rates of cannabis use compared to other states, however the effect of medical legalization within a single state on changing rates of cannabis use is insignificant.[39,40] It is possible that in Canada, the pricing and accessibility will have a significant impact on changes in rates of use. If the price of cannabis decreases, it may result in an increased number of new users and heavy users[38,41], as well as initiation at a younger age.[42]

1.5 Thesis Objectives

The objectives of this thesis project were to:

1. Determine the prevalence of Canadians (aged 15 years or older) likely to try or increase cannabis use following legalization for recreational purposes.

2. Explore the association between intent to try or increase use and age, gender, education, income, occupation, previous cannabis use, mental health and province (or territory) or residence.

1.6 References

1.   Parliament of Canada. Government Bill (House of Commons) C-45 (42-1) - Royal Assent - Cannabis Act. http://www.parl.ca/DocumentViewer/en/42-1/bill/C-45/royal-assent. Accessed January 9, 2019.

2.   United Nations Office on Drugs and Crime. *Recent Statistics and Trend Analysis of Illicit Drug Markets - Cannabis Overview*. Vienna, Austria; 2014. https://www.unodc.org/documents/wdr2014/World_Drug_Report_2014_web.pdf.

3.   Statistics Canada. Canadian Tobacco, Alcohol and Drugs Survey, 2017. https://www150.statcan.gc.ca/n1/daily-quotidien/181030/dq181030b-eng.htm. Published 2018. Accessed January 29, 2019.

4.   Ialomiteanu AR, Hamilton HA, Adlaf EM, Mann RE. *CAMH Monitor E-Report: Substance Use, Mental Health and Well-Being Among Ontario Adults, 1977-2017 (CAMH Research Document Series No. 48)*. Toronto, ON; 2018. https://www.camh.ca/-/media/files/pdfs---camh-monitor/camh-monitor-2017-ereport-final-pdf.pdf?la=en&hash=A411E25BB4E8838EE41F89D46799C3E527352B21.

5.   Fischer B, Kuganesan S, Room R. Medical marijuana programs: Implications for cannabis control policy - Observations from Canada. *Int J Drug Policy*. 2015;26(1):15-19. doi:10.1016/j.drugpo.2014.09.007

6.   Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *BMJ*. 2012;344(7846):e536. doi:10.1136/bmj.e536

7.   Gunn JKL, Rosales CB, Center KE, et al. Prenatal exposure to cannabis and maternal and child health outcomes: A systematic review and meta-analysis. *BMJ Open*. 2016;6(4):e009986. doi:10.1136/bmjopen-2015-009986

8.   Hall W. What has research over the past two decades revealed about the adverse health effects of recreational cannabis use? *Addiction*. 2015;110(1):19-35. doi:10.1111/add.12703

9.   Gurney J, Shaw C, Stanley J, Signal V, Sarfati D. Cannabis exposure and risk of testicular cancer: A systematic review and meta-analysis. *BMC Cancer*. 2015;15(1):897. doi:10.1186/s12885-015-1905-6

10.   Government of Canada. Canadian Cannabis Survey 2018 Summary. https://www.canada.ca/en/services/health/publications/drugs-health-products/canadian-cannabis-survey-2018-summary.html. Accessed March 13, 2019.

11.   Moore BA, Augustson EM, Moser RP, Budney AJ. Respiratory effects of marijuana and tobacco use in a U.S. sample. *J Gen Intern Med*. 2005;20(1):33-37. doi:10.1111/j.1525-1497.2004.40081.x

12.   Broyd SJ, Van Hell HH, Beale C, Yücel M, Solowij N. Acute and chronic effects of cannabinoids on human cognition - A systematic review. *Biol Psychiatry*. 2016;79(7):557-567. doi:10.1016/j.biopsych.2015.12.002

13.   Horwood LJ, Fergusson DM, Hayatbakhsh MR, et al. Cannabis use and educational achievement: Findings from three Australasian cohort studies. *Drug Alcohol Depend*. 2010;110(3):247-253. doi:10.1016/j.drugalcdep.2010.03.008

14.   Fergusson DM, Boden JM. Cannabis use and later life outcomes. *Addiction*. 2008;103(6):969-976. doi:10.1111/j.1360-0443.2008.02221.x

15.   Moore TH, Zammit S, Lingford-Hughes A, et al. Cannabis use and risk of psychotic or affective mental health outcomes: a systematic review. *Lancet*. 2007;370(9584):319-328. doi:10.1016/S0140-6736(07)61162-3

16. Pearson C, Janz T, Ali J. Mental and substance use disorders in Canada. *Stat Canada Cat*. 82-624-X. https://www150.statcan.gc.ca/n1/pub/82-624-x/2013001/article/11855-eng.htm.

17. ElSohly MA, Mehmedic Z, Foster S, Gon C, Chandra S, Church JC. Changes in cannabis potency over the last 2 decades (1995-2014): Analysis of current data in the United States. *Biol Psychiatry*. 2016;79(7):613-619. doi:10.1016/j.biopsych.2016.01.004

18. Volkow ND, Baler RD, Compton WM, Weiss SRB. Adverse Health Effects of Marijuana Use. *N Engl J Med*. 2014;370(23):2219-2227. doi:10.1056/NEJMra1402309

19. Di Forti M, Sallis H, Allegri F, et al. Daily use, especially of high-potency cannabis, drives the earlier onset of psychosis in cannabis users. *Schizophr Bull*. 2014;40(6):1509-1517. doi:10.1093/schbul/sbt181

20. Substance Abuse and Mental Health Services Administration. *Drug Abuse Warning Network 2011: National Estimated of Drug-Related Emergency Department Visits*. Rockville, MD. HHS Publication No. (SMA) 13-4760, DAWN Series D-39; 2013.

21. Memedovich KA, Dowsett LE, Spackman E, Noseworthy T, Clement F. The adverse health effects and harms related to marijuana use: an overview review. *C Open*. 2018;6(3):E339-E346. doi:10.9778/cmajo.20180023

22. Webb CW, Webb SM. Therapeutic benefits of cannabis: a patient survey. *Hawaii J Med Public Health*. 2014;73(4):109-111. http://www.ncbi.nlm.nih.gov/pubmed/24765558. Accessed April 11, 2018.

23.   Fiz J, Durán M, Capellà D, Carbonell J, Farré M. Cannabis use in patients with Fibromyalgia: Effect on symptoms relief and health-related quality of life. García AV, ed. *PLoS One*. 2011;6(4):e18440. doi:10.1371/journal.pone.0018440

24.   Hill KP. Medical marijuana for treatment of chronic pain and other medical and psychiatric problems: A clinical review. *JAMA - J Am Med Assoc*. 2015;313(24):2474-2483. doi:10.1001/jama.2015.6199

25.   Ware MA, Wang T, Shapiro S, et al. Smoked cannabis for chronic neuropathic pain: a randomized controlled trial. *CMAJ*. 2010;182(14):E694-701. doi:10.1503/cmaj.091414

26.   Ogborne AC, Smart RG, Weber T, Birchmore-Timney C. Who is using cannabis as a medicine and why: An exploratory study. *J Psychoactive Drugs*. 2000;32(4):435-443. doi:10.1080/02791072.2000.10400245

27.   Walsh Z, Callaway R, Belle-Isle L, et al. Cannabis for therapeutic purposes: Patient characteristics, access, and reasons for use. *Int J Drug Policy*. 2013;24(6):511-516. doi:10.1016/j.drugpo.2013.08.010

28.   Walsh Z, Gonzales R, Crosby K, Carroll C. Medical cannabis and mental health: a systematic review. *Clin Psychol Rev*. 2017;51:15-29. https://www.sciencedirect.com/science/article/pii/S0272735816300939.

29.   Fischer B, Russell C, Rehm J, Leece P. Assessing the public health impact of cannabis legalization in Canada: core outcome indicators towards an 'index' for monitoring and evaluation. *J Public Health (Bangkok)*. 2018. doi:10.1093/pubmed/fdy090

30.   Statistics Canada. National Cannabis Survey (NCS). http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5262. Published 2018. Accessed January 9, 2019.

31.   Statistics Canada. National Cannabis Survey Questionnaire.
      http://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Ite
      m_Id=1173861. Published 2018. Accessed January 9, 2019.

32.   Miller A, Rosenman R, Cowan BW. Recreational marijuana legalization and
      college student use: Early evidence. *SSM - Popul Heal*. 2017;3.
      doi:10.1016/j.ssmph.2017.08.001

33.   Cerdá M, Wall M, Feng T, Al E. Association of state recreational marijuana laws
      with adolescent marijuana use. *JAMA Pediatr*. 2016.
      https://jamanetwork.com/journals/jamapediatrics/fullarticle/2593707. Accessed
      September 2, 2018.

34.   Kerr DCR, Bae H, Koval AL. Oregon recreational marijuana legalization: Changes
      in undergraduates' marijuana use rates from 2008 to 2016. *Psychol Addict Behav*.
      2018. doi:10.1037/adb0000385

35.   Ghosh TS, Vigil DI, Maffey A, et al. Lessons learned after three years of legalized,
      recreational marijuana: The Colorado experience. *Prev Med (Baltim)*. 2017;104:4-
      6. doi:10.1016/j.ypmed.2017.02.021

36.   Estoup AC, Moise-Campbell C, Varma M, Stewart DG. The Impact of Marijuana
      Legalization on Adolescent Use, Consequences, and Perceived Risk. *Subst Use
      Misuse*. 2016;51(14):1881-1887. doi:10.1080/10826084.2016.1200623

37.   Cohn AM, Johnson AL, Rose SW, Rath JM, Villanti AC. Support for Marijuana
      Legalization and Predictors of Intentions to Use Marijuana More Often in
      Response to Legalization Among U.S. Young Adults. *Subst Use Misuse*.
      2017;52(2):203-213. doi:10.1080/10826084.2016.1223688

38.   Hall W, Lynskey M. Evaluating the public health impacts of legalizing recreational cannabis use in the United States. *Addiction*. 2016;111(10):1764-1773. doi:10.1111/add.13428

39.   Khatapoush S, Hallfors D. "Sending the wrong message": Did medical marijuana legalization in California change attitudes about and use of marijuana? *J Drug Issues*. 2004;34(4):751-770. doi:10.1177/002204260403400402

40.   Harper S, Strumpf E, Kaufman J. Do medical marijuana law increase marijuana use? Replication study and extension. *Ann Epidemiol*. 2012;22(3):207-212. https://www.sciencedirect.com/science/article/pii/S1047279711003723. Accessed September 2, 2018.

41.   Pacula RL. Examining the Impact of Marijuana Legalization on Marijuana Consumption. Insights from the Economics Literature. *RAND Corp WR-770-RC*. 2010. doi:10.7249/WR770

42.   van Ours JC, Williams J. Cannabis prices and dynamics of cannabis use. *J Health Econ*. 2007;26(3):578-596. doi:10.1016/j.jhealeco.2006.10.001

Chapter 2: Manuscript

Title: Characteristics of Canadians likely to try or increase cannabis use following legalization for recreational purposes: A cross–sectional study

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2.1 Abstract

Background: The Government of Canada legalized recreational use of cannabis in October 2018.

Methods: We used data from the 2018 National Cannabis Survey to investigate factors associated with intent to try or increase cannabis use post–legalization among Canadians using multivariable logistic regression. Respondents' data were weighted and bootstrapped. We report relative measures of association as adjusted odds ratios (aORs) and absolute measure of association as adjusted risk increases (ARIs).

Results: An estimated 18.5% (95%CI: 17.6–19.5) of the study population indicated that they intended to try (15.7%) or increase (2.8%) cannabis use following legalization. Our weighted analysis represented 27,808,081 Canadians 15 years of age or older (unweighted n = 17,089). In our adjusted regression model, being more likely to try or increase cannabis use was associated with younger age (15–24 years versus ≥65; aOR 3.8, 95%CI: 2.6–5.6; ARI 20.1%, 95%CI: 13.9–26.2), cannabis use in the past three

months versus not (aOR 3.3, 95%CI: 2.8–3.9; ARI 20.4%, 95%CI: 17.1–23.6), higher

income (≥$80,000 versus <$40,000; aOR 1.5, 95%CI: 1.3–1.9; ARI 6.1%, 95%CI: 3.2–

9.0), and poor or fair mental health compared to good or excellent mental health (aOR

2.0, 95%CI: 1.6–2.6; ARI 11.5%, 95%CI: 6.7–16.2).

Interpretation: Nearly 1 in 5 respondents reported their intention to try or increase

cannabis use post–legalization. Efforts to promote responsible use of cannabis should be a

priority for clinicians, public health officials, and policymakers.

Keywords: Cannabis; Marijuana; Health behavior; Canada; Health policy; Public health

2.2 Introduction

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

Observational studies have shown that cannabis users are more likely to be involved in motor vehicle collisions, with a systematic review finding double the odds of being involved in a collision while under the influence of cannabis compared to unimpaired driving (OR 1.92, 95%CI: 1.35–2.73).[5] Cannabis use is also associated with anxiety, psychotic symptoms, chronic bronchitis, impaired respiratory function, and cannabis use disorder.[6–11] The lifetime risk of addiction among Canadians who used cannabis was estimated to be 6.8% in 2012 and an estimated 1.3% met criteria for cannabis abuse or

dependence in the past year.[12] Moreover, the potency of illicit cannabis has increased

from 4% in 1995, to 12% in 2014, in the United States (US)[13], and higher potency has

been shown to be associated with adverse health outcomes such as greater emergency

department visits involving drug use.[10,11,14,15]

In an effort to promote responsible use, deter criminal activity, and protect public health

and safety, the federal government legalized the use of recreational cannabis on October

17th, 2018.[16] This is in addition to medical cannabis which has been legal in Canada since

2001.[17] There are concerns that recreational cannabis may increase use and subsequent

harm.[18] The impact of legalization based on evidence from US States is mixed with some

studies showing increased rates of use and other showing no change.[19–22] Moreover, a

2016 narrative review found inconsistent evidence for an association between policy

change and increased uptake of cannabis among youth.[23]

Monitoring cannabis use prevalence, patterns of use, and modes of use are crucial to

determining the impact of policy change.[24] Statistics Canada, the national statistics

agency, developed and implemented the 2018 National Cannabis Survey (NCS), a novel

cross–sectional survey which aims to better understand the frequency of cannabis use and

to monitor changes in attitudes and behavior as a result of legalization.[25] Our objectives were to: (1) determine the prevalence of Canadians (aged 15 years or older) likely to try or increase cannabis use after legalization for recreational purposes; and (2) explore characteristics associated with intent to try or increase use.

2.3 Methods

We followed standards set by the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) statement for reporting our study.[26]

2.3.1 *Study design & respondents*

This is a cross–sectional study involving analysis of the 2018 NCS master file.[25,27] The NCS was developed by Statistics Canada in consultation with the Public Health Agency of Canada, Department of Justice of Canada, and Public Safety Canada.[25] Cognitive testing of questionnaire content was conducted and validation of estimates was done through cross-tabulations of other data and consultation with Statistics Canada stakeholders.[25] The data used in this study were collected just prior to legalization of recreational cannabis, from February to September 2018 (waves 1–3).[25] Data from the three waves were independent of each other, and were combined and analyzed together.

Participation in the NCS was voluntary and data were collected through an electronic

questionnaire or computer–assisted telephone interview.[25] The study population consisted

of non–institutionalized Canadians, aged 15 years or older, residing in Canada's 10

provinces and three territory capital cities.[25] The sampling method was two–stage

(dwelling and person) stratified by province or territory, and a simple random sample of

dwellings which aimed to represent the Canadian population.[25] The NCS master file was

accessed through the McMaster University Statistics Canada Research Data Centre.[28]

2.3.2 *Measures*

Our primary outcome measure was derived from an NCS question that asked when

cannabis consumption becomes legal for recreational purposes, would respondents be

more likely to try cannabis or increase their consumption?[27] Response options included:

"Yes", "Maybe", or "No". We also summarized whether respondents would be more

likely to try different types of cannabis products or acquire cannabis from another source

after legalization. Information on gender, age, cannabis use in the past three months,

education and income level, main activity during the previous week, and self–reported

mental health were also collected and analyzed for association with intention to try or

increase cannabis use. Categories for age, education level, income level, main activity,

and self–reported mental health were collapsed to ensure adequate cell size and simplify

analysis and subsequent interpretation. The full questionnaire is available through Statistics Canada.[27]

2.3.3 *Statistical analysis*

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

Prior to analysis, we reviewed unweighted frequencies of the independent variables to ensure adequate cell sizes (at least 10 events per variable).[29] Bootstrap weights provided

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by Statistics Canada were applied to convert unweighted frequencies to represent the Canadian population and adjust for biases in the survey sampling design.[30] Missing data were excluded from our regression analysis using listwise deletion. For all statistically significant associations in our adjusted model, we calculated adjusted risk increases (ARI) by subtracting the risk of the outcome in the referent group (e.g. age ≥65) from the risk in the comparator group (e.g. age 15-24), while holding all other variables constant.[31] The likelihood ratio test was performed to determine if the multivariable logistic regression model fit significantly better than a model with no predictors and the Wald test determined significance of individual predictors in the model. A Hosmer–Lemeshow test was performed to assess goodness–of–fit of our adjusted model.[32] All analyses were performed using Stata/SE 15 software.[33]

2.3.4 *Ethics consideration*

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

2.4 Results

Of 39,000 households selected for recruitment of NCS waves 1–3, 17,089 respondents had provided complete data and were included in our multivariable logistic regression analysis (survey completion rate = 43.8%).[25] There was an equal distribution of males and females, most were employed (59.2%), the majority (93.8%) reported good to excellent mental health, and 15.2% reported use of cannabis in the past three months (Table 1). The "please specify" 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 (≥$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.

2.5 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 cannabis users prefer edible products.[37] We also found that 1 in 6 respondents intended to obtain cannabis from alternate sources after legalization and the Deloitte survey found that Canadian cannabis users will shift up to 63% of their purchases towards legal channels.[37]

Further complementing our findings, a 2014 survey of 3,532 US adults aged 18 to 34 found that 13.5% reported they would use cannabis more frequently if it were legalized.[38]

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This may be cause for concern as younger individuals are at a higher risk of experiencing harms associated with cannabis use;[7,10,11,39–41] however, intent may or may not translate into action. Consistent with our findings, the 2014 US study also found that cannabis non–users experiencing anxiety were more likely to endorse interest in trying cannabis if it were legal.[38] Although some studies have reported an association between cannabis use and mental illness (e.g. early onset psychosis among those who are predisposed, depression, anxiety, substance use disorder), management of psychiatric disorders is also one of the top cited reasons for cannabis use.[41–45] The association may therefore be bi–directional. The Canadian Psychiatric Association released a position statement in 2018 highlighting concerns over the impact of increased access to cannabis and mental health, particularly for youth.[46] Healthcare incidences involving cannabis increased following legalization in Colorado[47], and cannabis–related hospitalizations have been shown to be associated with higher rates of mental illness.[48,49]

There is also evidence to suggest that the general public may underestimate harms associated with cannabis. A 2017 national survey of 16,280 US adults found 22.4% believe cannabis is not addictive and 9% believe there are no risks associated with cannabis use.[50] A 2013 qualitative study of 76 Canadian youth (aged 14–19 years) found that many were unaware of the potential harms associated with cannabis use, highlighting a potential area for further education.[51] Continued national–level monitoring of changing

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attitudes and behaviours regarding cannabis use through surveys like the NCS will help

assess the public health impact of cannabis legalization.[4,21,52]

2.5.1 *Limitations*

Self-reported use of cannabis and intention to try or increase use may be subject to

measurement error and bias. It is possible that prevalence of cannabis use may have been

underreported, although a number of studies have found self–reported cannabis use to be

as reliable as other self–reported behaviors.[7,53,54] There is a potential for non–response

bias due to sampling design and the completion rate, however bootstrap weighting by

Statistics Canada attempts to addresses this by adjusting the representation of the data to

be closer to the intended sample. Furthermore, the NCS did not collect information on

institutionalized persons and our findings may not be generalizable to this population.

Finally, the NCS data used for our study only measured intentions to use cannabis, not

actual changes in behaviour, and only associations are reported.

2.5.2 *Conclusion*

Almost 1 in 5 Canadians intend to try or increase cannabis use following legalization for

recreational purposes; particularly those who are younger, have used cannabis in the past

three months, have higher income, and self–report their mental health as poor or fair. Clinicians, public health officials, and policymakers should pay special attention to these higher–risk populations to ensure informed decision–making and responsible use. Continued monitoring through national–level surveys, such as the NCS, will be crucial in establishing rates and patterns of cannabis use among Canadians after recreational use becomes legal.

2.7 Data access: The 2018 National Cannabis Survey master file can be accessed through a Statistics Canada Research Data Centre. The analysis code can be accessed by contacting the corresponding author.

2.8 References:

1. Russo E. *Cannabis and Cannabinoids: Pharmacology, Toxicology and Therapeutic Potential.* Routledge; 2003.

2. United Nations Office on Drugs and Crime. *Recent Statistics and Trend Analysis of Illicit Drug Markets - Cannabis Overview*. Vienna, Austria; 2014. https://www.unodc.org/documents/wdr2014/World_Drug_Report_2014_web.pdf.

3. Rotermann M, Langlois K. Prevalence and correlates of marijuana use in Canada, 2012. *Heal Rep*. 2015;26(4):10-15.

4. Rotermann M, Macdonald R. *Analysis of Trends in the Prevalence of Cannabis Use in Canada, 1985 to 2015*. Statistics Canada; 2018. http://www.statcan.gc.ca/pub/82-003-x/2018002/article/54908-eng.htm. Accessed January 9, 2019.

5. Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *BMJ*. 2012;344(7846):e536. doi:10.1136/bmj.e536

6. Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *Lancet*. 2009;374(9698):1383-1391. doi:10.1016/S0140-6736(09)61037-0

7. Hall W, Pacula RL. *Cannabis Use and Dependence : Public Health and Public Policy*. Melbourne: Cambridge University Press; 2003.

8. Budney AJ, Hughes JR. The cannabis withdrawal syndrome. *Curr Opin Psychiatry*. 2006;19(3):233-238. doi:10.1097/01.yco.0000218592.00689.e5

9. Roffman R, Stephens R. *Cannabis Dependence: Its Nature, Consequences and Treatment*. Camebridge, United Kingdom: Cambridge University Press; 2006.

10. Volkow ND, Baler RD, Compton WM, Weiss SRB. Adverse Health Effects of Marijuana Use. *N Engl J Med*. 2014;370(23):2219-2227. doi:10.1056/NEJMra1402309

11. Hall W. What has research over the past two decades revealed about the adverse health effects of recreational cannabis use? *Addiction*. 2015;110(1):19-35. doi:10.1111/add.12703

12. Pearson C, Janz T, Ali J. Mental and substance use disorders in Canada. *Stat Canada Cat*. 82-624-X. https://www150.statcan.gc.ca/n1/pub/82-624-x/2013001/article/11855-eng.htm.

13. ElSohly MA, Mehmedic Z, Foster S, Gon C, Chandra S, Church JC. Changes in cannabis potency over the last 2 decades (1995-2014): Analysis of current data in the United States. *Biol Psychiatry*. 2016;79(7):613-619. doi:10.1016/j.biopsych.2016.01.004

14. Di Forti M, Sallis H, Allegri F, et al. Daily use, especially of high-potency cannabis, drives the earlier onset of psychosis in cannabis users. *Schizophr Bull*. 2014;40(6):1509-1517. doi:10.1093/schbul/sbt181

15. Substance Abuse and Mental Health Services Administration. *Drug Abuse Warning Network 2011: National Estimated of Drug-Related Emergency Department Visits*. Rockville, MD. HHS Publication No. (SMA) 13-4760, DAWN Series D-39; 2013.

16. Parliament of Canada. Government Bill (House of Commons) C-45 (42-1) - Royal Assent - Cannabis Act. http://www.parl.ca/DocumentViewer/en/42-1/bill/C-45/royal-assent. Accessed January 9, 2019.

17. Fischer B, Kuganesan S, Room R. Medical marijuana programs: Implications for cannabis control policy - Observations from Canada. *Int J Drug Policy*. 2015;26(1):15-19. doi:10.1016/j.drugpo.2014.09.007

18. Kelsall D. Watching Canada's experiment with legal cannabis. *CMAJ*. 2018;190(41):E1218. doi:10.1503/cmaj.181287

19. Cerdá M, Wall M, Feng T, Al E. Association of state recreational marijuana laws with adolescent marijuana use. *JAMA Pediatr*. 2016. https://jamanetwork.com/journals/jamapediatrics/fullarticle/2593707. Accessed September 2, 2018.

20. Kerr DCR, Bae H, Koval AL. Oregon recreational marijuana legalization: Changes in undergraduates' marijuana use rates from 2008 to 2016. *Psychol Addict Behav*. 2018. doi:10.1037/adb0000385

21. Ghosh TS, Vigil DI, Maffey A, et al. Lessons learned after three years of legalized, recreational marijuana: The Colorado experience. *Prev Med (Baltim)*. 2017;104:4-6. doi:10.1016/j.ypmed.2017.02.021

22. Estoup AC, Moise-Campbell C, Varma M, Stewart DG. The Impact of Marijuana Legalization on Adolescent Use, Consequences, and Perceived Risk. *Subst Use Misuse*. 2016;51(14):1881-1887. doi:10.1080/10826084.2016.1200623

23. Dirisu O, Shickle D, Elsey H. Influence of legal status on the uptake of cannabis in young people. *Curr Opin Psychiatry*. 2016;29(4):231-235. doi:10.1097/YCO.0000000000000253

24. Fischer B, Russell C, Rehm J, Leece P. Assessing the public health impact of cannabis legalization in Canada: core outcome indicators towards an 'index' for monitoring and evaluation. *J Public Health (Bangkok)*. 2018. doi:10.1093/pubmed/fdy090

25. Statistics Canada. National Cannabis Survey (NCS). http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5262. Published 2018. Accessed January 9, 2019.

26. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. *PLoS Med*. 2007;4(10):e296. doi:10.1371/journal.pmed.0040296

27. Statistics Canada. National Cannabis Survey Questionnaire. http://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id= 1173861. Published 2018. Accessed January 9, 2019.

28. Statistics Canada. The Research Data Centres (RDC) Program. https://www.statcan.gc.ca/eng/rdc/index. Accessed January 9, 2019.

29. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373-1379. http://www.ncbi.nlm.nih.gov/pubmed/8970487.

30. Gagne C, Roberts G, Keown L-A. *Weighted Estimation and Bootstrap Variance Estimation for Analyzing Survey Data: How to Implement in Selected Software*. Ottawa, ON; 2014.

31. Norton EC, Miller MM, Kleinman LC. Computing adjusted risk ratios and risk differences in Stata. *Stata J*. 2013;13(3):492-509. https://pdfs.semanticscholar.org/28cb/e7852bb3d11c5e9518c0a7a06ce022a89ccb.pdf.

32. Hosmer DW, Lemeshow S. Goodness of fit tests for the multiple logistic regression model. *Commun Stat - Theory Methods*. 1980;9(10):1043-1069. doi:10.1080/03610928008827941

33. StataCorp. Stata Statistical Software: Release 15. 2017.

34. Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada. *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*.; 2014. doi:1

35. Hansen L. Cannabis edibles, drinks will mark "2nd wave" of legalization | CBC News.https://www.cbc.ca/news/canada/ottawa/cannabis-legalization-second-wave-edibles-1.4901297. Published November 12, 2018.

36. Charlebois S, Somogyi S. Marijuana-infused food and Canadian consumers' willingness to consider recreational marijuana as a food ingredient. https://cdn.dal.ca/content/dam/dalhousie/pdf/management/News/Preliminary results cannibis-infused foods EN.pdf. Published 2017. Accessed January 9, 2019.

37. Deloitte. A society in transition, an industry ready to bloom. https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/consulting/ca-cannabis-2018-report-en.PDF. Published 2018. Accessed January 9, 2019.

38. Cohn AM, Johnson AL, Rose SW, Rath JM, Villanti AC. Support for Marijuana Legalization and Predictors of Intentions to Use Marijuana More Often in Response to Legalization Among U.S. Young Adults. *Subst Use Misuse*. 2017;52(2):203-213. doi:10.1080/10826084.2016.1223688

39. Mehra R, Moore BA, Crothers K, Tetrault J, Fiellin DA. The association between marijuana smoking and lung cancer: A systematic review. *Arch Intern Med*. 2006;166(13):1359-1367. doi:10.1001/archinte.166.13.1359

40. Kandel DB. Examining the Gateway Hypothesis: Stages and Pathways of Drug Involvement. In: *Stages and Pathways of Drug Involvement*. ; 2002:3-16. doi:10.1017/CBO9780511499777.003

41. Memedovich KA, Dowsett LE, Spackman E, Noseworthy T, Clement F. The adverse health effects and harms related to marijuana use: an overview review. *C Open*. 2018;6(3):E339-E346. doi:10.9778/cmajo.20180023

42. Walsh Z, Gonzales R, Crosby K, Carroll C. Medical cannabis and mental health: a systematic review. *Clin Psychol Rev*. 2017;51:15-29. https://www.sciencedirect.com/science/article/pii/S0272735816300939.

43. Ogborne AC, Smart RG, Weber T, Birchmore-Timney C. Who is using cannabis as a medicine and why: An exploratory study. *J Psychoactive Drugs*. 2000;32(4):435-443. doi:10.1080/02791072.2000.10400245

44. Walsh Z, Callaway R, Belle-Isle L, et al. Cannabis for therapeutic purposes: Patient characteristics, access, and reasons for use. *Int J Drug Policy*. 2013;24(6):511-516. doi:10.1016/j.drugpo.2013.08.010

45. Ware MA, Wang T, Shapiro S, et al. Smoked cannabis for chronic neuropathic pain: a randomized controlled trial. *CMAJ*. 2010;182(14):E694-701. doi:10.1503/cmaj.091414

46. Tibbo P, Cracker CE, Lam RW, Meyer J, Sareen J, Aitchison KJ. Implications of Cannabis Legalization on Youth and Young Adults. *Can J Psychiatry*. 2018;63(1):65-71. doi:10.1177/0706743718759031

47. Vigil DI, Van Dyke M, Hall KE, Contreras AE, Ghosh TS, Wolk L. Marijuana Use and Related Health Care Encounters in Colorado Before and After Retail Legalization. *Int J Ment Health Addict*. 2018;16(4):806-812. doi:10.1007/s11469-018-9901-0

48. Wang GS, Hall K, Vigil D, Banerji S, Monte A, VanDyke M. Marijuana and acute health care contacts in Colorado. *Prev Med (Baltim)*. 2017;104:24-30. doi:10.1016/j.ypmed.2017.03.022

49. Wang GS, Davies SD, Halmo LS, Sass A, Mistry RD. Impact of Marijuana Legalization in Colorado on Adolescent Emergency and Urgent Care Visits. *J Adolesc Heal*. 2018;63(2):239-241. doi:10.1016/j.jadohealth.2017.12.010

50. Keyhani S, Steigerwald S, Ishida J, et al. Risks and benefits of marijuana use a national survey of U.S. Adults. *Ann Intern Med*. 2018;169(5):282-290. doi:10.7326/M18-0810

51. Porath-Waller A, Brown J, Clark H. What Canadian youth think about cannabis. Canadian Centre on Substance Abuse. http://www.ccdus.ca/Resource Library/CCSA-What-Canadian-Youth-Think-about-Cannabis-2013-en.pdf. Published 2013. Accessed January 9, 2019.

52. Han BH, Palamar JJ. Marijuana use by middle-aged and older adults in the United States, 2015–2016. *Drug Alcohol Depend*. 2018;191:374-381. doi:10.1016/j.drugalcdep.2018.07.006

53. O'malley PM, Bachman JG, Johnston LD. Reliability and Consistency in Self-Reports of Drug Use. *Int J Addict*. 1983;18(6):805-824. doi:10.3109/10826088309033049

54. Harrison ER, Haaga J, Richards T. Self-Reported Drug Use Data: What Do They Reveal? *Am J Drug Alcohol Abuse*. 1993;19(4):423-441. doi:10.3109/00952999309001632

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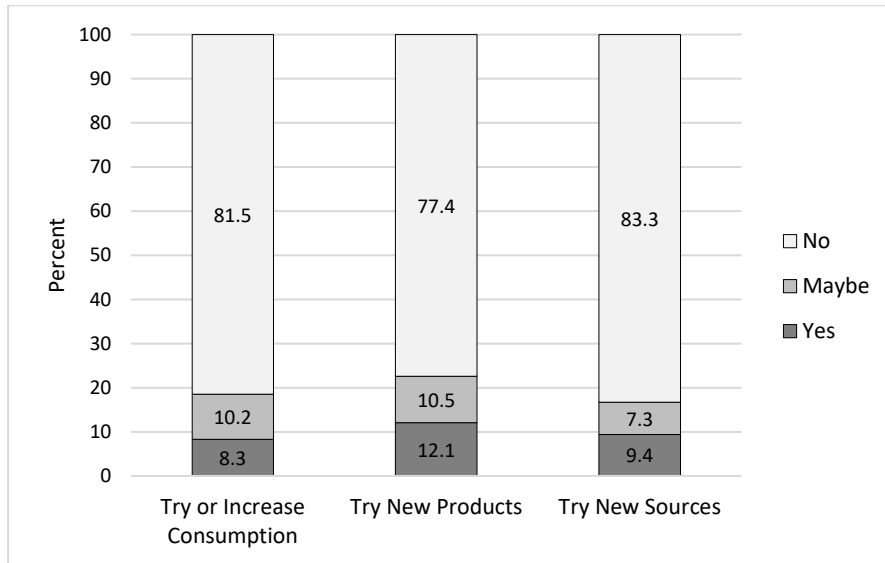
Figure 1: Full responses to whether respondents would (1) try or increase their cannabis consumption (n = 29,928,424); (2) try or consume different types of cannabis products (n = 29,607,064); and (3) obtain or purchase cannabis from another source (n = 29,300,593), following legalization for recreational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

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	13.3% (13.1–13.5)
	Territorial Capital Cities	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)

Percentage totals for ages and provinces do not add up to 100% exactly due to bootstrapping and rounding.

HS = high school, LTI = long–term illness.

Table 2: Variables associated with intent to try or increase cannabis use post–legalization

(n = 27,808,081).

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)

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

Adjusted model included province/territory and survey wave.

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

Chapter 3: Additional Analyses

3.1 Methods

Among respondents that endorsed the intent to try or increase cannabis use, we considered those who had used cannabis in the last three months to be intended "increasers", and those who had not used cannabis in the last three months to be intended "triers". The sample was then stratified into these two separate populations. Two additional multivariable logistic regression models were created using the same predictors as the combined model and were adjusted for wave and province/territory. An adjusted risk difference (ARD) was calculated after multivariable logistic regression by calculating the difference between the risk of the outcome among those who had a particular predictor (e.g. age 15 – 24) and the baseline risk (e.g. age 65+), while holding all other predictors constant, resulting in an absolute effect measure.[25] A likelihood ratio test and Wald test were performed to assess the logistic regression model and predictor significance, as well as a Hosmer-Lemeshow test for model goodness-of-fit.

The responses to the primary outcome (i.e. whether respondents were likely to try or increase cannabis use following legalization) had the following three options "Yes", "Maybe" and "No". Although the multivariable logistic regression analysis involved the combination of the first two options to create a binary outcome, a multinomial logistic regression analysis was also performed using these responses as a 3-category outcome

(with "Yes" and "Maybe" being the responses of interest and "No" being the referent category) along with the same predictors from the previous multivariable logistic regression. A relative risk ratio (RRR) and ARD were reported for the models along with their 95%CIs. As RRR indicates how the risk of the outcome in the comparison group compares to the risk of the outcome in the referent group with all other variables held constant. An RRR > 1 indicates an increased association and an RRR < 1 indicates a decreased association.

3.2 Results

The multivariable logistic regression model stratified by those who had not used cannabis in past three months and indicated the outcome ("triers") showed results consistent with the overall analysis: younger age, higher income, and poorer mental health were associated with intention to try cannabis compared to referent categories (Table 3). The Likelihood Ratio (p < 0.01) and Hosmer-Lemeshow (p = 0.50) tests indicated a good model fit.

Among those who used in the past three months and indicated the outcome ("increasers"), those aged 15 to 24 years were more likely to increase use compared to those 65 and older, and those with college or diploma level education were less likely to increase use

(39)

compared to bachelor's or higher level (Table 4). No other significant associations were seen. The Likelihood Ratio (p < 0.01) and Hosmer-Lemeshow (p = 0.29) tests suggested a good model fit.

The results of the multinomial logistic regression are reported in Tables 5, 6 and 7. Factors associated with increased intent to try were: younger age, fair or poor mental health, being male and higher income (Table 6). Respondents from Quebec were less likely to report intending to try compared to the referent category (Ontario). Younger age was also associated with intent to increase cannabis use where as those from Quebec and BC were less likely to report intention to increase use compared to Ontario (Table 7). In the combined model, those who had reported using cannabis in the past 3 months were more likely to report intention of increasing use compared to those who had not used in the past 3 months (Table 5). Overall, these sub-groups involved lower number of respondents and may have resulted in lower power compared to the combined analysis.

3.3.Tables

3.3.1 Table 3: Variables associated with intent to try or increase cannabis use post-legalization among those who did not use cannabis in the past 3 months ("triers") (n = 14,661, weighted n = 23,585,735)

Variable	Levels	Unadjusted OR (95% CI) p-value	Adjusted OR (95% CI) p-value	Adjusted risk difference percent (95%CI)
Gender	Female	Ref.	Ref.	Ref.
	Male	1.3 (1.1,1.4) p < 0.01	1.2 (1.0,1.4) p = 0.10	1.7% (-0.3,3.6) p = 0.10
Age (years)	65 or older	Ref.	Ref.	Ref.
	45 – 64	1.7 (1.4,2.1) p < 0.01	1.2 (0.9,1.6) p = 0.13	2.0% (-0.5,4.5) p = 0.12
	35 – 44	2.3 (1.9,2.9) p < 0.01	1.7 (1.2,2.3) p < 0.01	5.1% (2.0,8.3) p < 0.01
	25 – 34	3.5 (2.8,4.4) p < 0.01	2.7 (1.9,3.7) p < 0.01	12.0% (8.1,15.8) p < 0.01
	15 to 24	3.9 (2.8,5.3) p < 0.01	3.8 (2.4,6.0) p < 0.01	18.1% (11.1,25.1) p < 0.01
Education Level	≥ Bachelor's	Ref.	Ref.	Ref.
	College or diploma	0.8 (0.7,1.0) p = 0.03	1.0 (0.9,1.2) p = 0.77	0.3% (-1.8,2.5) p = 0.77
	≤ HS	0.8 (0.6,1.0) p = 0.01	0.9 (0.8,1.1) p = 0.43	-1.0% (-3.4,1.4) p = 0.42
Income Level	< $40,000	Ref.	Ref.	Ref.
	$40-79,999	1.1 (0.9,1.3) p = 0.33	1.3 (1.1,1.6) p < 0.01	2.9% (0.8,5.1) p < 0.01
	≥ $80,000	1.6 (1.4,1.9) p < 0.01	1.9 (1.5,2.3) p < 0.01	8.1% (5.1,11.1) p < 0.01
Main Activity	Employed	Ref.	Ref.	Ref.
	Student	1.4 (1.0,2.0) p = 0.10	0.9 (0.6,1.4) p = 0.65	-1.3% (-6.8,4.2) p = 0.65
	Caregiving or housework	0.9 (0.7,1.1) p = 0.22	1.1 (0.8,1.4) p = 0.60	1.0% (-2.7,4.6) p = 0.60
	Retired or LTI	0.4 (0.4,0.5) p < 0.01	0.8 (0.6,1.1) p = 0.14	-2.5% (-5.7,0.8) p = 0.14
	Other	0.9 (0.6,1.2) p = 0.46	0.7 (0.5,1.1) p = 1.13	-3.6% (-7.8,0.6) p = 0.09
Mental Health	Good to excellent	Ref.	Ref.	Ref.
	Poor or fair	2.6 (2.0,3.3) p < 0.01	2.7 (2.0,3.6) p < 0.01	15.4% (9.7,21.1) p < 0.01
Wave	1	Ref.	Ref.	Ref.
	2	0.7 (0.6,0.9) p < 0.01	0.8 (0.6,0.9) p < 0.01	-3.7% (-6.0,-1.4) p < 0.01
	3	0.7 (0.6,0.9) p < 0.01	0.7 (0.6,0.9) p < 0.01	-4.3% (-6.6,-1.9) p < 0.01
Province/ Territory	Ontario	Ref.	Ref.	Ref.
	Quebec	0.5 (0.4,0.7) p < 0.01	0.6 (0.5,0.8) p < 0.01	-5.5% (-7.9,-3.0) p < 0.01
	Atlantic Provinces	1.1 (0.9,1.3) p = 0.24	1.3 (1.1,1.6) p < 0.01	3.6% (1.1,6.1) p < 0.01
	Manitoba	0.9 (0.7,1.1) p = 0.23	0.9 (0.7, 1.2) p = 0.44	-1.3% (-4.3,1.8) p = 0.43
	Sask.	1.0 (0.8,1.2) p = 0.70	1.0 (0.8,1.2) p = 0.72	-0.6% (-3.6,2.4) p = 0.71
	Alberta	1.1 (0.9,1.3) p = 0.63	1.0 (0.8,1.3) p = 0.99	0.0% (-2.9,3.0) p = 0.99
	BC	0.8 (0.6,1.0) p = 0.07	0.9 (0.7,1.1) p = 0.25	-1.8% (-4.8,1.1) p = 0.23

	Territory Cap. Cit.	1.5 (1.2,1.9) p < 0.01	1.3 (1.0,1.8) p = 0.04	4.1% (0.0,8.2) p = 0.05

3.3.2 Table 4: Variables associated with intent to try or increase cannabis use post-legalization among those who used cannabis in the past 3 months ("increasers") (n = 2,428, weighted n = 4,222,346).

Variable	Levels	Unadjusted OR (95% CI) p-value	Adjusted OR (95% CI) p-value	Adjusted risk difference percent (95%CI) p-value
Gender	Female	Ref.	Ref.	Ref.
	Male	1.0 (0.8,1.4) p = 0.91	1.1 (0.8,1.5) p = 0.68	1.5% (-5.2,8.1) p = 0.67
Age (years)	65 or older	Ref.	Ref.	Ref.
	45 – 64	0.9 (0.6,1.4) p = 0.65	1.0 (0.5,1.8) p = 0.92	-0.6% (-12.8,11.6) p = 0.92
	35 – 44	1.7 (1.0,2.7) p = 0.06	1.8 (0.9,3.6) p = 0.12	12.5% (-1.5,26.6) p = 0.08
	25 – 34	1.8 (1.1,2.9) p = 0.02	1.8 (0.9,3.6) p = 0.10	13.2% (-1.1,27.4) p = 0.07
	15 to 24	3.0 (1.8,5.2) p < 0.01	2.9 (1.3,6.6) p < 0.01	24.1% (6.8,41.5) p < 0.01
Education Level	≥ Bachelor's	Ref.	Ref.	Ref.
	College or diploma	0.6 (0.4,0.8) p < 0.01	0.6 (0.4,0.8) p < 0.01	-13.3% (-5.3,-21.2) p < 0.01
	≤ HS	1.1 (0.8,1.5) p = 0.45	0.9 (0.6,1.4) p = 0.68	-2.0% (-11.5,7.5) p = 0.68
Income Level	< $40,000	Ref.	Ref.	Ref.
	$40-79,999	0.8 (0.6,1.1) p = 0.11	0.9 (0.7,1.3) p = 0.70	-1.6% (-9.4,6.3) p = 0.69
	≥ $80,000	0.6 (0.4,0.9) p < 0.01	0.7 (0.5,1.1) p = 0.15	-7.1% (-16.4,2.2) p = 0.14
Main Activity	Employed	Ref.	Ref.	Ref.
	Student	1.5 (0.9, 2.7) p = 0.14	0.9 (0.4,1.8) p = 0.76	-2.5% (-18.5,13.5) p = 0.76
	Caregiving or housework	1.1 (0.7,1.8) p = 0.74	1.0 (0.6,1.6) p = 0.86	-1.1% (-12.7,10.4) p = 0.85
	Retired or LTI	0.7 (0.5,1.0) p = 0.05	1.0 (0.5,1.8) p = 0.96	-0.4% (-14.0,13.2) p = 0.95
	Other	1.2 (0.7,2.2) p = 0.52	0.9 (0.5,1.7) p = 0.74	-2.5% (-16.2,11.2) p = 0.72
Mental Health	Good to excellent	Ref.	Ref.	Ref.
	Poor or fair	1.4 (0.9,2.1) p = 0.10	1.1 (0.7,1.8) p = 0.69	2.2% (-8.1,12.5) p = 0.68
Wave	1	Ref.	Ref.	Ref.
	2	0.9 (0.7,1.2) p = 0.51	0.8 (0.6,1.2) p = 0.30	-4.1% (-11.7,3.6) p = 0.30
	3	0.8 (0.6,1.0) p = 0.09	0.8 (0.5,1.1) p = 0.12	-6.1% (-13.4,1.2) p = 0.10
Province/ Territory	Ontario	Ref.	Ref.	Ref.
	Quebec	0.4 (0.3,0.7) p < 0.01	0.4 (0.2, 0.6) p < 0.01	-21.5% (-31.1,-11.9) p < 0.01
	Atlantic Provinces	0.9 (0.6,1.2) p = 0.29	0.9 (0.6,1.2) p = 0.48	-2.8% (-10.5,4.8) p = 0.47
	Manitoba	0.9 (0.6, 1.4) p = 0.71	1.0 (0.6,1.5) p = 0.84	-1.1% (-11.1,9.0) p = 0.84
	Sask.	0.9 (0.6,1.4) p = 0.63	0.9 (0.5,1.5) p = 0.63	-2.9% (-14.1,8.4) p = 0.62
	Alberta	0.9 (0.6, 1.3) p = 0.55	0.9 (0.6, 1.4) p = 0.68	-2.0% (-11.4,7.3) p = 0.67
	BC	0.6 (0.4,0.9) p < 0.01	0.6 (0.4,0.9) p = 0.01	-11.6% (-20.7,-2.4) p = 0.01
	Territory Cap. Cit.	0.9 (0.6, 1.3) p = 0.43	0.8 (0.5, 1.3) p = 0.44	-4.4% (-15.5,6.7) p = 0.43

3.3.3 Table 5: Results of adjusted multinomial logistic regression for combined sample, n = 17,089, weighted population size = 27,808,081. "Yes" and "Maybe" responses are in reference to the "No" category.

Variables	Level	"Maybe" RRRs (95% C.I) p -value	"Maybe" ARDs (95%CI) p-value	"Yes" RRRs (95% CI) p-value	"Yes" ARDs (95%CI) p-value
Sex	Female	Ref.	Ref.	Ref.	Ref.
	Male	1.1 (0.9,1.3) p = 0.33	0.6% (-1.0,2.1) p = 0.50	1.2 (1.0,1.5) p = 0.09	1.2% (-0.3,2.7) p = 0.11
Age	65 or older	Ref.	Ref.	Ref.	Ref.
	45-64 years	1.0 (0.8,1.4) p = 0.79	0.0% (-2.3,2.4) p = 0.98	1.8 (1.2,2.7) p < 0.01	2.3% (0.9,3.8) p < 0.01
	35-44 years	1.4 (1.0,2.0) p = 0.06	2.2% (-0.7,5.1) p = 0.13	2.7 (1.7,4.3) p < 0.01	4.5% (2.5,6.5) p < 0.01
	25-34 years	1.7 (1.2,2.4) p < 0.01	3.2% (0.2,6.3) p = 0.04	5.00 (3.1,7.9) p < 0.01	9.3% (6.7,12.00) p < 0.01
	15-24 years	2.1 (1.4,3.3) p < 0.01	4.5% (0.1,8.9) p = 0.04	8.8 (5.1, 15.4) p < 0.01	15.8% (10.7,20.9) p < 0.01
Cannabis use in the past 3 months	No	Ref.	Ref.	Ref.	Ref.
	Yes	2.5 (2.1,3.1) p < 0.01	7.6% (5.00,10.2) p < 0.01	4.3 (3.5,5.4) p < 0.01	12.4% (9.8,15.0) p < 0.01
Education level	Bachelor's or higher	Ref.	Ref.	Ref.	Ref.
	College or diploma	0.9 (0.7,1.1) p = 0.15	-1.2% (-3.0,0.6) p = 0.19	0.9 (0.7,1.1) p = 0.37	-0.6% (-2.2,1.1) p = 0.49
	Less than HS or HS only	0.9 (0.7,1.2) p = 0.49	-0.7% (-2.8,1.5) p = 0.54	0.9 (0.7, 1.2) p = 0.54	-0.5% (-2.3,1.3) p = 0.61
Income	<40k	Ref.	Ref.	Ref.	Ref.
	40-80k	1.1 (0.9,1.4) p = 0.22	0.8% (-1.0,2.6) p = 0.38	1.3 (1.0,1.7) p = 0.03	1.7% (0.1,3.3) p = 0.04
	>80k	1.4 (1.1,1.8) p < 0.01	2.6% (0.3,5.00) p = 0.03	1.7 (1.3,2.3) p < 0.01	3.6% (1.3,5.9) p < 0.01
Main activity	Employed	Ref.	Ref.	Ref.	Ref.
	Student	1.1 (0.7,1.7) p = 0.66	1.5% (-3.1,6.1) p = 0.53	0.7 (0.4,1.2) p = 0.17	-2.5% (-5.5,0.5) p = 0.10
	Caregiving or housework	1.1 (0.8,1.5) p = 0.52	1.0% (-1.8,3.9) p = 0.48	0.9 (0.6,1.4) p = 0.75	-0.6% (-3.3,2.1) p = 0.67
	Retired or LTI	0.7 (0.5,1.0) p = 0.02	-3.0% (-5.3,-0.8) p < 0.01	1.1 (0.8,1.7) p = 0.36	1.5% (-1.8, 4.8) p = 0.38
	Other	0.8 (0.5,1.3) p = 0.35	-1.6% (-5.2,2.0) p = 0.39	0.8 (0.5,1.3) p = 0.36	-1.2% (-4.2,1.8) p = 0.42
Mental health	Good to excellent	Ref.	Ref.	Ref.	Ref.
	Fair or poor	2.1 (1.5,2.8) p < 0.01	6.9% (2.7,11.1) p < 0.01	2.0 (1.4,2.9) p < 0.01	4.5% (1.1,8.0) p < 0.01
Wave	1	Ref.	Ref Ref.	Ref.	Ref.
	2	0.7 (0.5,0.8) p < 0.01	-3.9% (-5.7,-2.0) p < 0.01	0.9 (0.7,1.2) p = 0.55	0.1% (-1.7,1.8) p = 0.95

	3	0.7 (0.6,0.9) $p < 0.01$	-2.9% (-4.8,-1.0) $p < 0.01$	0.7 (0.6,0.9) $p = 0.01$	-1.8% (-3.5,-0.1) $p = 0.04$
Province/ Territory	Ontario	Ref.	Ref.	Ref.	Ref.
	Quebec	0.6 (0.5, 0.8) $p < 0.01$	-2.9% (-5.0,-0.8) $p < 0.01$	0.4 (0.3,0.6) $p < 0.01$	-4.8% (-6.6,-2.9) $p < 0.01$
	Atlantic Provinces	1.2 (1.0,1.5) $p = 0.04$	2.0% (0.0,4.0) $p = 0.05$	1.1 (0.9, 1.4) $p = 0.48$	0.4% (-1.5,2.2) $p = 0.71$
	Manitoba	0.9 (0.7,1.2) $p = 0.46$	-0.9% (-3.4,1.7) $p = 0.51$	0.9 (0.7, 1.3) $p = 0.65$	-0.4% (-2.9,2.0) $p = 0.73$
	Sask.	1.0 (0.7,1.2) $p = 0.88$	-0.2% (-2.7,2.3) $p = 0.85$	0.9 (0.7,1.2) $p = 0.41$	-0.9% (-3.2,1.4) $p = 0.43$
	Alberta	1.0 (0.8,1.3) $p = 0.88$	-0.1% (-2.5,2.2) $p = 0.91$	1.0 (0.7, 1.3) $p = 0.79$	-0.3% (-2.5,1.9) $p = 0.81$
	BC	0.8 (0.7,1.1) $p = 0.13$	-1.4% (-3.6,0.9) $p = 0.23$	0.7 (0.5,1.0) $p = 0.05$	-2.1% (-4.3,0.2) $p = 0.07$
	Territory Cap. Cit.	1.5 (1.1,2.0) $p < 0.01$	4.7% (1.2,8.2) $p < 0.01$	0.9 (0.6, 1.2) $p = 0.42$	-1.7% (-4.2,0.7) $p = 0.17$

3.3.4 Table 6: Results of adjusted multinomial logistic regression for those who had not used cannabis in the past 3 months, n = 14,661, weighted population size = 23,585,735. "Yes" and "Maybe" responses are in reference to the "No" category.

Variables	Level	"Maybe" RRRs (95% CI) p -value	"Maybe" ARDs (95%CI) p-value	"Yes" RRRs (95% CI) p-value	"Yes" ARDs (95%CI) p-value
Sex	Female	Ref.	Ref.	Ref.	Ref.
	Male	1.0 (0.8,1.3) p = 0.81	0.0% (-1.6,1.6) p = 0.99	1.4 (1.1,1.8) p = 0.01	1.7% (0.3,3.0) p = 0.01
Age	65 or older	Ref.	Ref.	Ref.	Ref.
	45-64 years	1.0 (0.7,1.4) p = 0.91	-0.0% (-2.3,2.2) p = 0.98	1.9 (1.2,3.1) p < 0.08	1.8% (0.6,3.0) p < 0.01
	35-44 years	1.3 (0.9,2.0) p = 0.12	2.0% (-0.9,4.8) p = 0.18	2.6 (1.6,4.5) p < 0.01	3.0% (1.4,4.7) p < 0.01
	25-34 years	1.7 (1.3,2.5) p < 0.01	3.3% (0.2,6.4) p = 0.04	6.2 (3.7,10.6) p < 0.01	8.8% (6.1,11.5) p < 0.01
	15-24 years	2.0 (1.2,3.4) p < 0.01	4.1% (-0.5,8.8) p = 0.08	11.0 (5.6,21.7) p < 0.01	14.9% (8.5,21.4) p < 0.01
Education level	Bachelor's or higher	Ref.	Ref.	Ref.	Ref.
	College or diploma	1.1 (0.9,1.3) p = 0.48	0.7% (-1.1,2.4) p = 0.45	1.0 (0.7,1.2) p = 0.71	-0.3% (-1.8,1.1) p = 0.64
	Less than HS or HS only	1.0 (0.8,1.3) p = 0.94	0.1% (-1.9,2.0) p = 0.96	0.8 (0.6,1.1) p = 0.22	-1.0% (-2.6,0.6) p = 0.21
Income	<40k	Ref.	Ref.	Ref.	Ref.
	40-80k	1.2 (1.0,1.6) p = 0.08	1.5% (-0.3,3.3) p = 0.11	1.4 (1.1,1.9) p = 0.02	1.5% (0.1,2.9) p = 0.03
	>80k	1.7 (1.3,2.2) p < 0.01	3.8% (1.4,6.2) p < 0.01	2.3 (1.6,3.2) p < 0.01	4.4% (2.2,6.6) p < 0.01
Main activity	Employed	Ref.	Ref.	Ref.	Ref.
	Student	1.3 (0.7,2.1) p = 0.41	2.4% (-2.9,7.6) p = 0.37	0.6 (0.3,1.3) p = 0.16	-2.5% (-5.4,0.3) p = 0.08
	Caregiving or housework	1.2 (0.9,1.6) p = 0.36	1.4% (-1.5,4.2) p = 0.36	0.9 (0.6,1.6) p = 0.82	-0.4% (-3.1,2.2) p = 0.75
	Retired or LTI	0.7 (0.5,0.9) p = 0.01	-3.0% (-5.2,-0.9) p < 0.01	1.2 (0.7,1.9) p = 0.50	1.3% (-1.8,4.3) p = 0.41
	Other	0.8 (0.5,1.3) p = 0.36	-1.5% (-4.9,1.9) p = 0.40	0.6 (0.3,1.2) p = 0.15	-2.1% (-4.6,0.5) p = 0.11
Mental health	Good to excellent	Ref.	Ref.	Ref.	Ref.
	Fair or poor	2.8 (1.9,3.9) p < 0.01	10.1% (5.0,15.1) p < 0.01	2.6 (1.6,4.0) p < 0.01	5.3% (1.5,9.1) p < 0.01
Wave	1	Ref.	Ref.	Ref.	Ref.
	2	0.7 (0.5,0.8) p < 0.01	-3.4% (-5.3,-1.5) p < 0.01	0.9 (0.7,1.2) p = 0.53	-0.2% (-1.8,1.4) p = 0.81
	3	0.7 (0.6,0.9) p < 0.01	-3.0% (-5.0,-1.1) p < 0.01	0.8 (0.6,1.0) p = 0.07	-1.2% (-2.8,0.4) p = 0.13
Province/Territory	Ontario	Ref.	Ref.	Ref.	Ref.
	Quebec	0.7 (0.6,1.0) p = 0.04	-1.9% (-4.0,0.2) p = 0.08	0.4 (0.3,0.6) p < 0.01	-3.6% (-5.2,-2.1) p < 0.01

	Atlantic Provinces	1.3 (1.0,1.6) p = 0.03	2.0% (0.0,4.1) p = 0.05	1.3 (1.0,1.8) p = 0.07	1.6% (-0.2,3.4) p = 0.09
	Manitoba	0.8 (0.6,1.1) p = 0.16	-1.8% (-4.1,0.5) p = 0.13	1.1 (0.7,1.6) p = 0.75	0.5% (-1.7,2.8) p = 0.64
	Sask.	1.0 (0.7,1.3) p = 0.92	-0.1% (-2.5,2.4) p = 0.96	0.9 (0.6,1.3) p = 0.64	-0.5% (-2.5,1.5) p = 0.63
	Alberta	1.0 (0.8,1.3) p = 1.00	0.0% (-2.4,2.4) p = 1.00	1.0 (0.7,1.4) p = 0.99	0.0% (-2.0,2.0) p = 0.99
	BC	0.9 (0.6,1.1) p = 0.28	-1.2% (-3.4,1.0) p = 0.30	0.9 (0.6,1.3) p = 0.52	-0.6% (-2.8,1.5) p = 0.57
	Territory Cap. Cit.	1.7 (1.2,2.3) p < 0.01	5.3% (1.5,9.1) p < 0.01	1.0 (0.6,1.4) p = 0.79	-0.8% (-3.1,1.5) p = 0.51

3.3.5 Table 7: Results of adjusted multinomial logistic regression for those who had used cannabis in the past 3 months, n = 2,428, weighted population size: 4,222,346. "Yes" and "Maybe" responses are in reference to the "No" category.

Variables	Level	"Maybe" RRRs (95%CI) p -value	"Maybe" ARDs (95%CI) p-value	"Yes" RRRs (95% CI) p-value	"Yes" ARDs (95%CI) p-value
Sex	Female	Ref.	Ref.	Ref.	Ref.
	Male	1.3 (0.9,1.9) p = 0.17	4.3% (-1.0,9.6) p = 0.11	0.9 (0.6,1.3) p = 0.63	-2.9% (-9.1,3.3) p = 0.36
Age	65 or older	Ref.	Ref.	Ref.	Ref.
	45-64 years	0.9 (0.4,1.9) p = 0.81	-1.4% (-11.3,8.6) p = 0.79	1.1 (0.4,2.5) p = 0.91	0.8% (-8.6,10.2) p = 0.87
	35-44 years	1.4 (0.6,3.1) p = 0.40	2.2% (-8.7,13.1) p = 0.69	2.2 (0.8,5.9) p = 0.12	10.4% (-1.1,21.9) p = 0.08
	25-34 years	1.4 (0.6,3.0) p = 0.42	1.5% (-9.1,12.1) p = 0.78	2.4 (0.9,6.2) p = 0.08	11.7% (0.3,23.1) p = 0.05
	15-24 years	1.8 (0.7,4.7) p = 0.23	2.0% (-10.8,14.8) p = 0.76	4.3 (1.5,12.5) p < 0.01	22.2% (7.9,36.5) p < 0.01
Education level	Bachelor's or higher	Ref.	Ref.	Ref.	Ref.
	College or diploma	0.4 (0.3,0.6) p < 0.01	-12.4% (-18.8,-6.0) p < 0.01	0.7 (0.5,1.2) p = 0.19	-0.8% (-7.8,6.1) p = 0.81
	Less than HS or HS only	0.7 (0.4,1.2) p = 0.22	-5.9% (-14.1,2.2) p = 0.15	1.1 (0.7,1.8) p = 0.65	3.8% (-4.1,11.8) p = 0.34
Income	<40k	Ref.	Ref.	Ref.	Ref.
	40-80k	0.8 (0.5,1.2) p = 0.26	-4.1% (-10.1,1.9) p = 0.18	1.1 (0.7,1.7) p = 0.75	2.6% (-4.8,9.9) p = 0.50
	>80k	0.7 (0.4,1.2) p = 0.18	-4.0% (-11.1,3.1) p = 0.27	0.7 (0.4,1.3) p = 0.27	-3.5% (-12.0,5.0) p = 0.42
Main activity	Employed	Ref.	Ref.	Ref.	Ref.
	Student	1.0 (0.4,2.6) p = 0.98	0.7% (-12.4,13.7) p = 0.92	0.8 (0.4,1.9) p = 0.66	-2.9% (-14.6,8.7) p = 0.62
	Caregiving or housework	1.0 (0.5,2.0) p = 0.99	0.6% (-8.9,10.1) p = 0.90	0.9 (0.5,1.8) p = 0.76	-1.8% (-12.3,8.7) p = 0.74
	Retired or LTI	0.8 (0.4,1.7) p = 0.62	-3.1% (-11.6,5.5) p = 0.48	1.1 (0.5,2.5) p = 0.77	3.0% (-10.5,16.5) p = 0.66
	Other	0.7 (0.3,2.0) p = 0.56	-4.2% (-15.1,6.7) p = 0.45	1.0 (0.5,2.2) p = 0.94	1.9% (-10.2,14.0) p = 0.76
Mental health	Good to excellent	Ref.	Ref.	Ref.	Ref.
	Fair or poor	1.0 (0.5,1.9) p = 0.99	-0.9% (-9.1,7.4) p = 0.84	1.2 (0.7,2.1) p = 0.60	2.9% (-7.1,12.8) p = 0.57
Wave	1	Ref.	Ref.	Ref.	Ref.
	2	0.7 (0.4,1.0) p = 0.06	-6.3% (-12.4,-0.1) p = 0.05	1.0 (0.7,1.5) p = 1.00	2.2% (-4.9,9.3) p = 0.54
	3	0.8 (0.5,1.2) p = 0.27	-2.2% (-8.3,3.9) p = 0.48	0.7 (0.5,1.1) p = 0.17	-3.9% (-10.6,2.7) p = 0.25
Province/Territory	Ontario	Ref.	Ref.	Ref.	Ref.
	Quebec	0.3 (0.2,0.6) p < 0.01	-11.2% (-18.0,-4.4) p < 0.01	0.4 (0.2,0.8) p < 0.01	-10.2% (-18.9,-1.5)

					p = 0.02
	Atlantic Provinces	1.0 (0.7,1.5) p = 0.97	1.5% (-4.8,7.7) p = 0.64	0.8 (0.5,1.2) p = 0.27	-4.3% (-11.4,2.7) p = 0.23
	Manitoba	1.2 (0.6,2.1) p = 0.64	3.5% (-6.0,13.1) p = 0.47	0.8 (0.5,1.5) p = 0.50	-4.5% (-14.5,5.5) p = 0.38
	Sask.	0.9 (0.4,1.8) p = 0.75	-1.2% (-11.3,9.0) p = 0.82	0.9 (0.5,1.5) p = 0.65	-1.8% (-12.1,8.5) p = 0.74
	Alberta	1.0 (0.6,1.6) p = 0.87	-0.1% (-7.9,7.8) p = 0.99	0.9 (0.6,1.5) p = 0.64	-1.9% (-10.5,6.6) p = 0.66
	BC	0.7 (0.4,1.1) p = 0.15	-2.4% (-9.7,4.8) p = 0.51	0.5 (0.3,0.9) p = 0.02	-9.1% (-17.7,-0.6) p = 0.04
	Territory Cap. Cit.	1.07 (0.58,1.95) p = 0.837	3.2% (-6.5,12.8) p = 0.52	0.7 (0.4,1.3) p = 0.22	-6.9% (-16.3,2.4) p = 0.15

(49)

3.3.6 Table 8: A summary of the associations with ARDs (if either the RRR or ARD was at p = 0.05 level) from the multinomial logistic regression analysis listed in order of magnitude for being likely to intend on trying or increasing cannabis use stratified by whether they had used cannabis in the past 3 months.

	Factors associated with "Maybe"	Factors associated with "Yes"
"Triers" - those who had not used cannabis in the past 3 months and were intending to try it.	- Fair or poor mental health (+10.1%) - Territory capital city resident (+5.3%) - Age 15-24 yr (+4.1%) - Income > $80,000 (+3.8%) - Age 25-34 yr (+3.3%) - Atlantic provinces resident (+2.0%) - Wave 2 respondent (-3.4%) - Wave 3 respondent (-3.0%) - Retired or LTI (-3.0%) - Quebec resident (-1.9%)	- Age 15-24 yr (+14.9%) - Age 25-34 yr (+8.8%) - Fair or poor mental health (+5.3%) - Income > $80,000 (4.4%) - Age 35-44 yr (+3.0%) - Age 45-64 yr (+1.8%) - Males (+1.7%) - Income $40,000-80,000 (+1.5%) - Quebec resident (-3.6%)
"Increasers" - those who had used cannabis in the past 3 months and were intending to increase use.	- College or diploma education (-12.4%) - Quebec resident (-11.2%) - Wave 2 respondent (-6.3%)	- Age 15-24 yr (+22.2%) - Age 25-34 yr (+11.7%) - Quebec resident (-10.2%) - BC resident (-9.1%)

Note: these categories should be compared to the referent categories based on Tables 6 and 7 where the 95%CIs for the ARDs are also reported.

Chapter 4: Conclusion

4.1 Summary of Findings

The NCS data collected prior to legalization suggests that about 18.5% of Canadians intend on trying or increasing cannabis use following legalization for recreational purposes, with most being "triers", or those who have not used cannabis in the past 3 months. Overall intent to try or increase use was significantly associated with younger age, use of cannabis in last three months, higher income, and poorer mental health. The additional analyses showed that these associations are primarily driven by the "trier" population. We also found that almost 1 in 4 Canadians are likely to try consuming different types of cannabis products, which will become legally available in October 2019[1], and nearly 1 in 6 respondents intended to obtain cannabis from alternate sources after legalization. In all the subgroup analyses, being a resident of Quebec was associated with decreased intention to try or increase use compared to Ontario and other provinces, suggesting some inter-province variability in attitudes and behaviours.

4.2 Public Health and Policy Implications

There are concerns that an increase in use of cannabis following legalization will increase harms among the Canadian population, and thus could be seen as a failure of this policy.[2]

This thesis work suggests that a considerable proportion of Canadians intend to increase their cannabis use following legalization. A large portion of those could be those looking to try cannabis who are younger, have higher income, and poorer mental health. Youth with mental health issues seem to be at a higher risk for harm from cannabis use which has led to the Canadian Psychiatric Association proposing that access to cannabis should be restricted to those under the age of 21 years and limited for those between 21–25 years of age.[3] As fair or poor mental health was associated with an increased intent to try cannabis, it is possible that individuals are interested in exploring the therapeutic potential of cannabis. Medical professionals and public health officials should be prepared to discuss what evidence there is regarding cannabis and mental health with the population.

As the multinomial logistic regression showed, wave 2 and wave 3 respondents were less likely to report "maybe" trying or increasing their cannabis use compared to wave 1 respondents which may point to changing attitudes and behaviours over time. Intentions may have been stronger earlier in the policy development phase and it may be that as the actual policy change neared, those who were considering ("maybe") trying or increasing their use decided to change their mind.

The extent to which intentions translate into behaviour can vary. A 1999 study used the theory of planned behaviour to examine intentions and actual cannabis use among 249 undergraduate students over a 3–month period and found a correlation of 0.84 between intention and behaviour.[4] A more recent US study of 370 university students found a cannabis use intention-behaviour correlation ranging from 0.70–0.77 after two years.[5] Ritter (1998) studied 1,941 men (20–30 years of age) over a 10-year period and found a correlation of 0.45.[6] A European study of 3447 adolescents (age 15–18 years) reported a similar correlation ranging from 0.39–0.65 based on country.[7] This difference between intentions and action is referred to as the "intention-behaviour gap" and can be effected by attitudes towards cannabis use and subjective norms (perceived social pressure).[4,8]

Initial evidence from the NCS post-legalization data suggests that rates of cannabis use in past 3 months are the same as pre-legalization, indicating no significant change in cannabis use.[9] Although around 15% reported using in the past three months, 19% indicated they will use cannabis in the next three months.[9] It is possible that intentions might overestimate expected change in behavior, or that it may take more time for intentions to translate into action. Regardless, public health officials, practitioners, and clinicians should work with policymakers to ensure responsible use of cannabis by the

Canadian population as well as targeted education campaigns to prevent harmful use, particularly among higher risk populations (e.g. youth). This is particularly important as the policy continues to evolve and the growth of the market and increased availability of cannabis products occurs.[1]

4.3 Areas for Further Research

Rates of cannabis use following legalization should be compared to rates prior to legalization using the NCS's post-legalization data to determine whether intent translated to behaviour at the population-level. Combined with other national-level surveys such as the CCHS[10] and CTADS[11], we will be able to ascertain whether rates of cannabis use have actually changed following legalization. Evaluation of multiple surveys and methods of measurement may make future research more reliable. This work may also highlight certain populations (e.g. those that are younger and those with poorer mental health) that are worth monitoring closely as cannabis become legalized for recreational purposes. Other jurisdictions looking to conduct pre-legalization surveys could further separate the populations which intend to be new users of cannabis versus existing users intending to increase their frequency of use, as well as collect information on whether individuals are intending to use cannabis for medical or therapeutic purposes.

4.4 Final Remarks

This thesis work used existing data from the NCS from Statistics Canada which was released in 2018. Combined with a recent and major policy change, this topic was both timely and highly relevant to public health as there is a potential for public health harm. These findings will inform us about the sub-populations who are intending to try or increase their cannabis use following legalization and suggests areas for further research and monitoring. Although it is uncertain whether intentions are indicative of future behavior concerning cannabis use, those who are younger and have poorer mental health have emerged as populations to carefully monitor and further study as Canada's moves into an era of legalization.

4.5 References

1.   Hansen L. Cannabis edibles, drinks will mark "2nd wave" of legalization | CBC News.https://www.cbc.ca/news/canada/ottawa/cannabis-legalization-second-wave-edibles-1.4901297. Published November 12, 2018.

2.   Kelsall D. Watching Canada's experiment with legal cannabis. *CMAJ*. 2018;190(41):E1218. doi:10.1503/cmaj.181287

3.   Tibbo P, Cracker CE, Lam RW, Meyer J, Sareen J, Aitchison KJ. Implications of Cannabis Legalization on Youth and Young Adults. *Can J Psychiatry*. 2018;63(1):65-71. doi:10.1177/0706743718759031

4.   Conner M, McMillan B. Interaction effects in the theory of planned behaviour: Studying cannabis use. *Br J Soc Psychol*. 1999;38(2):195-222. doi:10.1348/014466699164121

5.   Ito TA, Henry EA, Cordova KA, Bryan AD. Testing an expanded theory of planned behavior model to explain marijuana use among emerging adults in a promarijuana community. *Psychol Addict Behav*. 2015;29(3):576-589. doi:10.1037/adb0000098

6.   Ritter C. Resources, Behavior Intentions, and Drug Use: A Ten-Year National Panel Analysis. *Soc Psychol Q*. 1988;51(3):250. doi:10.2307/2786923

7.   Morell-Gomis R, Moriano JA, Laguía A, Dias P, Lloret D. Adolescents cannabis use intention: Validating a theory of planned behavior questionnaire in four European countries. *J Subst Use*. 2019;24(1):66-72. doi:10.1080/14659891.2018.1510050

8. Sniehotta FF, Scholz U, Schwarzer R. Bridging the intention-behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychol Heal*. 2005;20(2):143-160. doi:10.1080/08870440512331317670

9. Statistics Canada. National Cannabis Survey, fourth quarter 2018. https://www150.statcan.gc.ca/n1/daily-quotidien/190207/dq190207b-eng.htm?HPA=1. Published 2019. Accessed February 21, 2019.

10. Statistics Canada. Canadian Community Health Survey - Annual Component (CCHS). http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226. Accessed January 23, 2018.

11. Statistics Canada. Canadian Tobacco, Alcohol and Drugs Survey (CTADS). 2016. http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=4440. Accessed January 24, 2018.