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Cannabis and Mental Health:
an Environmental Scan and Scoping Review

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Executive Summary

The association between cannabis use and mental health is a topic of increasing importance in Canada with the recent legalization of non-medical cannabis. Although there is an abundant amount of research examining cannabis use and mental health, the strength and direction of this relationship is still unclear. In order to move research forward in a meaningful direction, there is a need to understand the state and scope of the current literature, as well as appreciate the data assets currently available that allow for the assessment of the current cannabis and mental health landscape.

The purpose of this report is to identify and document the current knowledge base of cannabis and mental health to support the development of research and policy in Canada. The current state of cannabis use and mental health in Canada will be explored using readily available data assets, as well as the trends of countries and states that have pre- and post-legalization data. A comprehensive scoping review of the primary literature will identify populations and outcomes that have been heavily researched, as well as those where research may be scarce. Together, this report will serve as a guide for the direction of future research in the area of cannabis use and mental health.

After providing background on the current Canadian context of legalization, there are three research chapters that highlight different resources with a wealth of knowledge that can be used to guide future research: 1) data assets in Canada; 2) data assets of other legalized jurisdictions; and 3) a scoping review of the literature.

Data Assets in Canada: Statistics Canada has identified several surveys that can be used to explore the association between cannabis use and mental health. Two data sets were analyzed (The Canadian Tobacco, Alcohol, and Drugs Survey, and The Canadian Community Health Survey-Mental Health) to provide the overview of trends in cannabis use in Canada, to depict prevalence of mental disorders by cannabis use, and to determine the prevalence of cannabis use disorder within population subgroups. Overall, the prevalence of past year cannabis use from 2013 to 2017 increased for both males and females, with poor self-reported mental health tending to be more negative in cannabis users than non-users. The Canadian Community Health Survey- Mental Health was last conducted in 2012, and its data indicate that cannabis users have a higher prevalence of several mental health disorders; however, it is important to note that this is cross-sectional data, and no causal association between cannabis use and mental health disorder outcome can be made.

Data Assets in other jurisdictions: Aside from Canada, 12 jurisdictions have legalized non-medical cannabis worldwide (Uruguay, Alaska, California, Colorado, Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, Washington State, and Washington DC). In the United States, the National Survey on Drug Use and Health was used in order to analyze trends of use pre- and post-legalization. Overall, the pattern of cannabis use appears to remain consistent pre- and post-legalization, with the exception of Oregon. The trends of cannabis use were also analyzed based on sex, age, and age at first use. Given the recent timing of legalization in most jurisdictions, longitudinal associations between cannabis use and mental health could not be explored.

Scoping review: A comprehensive scoping review was conducted in order to capture all literature examining the relationship between cannabis use and mental health. There were a total of 1047 published papers that were included. These studies were then categorized based on the area of research, and data were extracted to better understand the populations and outcomes that have been more or less frequently studied. The literature spans decades, however the quality of research is highly variable. A large number of studies reported cross-sectional data, precluding the identification of causal relationships. Canadian studies, qualitative studies and those that consider a sex and/or gender lens were also analyzed separately to better understand the breadth of the literature.

Moving Forward

All methodologies should be strengthened and supported within the Canadian research context. High-quality, fit-for-purpose studies are required to advance our understanding of the relationship between cannabis use and mental health. One key focus should be on understanding the directionality and causal nature of the relationship. The already established data assets in Canada and internationally provide a valuable platform for rapid analysis. Continued investment and development is required including continued production of robust datasets for research.

An increased focus on understanding the context of cannabis use is required. The general harm lens through which the current body of literature has been developed is not nuanced enough to disentangle the complex context within which cannabis use may occur (e.g. within the context of other substance use, exposure to traumatic events, multiple negative social determinants of health). Importantly, the relationship between cannabis use and mental health outcomes must be placed, and interpreted, within this context.

Understanding of the unique needs and possibly differential relationships between cannabis and mental health of various populations should be a focus, specifically: seniors, 2SLBGTQ, IRER and those who are indigenous. Embedding the lived experiences of people who are using cannabis will enrich all this work.

Lastly, given the context of legalization, Canada has an opportunity to lead the research agenda across all methodologies. Promotion of growth through funding and increased partnership will amplify the research.

1. Introduction

In Canada, medical cannabis has been legal since 2001, and as of October 17, 2018, non-medical cannabis was legalized. To navigate this new cannabis landscape, research is required to better understand the potential impacts of legalization, as well as to inform new policy and research directions. In particular, the relationship between cannabis and mental health is an area of interest for policy-makers, clinicians and the public.

The relationships between cannabis use, and mental health is a topic that has been widely reported on with research literature spanning decades. However, the relationships, strength, and direction between cannabis use and mental health, positive and negative, is still unclear. In addition, there exist multiple data assets that could be analyzed to understand the relationship between mental health and cannabis use.

The purpose of this report will be to identify and document the current knowledge of cannabis and mental health to support the development of research and policy. We provide a high-level overview of the models of legalization that have emerged within each province. Subsequently, the report identifies data assets that are available in Canada that document cannabis use, and mental health outcomes at the national level. Additionally, two examples of how these data assets could be used to assess trends of use in Canada and mental health are provided. The demonstration of possible research questions that these existing public data may answer highlights the opportunity to assess trends and generate relevant Canadian information.

In the fourth chapter, databases are identified that are available for those countries and/or states that have legalized non-medical cannabis (Alaska, California, Colorado, Maine, Massachusetts, Nevada, Oregon, Vermont, Washington and Uruguay), and have public data available to assess cannabis use trends, and outcome comparisons pre- and post-legalization. We demonstrate the strength of these databases with simple analyses of cannabis use over time. Similarly, these demonstrations highlight the opportunities for the identification of outcomes or trends that Canada may wish to monitor moving forward post-legalization.

The final chapter presents a comprehensive scoping review of the literature. This chapter maps out the literature assessing cannabis use and mental health encompassing a broad range of scientific inquiry including preclinical neuroscience, systems and population health outcomes in mental health and cannabis use. The aim of this chapter is to highlight populations and/or outcomes that are well researched, and, importantly, gaps in our knowledge. We highlight specifically the Canadian research, research adopting a sex or gender lens, qualitative research, and research with Indigenous peoples. This report, in its totality, serves as a foundational report to guide research in the area of cannabis use and mental health moving forward.

2. Non-Medical Cannabis Legislations in Canada

Key points in this chapter:

- Non-medical cannabis became legal in Canada on October 17th, 2018
- Significant variation in legislation exists across the provinces and territories including the minimum age for consumption, maximum amount allowed for possession and taxation

Non-medical cannabis became legal in Canada on October 17th, 2018 with the Cannabis Act[1]. The Act sets regulations at the federal level, and stipulates responsibilities to oversee the regulations to provinces and territories. An overview of federal and provincial legislations is presented in Table 2.1.

Federally, the minimum age of consumption is set at 18 years of age or older. However, some provinces and territories have increased the minimum age of consumption to align the minimum age with that of alcohol[1]; 18 years of age in Alberta and Quebec and 19 years of age in all other provinces[2].

The maximum amount of non-medical cannabis allowed for public possession at the federal level is 30 grams of dried cannabis, or equivalent in non-dried form. The equivalents to one gram of dried-cannabis are: 5 grams of fresh cannabis; 15 grams of edible product, 70 grams of liquid product; 0.25 grams of concentrates; one cannabis plant seed. The provinces and territories have the authority to lower the maximum possession. However, the provinces and territories adopted the maximum allowed of 30 grams in public places.

The cultivation of up to four cannabis plants per residence for personal use is allowed under the federal legislation. However, some provinces and territories have prohibited growing cannabis at home (Manitoba, Quebec, and Nunavut)[1].

The cultivation, production, manufacturing, industry-wide rules and standards for non-medical cannabis are overseen by the federal government[3]. At the provincial/ territorial level, additional regulations may exist and municipal governments may not allow the commercial cultivation of non-medical cannabis. The provinces and territories oversee the licensing, distribution and retail with different models of private and public regulation and distribution in place[1]. Again, municipal governments may have additional regulations.

Regarding taxation of non-medical cannabis, federal flat-rates and additional flat-rate cannabis duties are imposed on the input included in the cannabis product (i.e. flower, trim, seed, and seedling). With the exception of Manitoba, all provinces and territories apply additional cannabis duties [4]. Alberta, Nunavut, Ontario and Saskatchewan apply an additional sale tax adjustment rates which apply to the additional cannabis rates[5]. The Federal and additional cannabis duties are determined by the maximum value between the corresponding flat-rate and ad valorem rates. Consumers have to pay the respective applicable province/ territory GST/ HST/ PST where the product was purchased[4] .

Driving under the influence (DUI) of cannabis is prohibited and it is considered a ticketable offense[6]. At the Federal level, there are two different penalties depending of the level of

tetrahydrocannabinol (THC) (i.e. primary psychoactive component of cannabis) found in the blood: between 2 nanograms and 5 nanograms of THC per millilitre of blood is a less serious offence whereas 5 nanograms or more of THC per millilitre of blood is a more serious offense. A blood test/ oral fluid sample can be demanded[6]. Also, a Standard Field Sobriety Test or a Drug Recognition Expert Evaluation (DRE) can be performed to screen for intoxication[6]. DUI is prohibited at the provincial and territorial level. Most of the provinces and the three territories follow the Federal regulations regarding screening for DIU, the THC levels, and the penalty amounts. However, some provinces have adopted a zero tolerance policy for drugs in the blood while driving.

Table 2.1. Overview of federal, provincial and territorial legislation

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
Canada[1,6]	18+ Varies by province	Up to 30 g of dried cannabis or equivalent in non-dried form	Regulations can vary by province/ territory and by municipality	Licensing overseen by Canada Revenue Agency (CRA), and Health Canada in provinces and territories	Overseen by provinces and territories	Flat-rate & additional flat-rate cannabis duties imposed on the input included in the cannabis product. Ad valorem & additional ad valorem duties applied at the time of delivery to a purchaser. Some provinces have additional sale tax adjustment rates. ***Federal cannabis duty & additional cannabis duty set as maximum between flat-rate and ad valorem rates.*** Manitoba does not have additional cannabis duty. Additional applicable Sales tax rates at retail purchase
British Columbia[2,4,5,7,8,]	19 +	Up to 30 g in a public place. Up to 1,000 g of dried non-medical cannabis or its equivalent in a non-public place	In places where tobacco smoking / vaping not allowed; in any motor vehicle except parked RVs; or moored or anchored boats used as temporary or permanent residence	Yes	Overseen by B.C.'s Liquor Distribution Branch. Public retail stores and online sales operated by B.C.'s Liquor Distribution Branch	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad valorem rate***: 7.5% ***GST+PST***: 12%
Alberta [2,4,5,9,10]	18+	Up to 30 g of dried cannabis or equivalent in non-dried form	In places where tobacco is restricted; in any motor vehicle except parked RVs; in areas frequented by children. Local governments may apply additional restrictions	Yes. In addition, local governments adjust the land use bylaws.	Overseen by the Alberta Gaming, Liquor and Cannabis. Private licensed stores/ government online store	***Federal flat rate***: Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. Plus additional 16.8% of base amount ***Federal ad valorem rate:*** 2.5%

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
						Additional ad valorem rate + Sales tax adjustment: 24.3% ***GST:*** 5%
Saskatchewan[2,4,5,11,]	19 +	Up to 30 g	In public places; in schools; school grounds or childcare facilities.	Yes. Follows land use and/ or zoning for business location	Overseen by the Saskatchewan Liquor and Gaming Authority (SLGA) Private Licensed stores and online sales	***Federal flat rate***: Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. Plus additional 6.45% of base amount ***Federal ad valorem rate:*** 2.5% ***Additional ad valorem rate + Sales tax adjustment***: 13.95% ***GST+PST:*** 11%
Manitoba[4,5,12,13,]	19 +	Up to 30 g	In public places (Outdoor or enclosed); in motor vehicles.	Yes. Limited to specific agricultural, commercial or industrial zones	Overseen by the Liquor Gaming and Cannabis Authority (LGCA). Private Licensed stores and online sales	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Federal ad valorem rate***: 2.5% ***GST+PST:*** 13%
Ontario[4,5,14]	19 +	Up to 30 g or dried cannabis or equivalent	In indoor common areas; schools and places where children gather; hospitals, hospices, care homes; vehicles and boats; publicly owned spaces; other outdoor areas	Yes	Overseen by the Alcohol and Gaming Commission of Ontario (AGCO). Government operated online stores. Licensing for retail authorized stores starting April 2019	***Federal flat rate***: Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. Plus additional 3.9% of base amount

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
						Federal ad valorem rate: 2.5% ***Additional ad valorem rate + Sales tax adjustment***: 11.4% ***HST:*** 13%
Quebec[4] [2,15,5]	18 +	Up to 30 g in public places.150 g in a private residence	In places where tobacco smoking/ vaping is prohibited. In addition, on the grounds of health and social services institutions, CEGEPs and universities; on bicycle paths; in bus shelters/ transportation waiting areas. Municipalities can impose additional restrictions	Yes. The government might apply additional regulations	The SOCIÉTÉ QUÉBÉCOISE DU CANNABIS (SQDC) authorized to sell cannabis in stores or online	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal Ad valorem rate***: 2.5% ***Additional ad valorem rate:*** 7.5% ***GST+PST:*** 15%
New Brunswick [2,4,5,16,17]	19+	Up to 30 g or dried cannabis or equivalent	In public places. Consumption only allowed in private dwellings or land adjacent to private dwelling (e.g., backyard)	Yes	Cannabis NB is the only legal retailer	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad valorem rate:*** 7.5% ***HST:*** 15%
Nova Scotia [2,4,5,18]	19 +	Up to 30 g of dried cannabis or equivalent. No	In public places as per Smoke-free places act, or in motor vehicles. Municipalities might	Yes	The Nova Scotia Liquor Corporation is the only authorized retailer. Stores or online	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling.

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
		restriction at home as soon as properly stored	have additional restrictions.			***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad valorem rate:*** 7.5% ***HST:*** 15%
Newfoundland and Labrador[2,4,5,19]	19 +	Up to 30 g	In public places; motor vehicles or boats similar restrictions to that of consuming alcohol	Yes	Overseen by the Newfoundland and Labrador Liquor Corporation (NLC). Private licensed stores or online sales	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad valorem rate:*** 7.5% ***HST:*** 15%
Prince Edward Island [2,4,5,20]	19 +	Up to 30 g of dried cannabis or equivalent	Prohibited in public places. Consumption is restricted to residence.	Government currently buying from established cultivators. One of them a medical cannabis producer in the province	Government-owned and operated stores or online sales	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad valorem rate:*** 7.5% ***HST:*** 15%

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
Northwest Territories [2,4,21] [5]	19 +	Up to 30 g of dried cannabis or equivalent	In places where smoking tobacco not allowed; in public spaces frequented by children; in motor vehicles. Municipalities might have additional restrictions.	Yes	The NWT Liquor Cannabis Commission's Website for purchasing online. Most NWT Liquor Stores for in store. Drafting regulations for private retail licensing	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. ***Federal ad valorem rate***: 2.5% ***Additional ad Valorem rate:*** 7.5% ***GST:*** 5%
Nunavut [2,4,5,22]	19+	Up to 30 g	In same places where smoking tobacco is prohibited; in motor vehicles	Yes	The Nunavut Liquor and Cannabis Commission sales in physical store, online, by phone, through an agent	***Federal flat rate***: Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling. Plus additional 19.3% of base amount ***Federal ad valorem rate:*** 2.5% ***Additional ad valorem rate + Sales tax adjustment***: 26.8% ***GST:*** 5%
Yukon [2,4,5,23]	19 +	Up to 30 g	In public places as per Smoke-Free Places Act; in motor vehicles	Yes	Cannabis Yukon store – Government operated or online. Regulation under development for private retail stores	***Federal flat rate:*** Flower- $0.25/gram; trim- $0.075 /gram; seed- $0.25/ seed; Seedling- $0.25/ seedling. ***Additional flat-rate:*** Flower- $0.75/gram; trim- $0225 /gram; seed- $0.75/ seed; Seedling- $0.75/ seedling.

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited	Commercial cultivation allowed?	Retail Model and Distribution licensing	Taxation
						Federal ad valorem rate: 2.5% ***Additional ad valorem rate:*** 7.5% ***GST:*** 5%

Note: Legal cannabis use on First Nations reserves is established by the Cannabis Act. However, Chief and Council have jurisdiction that supersedes federal cannabis act and have ultimate powers to authorize or not on Indigenous land

3. Data Assets in Canada

Key points in this chapter:

- Data assets are readily available in Canada to explore the association between cannabis use and mental health.
- There is a linear increase of past-year cannabis use in Canada from 2013 to 2017.
- There is a likely decrease observed from 2015 to 2017 in past-year cannabis use by both male and female adolescents 15-17 years of age.
- Prevalence of mental disorders among those who reported past-year cannabis use is more than double that of those who reported never/ one-time cannabis use.
- Compared to females, males have more than double the prevalence of cannabis use disorder.

Statistics Canada has identified several Canadian surveys that can be used to address different questions regarding cannabis use[24], and to explore the association between cannabis use and mental health. Some of the surveys are available for analysis as Public Use Microdata Files (PUMFs). These surveys are based on representative samples of the Canadian household population. This represents approximately 97% of the total population, but excludes residents of certain remote areas, residents of institutions (i.e., hospitals, nursing homes, or prison[25]), and those experiencing homelessness. Some surveys also exclude residences of the three territories. The exclusion criteria does not allow identification of potential associations between cannabis use and mental health in those populations. The surveys use geographically- or telephone-based sampling frames, or some combination of these. Typically, they collect self-reported data using field-tested items and brief instruments concerning topics such as the frequency of use, and associated problems. The surveys are typically part of ongoing survey programs and often collect data on similar variables using similar items on an annual basis. An overview of the surveys are presented in Table 3.1. More in-depth information about the surveys can be found in *Appendix 1*.

Below, we present examples of analyses that are possible to obtain using two of the identified datasets: The Canadian Tobacco, Alcohol and Drugs Survey (CTADS) [26-28], and the Canadian Community Health Survey – Mental Health [29]. The objective of the analysis is three-fold. First, to provide an overview of trends in cannabis use in Canada within various population subgroups. Second, to depict prevalence of mental disorders by cannabis use. Third, to determine the prevalence of cannabis use disorder within population subgroups. The analyses were conducted using Stata 15[30] . Sample weights were used to calculate the estimates.

Table 3.1. Overview of Canadian Surveys Available

Survey	Survey Execution		Frequency of Surveying	Survey Conducted by	PUMF Available	Target Population	Excluded Population	Cannabis Variables						Mental Health			Unique Features
	First date	Last date						Ever use	Past year use	Current use	Frequency of use	Age first use	Risk level of consumption (Self-rated)	Self-rated mental health	Mental health disorders	Substance use disorders	
General Social Survey- Victimization (GSS)[31]	1999	Ongoing	Every 5 years	Statistics Canada	X	15 + years old living in ten Canadian provinces and three territories	Living in institutions [a]			X	X						Self-report victimization Childhood experiences
Canadian Addictions Survey (CAS) [32]	2004	2004	Once	Montreal-based research firm Jolicoeur & Associés	X	Canadians 15 + years old	No telephone	X	X	X	X	X	X	X			Harms and consequences of using Attitudes and beliefs
Canadian Tobacco Use Monitoring Survey (CTUMS) [33]	1999	2012	Annual	Statistics Canada	X	15 + years old living in ten Canadian provinces	Living in the 3 territories; or in institutions[a]	X	X		X	X					
Canadian Alcohol and Drug Use Monitoring Survey (CADUM)[34]	2008	2012	Annual	Montreal-based research firm Jolicoeur & Associés	X	15 + years old living in ten Canadian provinces in household with landline	Living in the 3 territories; institutions[a]; households with no landline	X	X	X	X	X		X			Drug use and harms
Canadian Tobacco Alcohol and Drugs Survey (CTADS) [26-28]	2013	2017	Biannual	Statistics Canada	X	15 + years old living in ten Canadian provinces	Living in the 3 territories; institutions; households with no	X	X	X	X	X	X	X			Replaced CTUMS and CADUM Starting in 2019 the CTADS will be divided

Survey	Survey Execution		Frequency of Surveying	Survey Conducted by	PUMF Available	Target Population	Excluded Population	Cannabis Variables						Mental Health			Unique Features
	First date	Last date						Ever use	Past year use	Current use	Frequency of use	Age first use	Risk level of consumption (Self-rated)	Self-rated mental health	Mental health disorders	Substance use disorders	
							landline or cellphone										into 2 surveys: tobacco and nicotine; and Canadian Alcohol and Drugs Survey.
Canadian Community Health Survey-Mental Health and Wellbeing (CCHS-MH) [29,35]	2002	2012	Twice for MH	Statistics Canada	X	15 + years old living in ten Canadian provinces	Living in the 3 territories; on reserves; institutions[a]. Members of Canadian Armed Forces	X	X					X	X	X	Mental health and health service utilization
Ontario Child Health Study (OCHS)[36]	1983	2014	Twice.	Statistics Canada		4-17 years old residing in Ontario, Canada	Household in reserves or in collective dwellings	X			X	X		X			Parent/ teacher questionnaires about child emotions / behaviors Mental health service utilization Victimization Two follow ups for 1983 study participants
Aboriginal Peoples Survey (APS) [37]	1991	Ongoing	Five cycles from 1991 to 2017	Statistics Canada	X	Canadians 15 + years old with Aboriginal	Living in Indian reserves[c] and settlements[d];				X			X	X		Only 2017 cycle has question on Cannabis use

Survey	Survey Execution		Frequency of Surveying	Survey Conducted by	PUMF Available	Target Population	Excluded Population	Cannabis Variables						Mental Health			Unique Features
	First date	Last date						Ever use	Past year use	Current use	Frequency of use	Age first use	Risk level of consumption (Self-rated)	Self-rated mental health	Mental health disorders	Substance use disorders	
						identity[b], living off reserves	or in certain First Nations communities in Yukon and North West Territories										
National Cannabis Survey (NCS) [38]	2018	Ongoing	Quarterly	Statistics Canada		15 + years old living in ten Canadian provinces	Living in the 3 territories; institutions[a].	X		X	X			X			Monitors consumption behaviors post non-medical cannabis legalization
Canadian Health Survey on Children and Youth (CHSCY) [39]	2019	Ongoing	Occasional	Statistics Canada		1 to 17 years of age as of January 31st 2019 living in the ten Canadian provinces and the three territories	Living in foster homes or institutions[a]; residents of First Nation reserves or Aboriginal (Indian, Inuit and Métis peoples of Canada)[G] settlements	X	X	X	X	X	X	X	X		
Canadian Students Tobacco Alcohol and Drugs Survey (CSTADS)[40,41]	1994	Ongoing	Biannual starting in 2002	A consortium of researchers across Canada coordinated by The Propel Centre for Population	X	Canadian Students enrolled in grades 6 to 12 in	-Living in provinces not participating in the survey; living in the three territories.	X	X	X	X	X					Formerly known as Youth Smoking Survey Alcohol and Drugs use

Survey	Survey Execution		Frequency of Surveying	Survey Conducted by	PUMF Available	Target Population	Excluded Population	Cannabis Variables						Mental Health			Unique Features
	First date	Last date						Ever use	Past year use	Current use	Frequency of use	Age first use	Risk level of consumption (Self-rated)	Self-rated mental health	Mental health disorders	Substance use disorders	
				Health Impact at the University of Waterloo		participating provinces	Students from virtual schools, special schools (e.g., for special needs, visually / hearing impaired) or schools located in military bases, or in reserves; or schools with less than 20 students in one of the grades selected										asked to grade 7-12 only Some cycles ask questions based on self-determination theory; bullying, sleep; school connectedness

Note:

[a] Institutions include hospitals, nursing homes or prisons[25]

[b] "'Aboriginal identity' refers to whether the person identified with the Aboriginal peoples of Canada. This includes those who are First Nations (North American Indian), Métis or Inuk (Inuit) and/or those who are Registered or Treaty Indians (that is, registered under the *Indian Act* of Canada[42]), and/or those who have membership in a First Nation or Indian band. Aboriginal peoples of Canada are defined in the *Constitution Act*, 1982, Section 35 (2)[43] as including the Indian, Inuit and Métis peoples of Canada"[44]

[c] "Indian reserve (IRI) – A tract of federally owned land with specific boundaries that is set apart for the use and benefit of an Indian band and that is governed by Indigenous and Northern Affairs Canada (INAC)"[45].

[d] "Indian settlement (S-É) – A place where a self-contained group of at least 10 Indian (Aboriginal) persons resides more or less permanently. It is usually located on Crown lands under federal or provincial/territorial jurisdiction. Indian settlements have no official limits and have not been set apart for the use and benefit of an Indian band as is the case with Indian reserves. Statistics Canada relies on INAC to identify Indian settlements"[45].

3.1. Trends in Cannabis Use

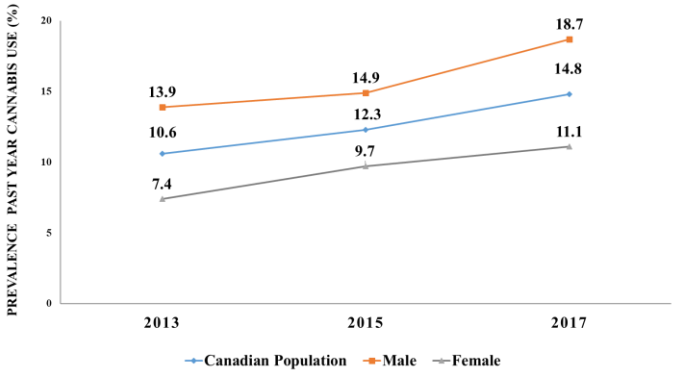
3.1.1. Data used

We used the Public Use Microdata Files (PUMFs) for the Canadian Tobacco, Alcohol and Drugs Survey (CTADS), cycles 2013[26] , 2015[27], and 2017[28] (Box 3.1). Data from the three cycles of the CTADS was used to provide an overview in trends in cannabis use in Canada. Past-year cannabis use, assessed by asking the question "During the past 12 months have you used marijuana?" Age of first use, assessed with the question "How old were you when you tried or started using marijuana?" was used to determine mean age when an individual started to use cannabis. Frequency of use in the past-three months was assessed using the question "During the past three months how often did you use marijuana?" Frequency of use was limited to those that reported past-year cannabis use.

3.1.2. Past-year Cannabis Use

According to CTADS, the prevalence of any past-year cannabis use has increased in Canada from 2013 to 2017 by about 1/3. A similar trend was observed for males and for females. However, males consistently have higher prevalence of past-year cannabis use, nearly twice as high as females (Figure 3.1).

Figure 3.1. Prevalence of Cannabis Use Past 12 Months in Canada 2013-2017



Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada. Population 15 years or older.

Box 3.1.
Canadian Tobacco Alcohol and Drugs Survey (CTADS)[26-28]

Overview: cross-sectional national Canadian household survey conducted by Statistics Canada biannually.

Objective: To measure prevalence, frequency, behaviours related to smoking, alcohol use and drug use (including cannabis), and harms related to use.

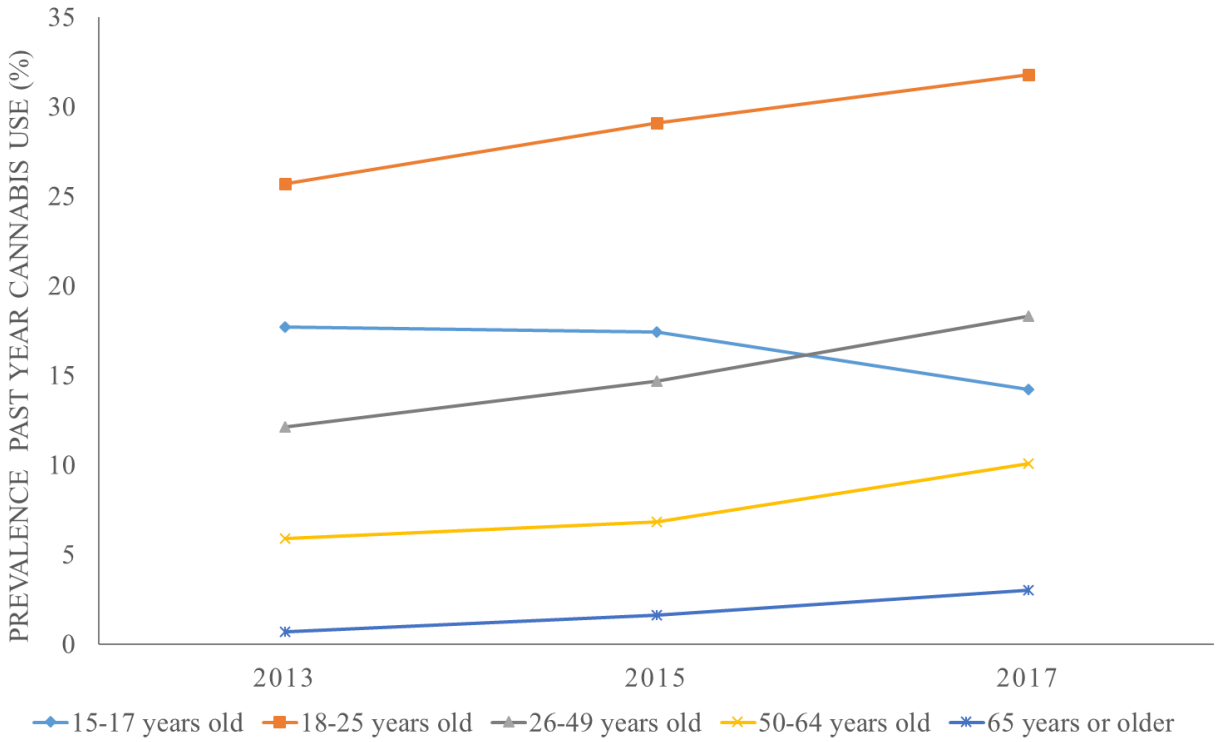
Target Population: Individuals 15 years of age or older living in the ten Canadian provinces. Excluded from the survey are institutionalized individuals (i.e., in hospitals, nursing homes or prisons) and individuals living in the three Canadian Territories.

Sampling: Statistics Canada used a two-phase stratified random sample of telephone numbers. First, households were selected using random digit dialing. Then, one or two individuals were selected to participate based on household composition. This method of sampling leaves out of the survey population individuals from households without landline or cellphones.

Data Collection: The computer-assisted telephone interviewing (CATI) was used to collect the data.

Individuals between 18-25 years of age had the highest prevalence of past year use, while the lowest prevalence was found in individuals 65 years or older (Figure 3.2). There was an observed increase for all age groups except for those between 15 and 17 years of age from 2013 to 2017. The largest relative increase was seen in the 65+ age group, where an approximately 4-fold relative increase has occurred from 2013 to 2017. Importantly, the increase in those over 65 years of age may represent increases in prescribed medicinal use and/or increased reporting due to decreased stigma associated with impending legalization at the time of data collection. For those 15-17 years of age, past year use remained similar with a small decrease in 2017. The decrease was observed for both males and females (Table 3.2).

Figure 3.2. Prevalence of Past-Year Cannabis Use in Canada 2013-2017 by Age



Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada.

Table 3.2. Prevalence of Past-year Cannabis Use in Canada by Age and Sex

	Canadian Population			Male			Female		
	2013	2015	2017	2013	2015	2017	2013	2015	2017
Age Category	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
15-17 years old	17.7	17.4	14.2	19.2	18.9	14.6	16.2	15.8	13.7
18-25 years old	25.7	29.1	31.8	29.8	30.9	37.0	21.0	27.3	25.9
26-49 years old	12.1	14.7	18.3	16.6	19.2	23.8	7.7	10.3	13.1
50-64 years old	5.9	6.8	10.1	7.8	8.1	12.1	4.0	5.5	8.1
65 years or more	0.7	1.6	3.0	1.0	2.1	4.0	0.5	1.2	2.2

Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada. Within this survey, sex is a self-report measure, not a biological measure.

3.1.3. Frequency of Cannabis Use

The estimates reported in this section are restricted to individuals who reported cannabis use in the past-year. No apparent linear pattern was observed in the frequency of cannabis use in the past- three months among those who reported past-year cannabis use (Table 3.3). A small increase in the estimated frequency of daily or almost daily use was observed between 2013 and 2015, however, it remained stable between 2015 and 2017. However, when examined with reference to the entire population (where there has also been an increase in the proportion with past year use), the reported frequency of daily or almost daily use of cannabis in the Canadian general population indicates an increasing pattern from 2013 to 2017 (see footnote on Table 3.3).

Table 3.3. Frequency of Cannabis Use in Past 3 Months among those who Used Cannabis in the Past Year in Canada 2013-2017

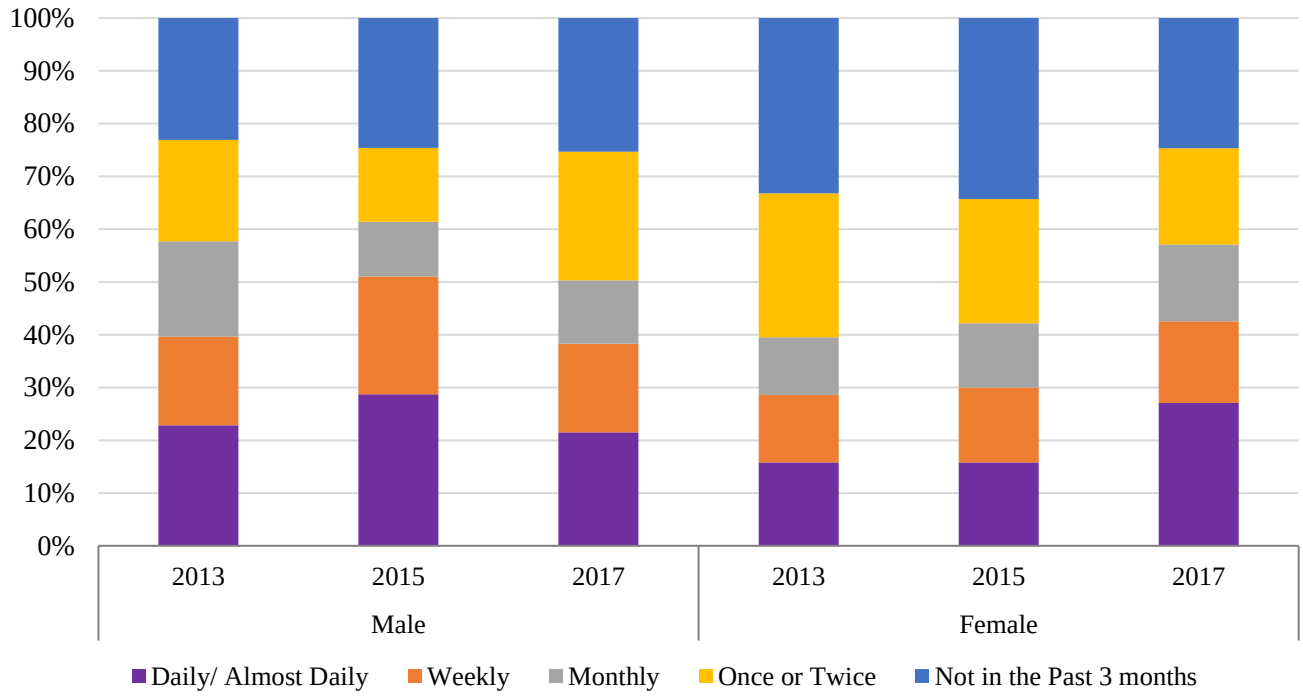
	2013	2015	2017
Frequency of Use	(%)	(%)	(%)
Daily/ Almost Daily *	20.4	23.6	23.6
Weekly	15.4	19.1	16.3
Monthly	15.6	11.1	13.0
Once or Twice	22.0	17.8	22.0
Not in the past 3 months	26.6	28.5	25.1

* Daily/ almost daily in the Canadian household population 15 years or older: 2.1% in 2013; 2.9% in 2015; and 3.5% in 2017

Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada. Population 15 years or older.

Stratifying by sex, the percentage of females who reported using cannabis daily/almost daily in the past three months was the same between 2013 and 2015, and increased in 2017. A small increase in the estimated frequency of weekly and monthly use in females was observed between 2013 and 2017 (Figure 3.3).

Figure 3.3. Frequency of Cannabis Use in Past Three Months among those who Used Cannabis in the Past 12 Months in Canada by Males and Females

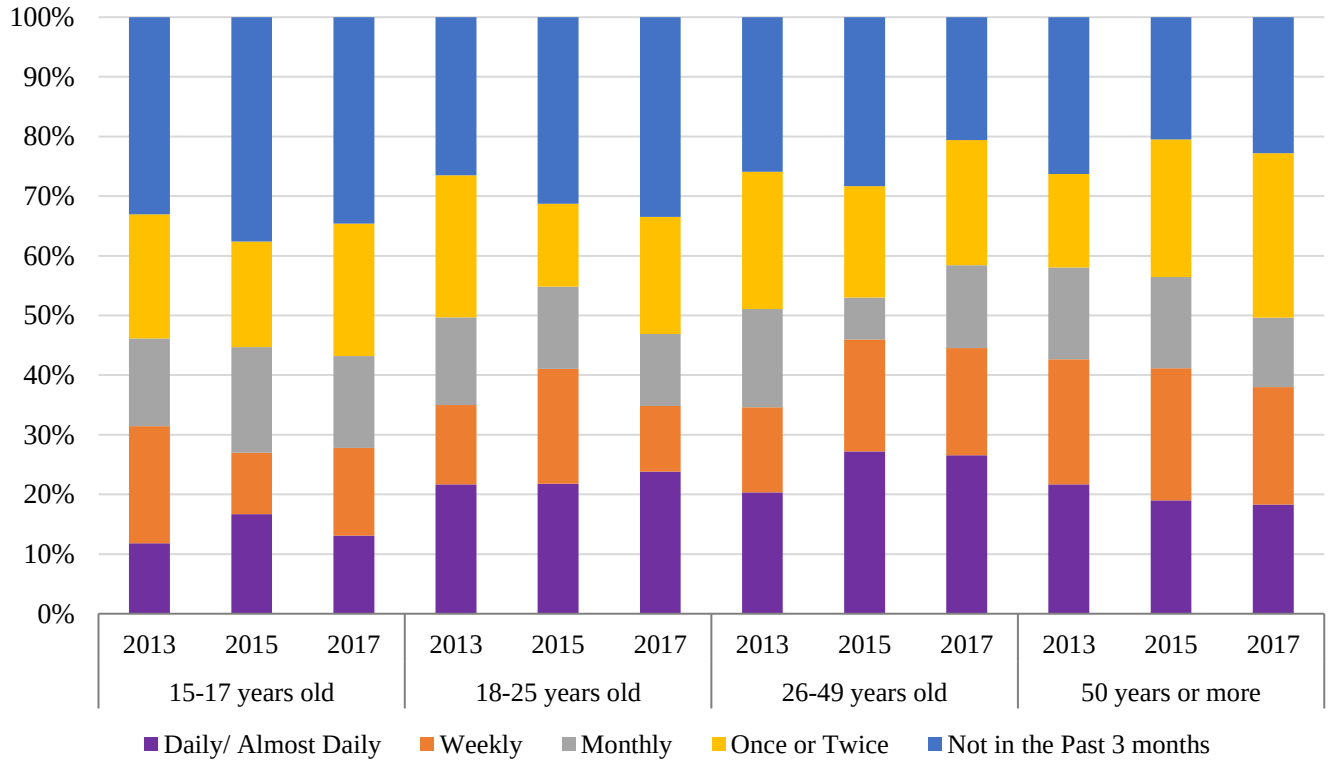


Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada. Population 15 years or older.

The frequency of use in the past-three months for males does not seem to follow a linear pattern in most of the categories, although any conclusions are limited due to the availability of only three data points. For those who reported using daily/ almost daily, an increase in the percentage was observed between 2013 and 2015, but the percentage decreased in 2017 to levels that seem lower than the one reported in 2013 (Figure 3.3).

The analysis by age categories do not reveal big changes over time in the frequency of use in the past- three months (Figure 3.4). The percentage of those 18-25 years of age who reported daily/ almost daily use in the past- three months seems to be increasing between 2013 and 2017; while there is a suggestion of a decrease among monthly use in the same age category. For the 50 + years of age category, an increasing pattern in the percentage reporting using once or twice was observed, while the opposite pattern was observed for the daily/almost daily category (Figure 3.4). Statistical tools may be helpful for determining which of the observed changes would be unlikely to occur due to chance, but would require a more detailed analysis.

Figure 3.4. Frequency of Cannabis Use in Past Three Months among those who Used Cannabis in the Past 12 Months in Canada 2013-2017 by Age Group

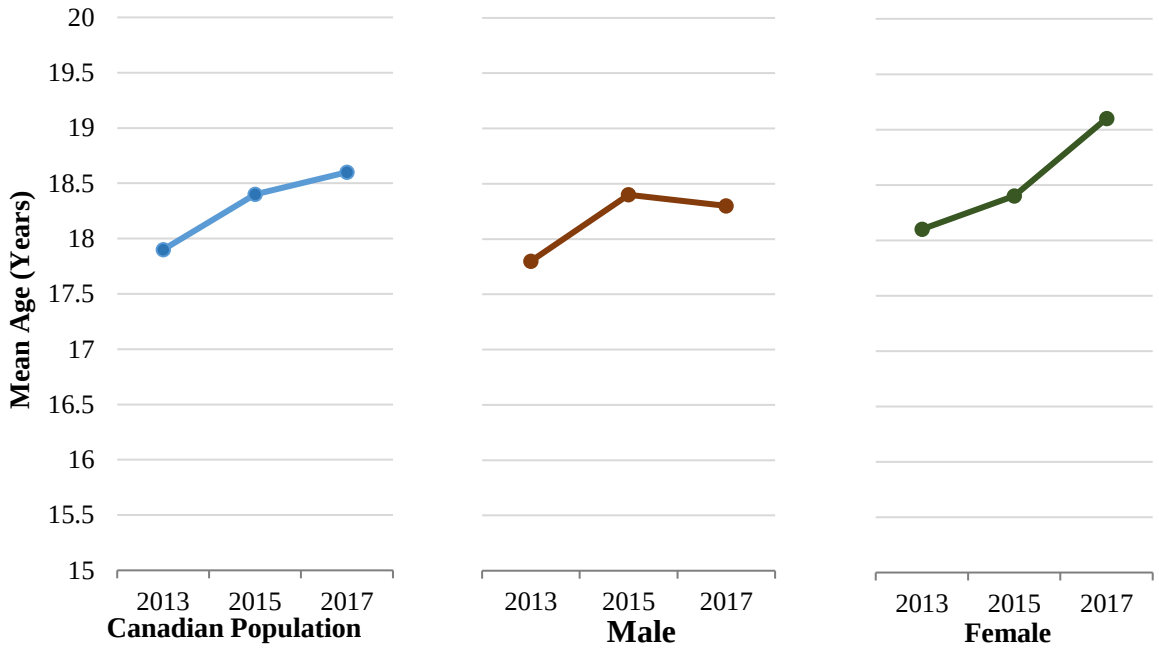


Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada.

3.1.4. Age of First Time Cannabis Use

The mean age of first time cannabis use in the Canadian household population has increased slightly since 2013. The increasing tendency is more apparent in females than in males (Figure 3.5).

Figure 3.5. Mean Age First Time Cannabis Use in Canada 2013 – 2017



Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey (CTADS) 2013, 2015, and 2017 collected by Statistics Canada. Population 15 years or older. Due to this sampling limitation, the mean age reported here may be higher compared to other surveys, such as CSTADS.

3.1.5. Self-Reported Mental Health by Cannabis Use in Canada 2013-2017

As seen in Figure 3.6, no apparent changes over time in self-reported mental health was observed for individuals who never have used cannabis. However, an increased reporting of mental health as poor was observed for those with ever or past-year cannabis use. The percentage increase seems to be higher among those who reported past-year cannabis use. As this is cross-sectional data, it is not possible to tell whether this reflects an effect of mental health on cannabis use (e.g. increasing use for treatment or self-management of mental health symptoms), the converse, or the effect of shared determinants of these two outcomes. For example, cannabis might be contributing to more negative perceptions of mental health, or people with poor mental health may be using cannabis more often for medicinal reasons. Furthermore, societal factors may be contributing to both trends, or the changes may be simultaneous but not related. Longitudinal data are needed to answer such questions.

Figure 3.6. Self-Reported Mental Health by Cannabis Use in Canada 2013 – 2017

Note: Data from the Public Use Microdata File of the Canadian Tobacco Alcohol and Drugs Survey 2013, 2015, and 2017 collected by Statistics Canada. Population 15 years or older.

3.3 Prevalence of Mental Disorders in Canada by Cannabis use

3.3.1. Data Used

The PUMF for the Canadian Community Health Survey- Mental Health (CCHS-MH) 2012[35] was used to determine the prevalence of mental disorders in relation to cannabis use; and the prevalence of cannabis use disorder (as defined by criteria of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, 4th Edition) within population subgroups (Box 3.2). This is the most recent national survey providing a detailed assessment of mental health using strongly validated measurement instruments. Cannabis use was determined by two different variables derived by Statistics Canada: Cannabis used - life (excluding one time use); and cannabis used –past 12 months (excluding one time use).

Box 3.2
Canadian Community Health Survey – Mental Health (CCHS-MH)

Overview: cross-sectional national survey collected by Statistics Canada. Two cycles of the survey have been collected, one in 2002 and one in 2012[29,35].

Objective: To provide information on the factors and processes that contribute to mental health.

Target Population: Individuals 15 years of age or older living in the ten Canadian provinces. Excluded from the survey are institutionalized individuals, persons living in the three Canadian territories, full-time member of the Canadian Forces, and individuals living on reserves or Aboriginal (i.e., Indian, Inuit and Métis) settings.

Sampling: Statistics Canada used a multi-stage stratified cluster design for the selection of the sample. First, households were selected using the area probability frame designed for the Canadian Labour Force Survey[35]; then, an individual from each household was selected to participate using selection probabilities based on age and household composition[35].

Data Collection: The computer-assisted interviewing system (CAI)

3.3.1.1 Measures of Mental Disorders:

Major depressive episode, generalized anxiety disorder, bipolar disorder, hypomania, mania, and cannabis use disorders were measured using the corresponding variables derived by Statistics Canada based on responses to the World Health Organization version of the Composite International Diagnostic Interview (WHO-CIDI), modified for the needs of CCHS - Mental Health[29]. Suicide ideation during the past 12 months was measured using a variable derived by Statistics Canada. It corresponds to a self-report of having "serious" suicidal thoughts in the past 12 months. Post-traumatic stress disorder (PTSD) was based on the question "Do you have post-traumatic stress disorder?" Mood disorders were measured using the question "Do you have a mood disorder such as depression, bipolar disorder, mania or dysthymia?" Participants were asked to report only on mood disorders that had been diagnosed by a health professional and that had lasted at least 6 months. Similarly, having a diagnosis of an anxiety disorder was measured using the question "Do you have an anxiety disorder such as a phobia, obsessive-compulsive disorder or a panic disorder?" Psychosis was available as a self-reported variable in the CCHS-MH 2012; however, analysis about this mental disorder was not possible since the variable is not available in the PUMFs.

3.3.1.2. Mental Health Disorders by Cannabis Use

The prevalence of mental disorders by cannabis use is presented in Table 3.4. The results indicate higher prevalence of each indicator of mental disorders in Canadians 15 years of age or older who reported cannabis use either ever or in the past 12 months, compared to those who reported never/ one-time use. Those who reported past-year cannabis use have higher prevalence of all mental disorders compared to those who reported ever use.

The prevalence of mental disorders among those who reported past-year cannabis use is more than double that of those who reported never/ one-time use. The results suggest associations between cannabis use and mental disorders. However, given the cross-sectional nature of the data, it is not possible to determine if cannabis use causes an increase in prevalence of mental disorders, or if those with mental disorders tend to use cannabis to alleviate the symptoms caused by their mental illness, or if some other factor determines both mental disorders and cannabis use.

Table 3.4. Prevalence of Mental Disorders in Canada by Cannabis Use in 2012

	Cannabis Use [a]		
	Never/ One-time	**Ever**	**Past 12 Months**
Mental Disorder[b]	**(%)**	**(%)**	**(%)**
Major Depressive Episode 12 Months [c]	3.3	7.5	11.1
Generalized Anxiety Disorder 12 Months [c]	2.0	3.8	4.5
Bipolar Disorder 12 Months [c]	0.9	2.8	4.9
Hypomania 12 Months [c]	0.5	1.6	2.6
Mania 12 Months [c]	0.6	1.8	3.0
Suicide Ideation 12 Months [d]	2.3	5.4	8.5
Has PTSD [e]	1.2	2.6	4.1
Has a Mood Disorder [f]	5.3	10.3	12.8
Has an Anxiety Disorder [g]	3.5	7.5	9.5

Note: Data from the Public File of the Canadian Community Health Survey- Mental Health 2012. Population 15 years or older.

[a] The ever and past 12 months cannabis use excludes those who have used Cannabis only one time

[b] The mental disorders included in the analyses are the ones available in the CCHS- Mental Health PUMFs. Analysis on the association between cannabis use and schizophrenia, and cannabis use and other psychosis would be possible using the Microdata File available to researchers at Statistics Canada Research Data Centres (RDCs).

[c] Derived based on meeting criteria for 12 months on the World Health Organization version of the Composite International Diagnostic Interview (WHO-CIDI) modified for the needs of CCHS - Mental Health

[d] Derived variable

[e] Self-reported

[f] Self-reported. Condition had been diagnosed by a doctor and it is supposed to last at least 6 months. Includes: Depression, bipolar disorder, mania or dysthymia

[g] Self-reported. Includes: phobia, obsessive-compulsive disorder or a panic disorder

3.3.1.3. Prevalence of Cannabis Use Disorder Past- 12 Month

The concept of cannabis use disorder, as assessed in the CCHS-MH survey, was based on DSM-IV (cannabis abuse and dependence). This differs from the approach taken in DSM-5 (cannabis use disorder). However, both classifications incorporate concepts such as an excessive amount of time spent using the substance, use of the substance to the exclusion of other important activities, inability to control use, etc.). While the overall prevalence of past-12 month cannabis use in this data set was 15%, only a minority of use is associated with patterns related to cannabis use disorder. The prevalence of past-year cannabis use disorder in the Canadian household population was 1.3% according to the CCHS-MH data. Compared to females, males have more than double the prevalence of past-year cannabis use disorder (Figure 3.7).

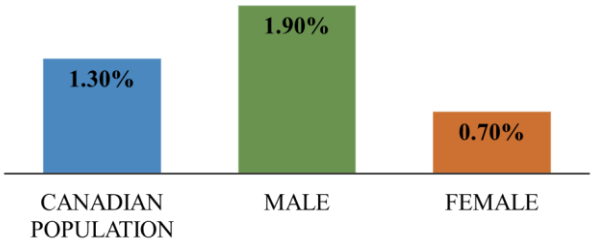


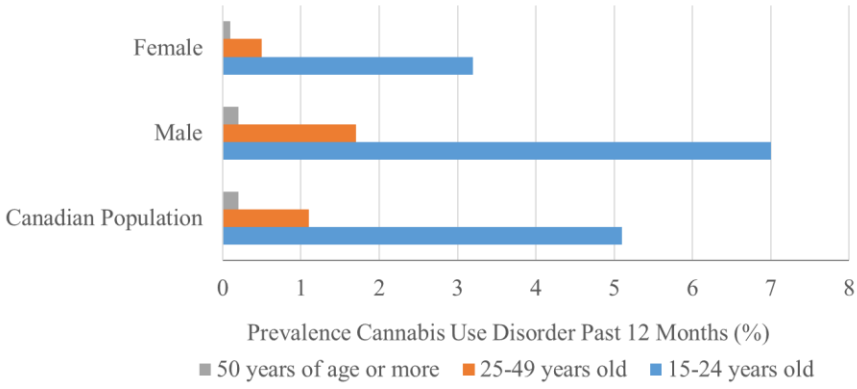
Figure 3.7. Prevalence of Cannabis Use Disorder Past 12 Months in the Canadian Household Population

Note: Data from the Public Use Microdata File of the Canadian Community Health Survey- Mental Health 2012 collected by Statistics Canada. Population 15 years or older

The prevalence of past-year cannabis use disorder diminishes with age. Among the age categories included in the analysis, Canadians 15-24 years old have the highest prevalence of past-year cannabis use disorder (5.1%) by a large margin; and those 50 years of age or older have the lowest (0.2%). A similar pattern of decreasing prevalence of past-year cannabis use disorder was observed when stratifying by age and sex (Figure 3.8).

Figure 3.8. Prevalence of Cannabis Use Disorder Past 12 Months in Canada in 2012 by Age and Sex

Note: Data from the Public Use Microdata File of the Canadian Community Health Survey- Mental Health 2012 collected by Statistics Canada.



This association of prevalence with age may represent an age effect (the problematic patterns of use may resolve with age) or a cohort effect (more recently born individuals may have grown up in a context of greater risk for these disorders). If this represents a cohort effect, the higher prevalence of cannabis use disorders will be seen in older age groups in future surveys, and the prevalence of these disorders may increase. Ongoing analysis of data from future surveys will be required in order to distinguish between these possibilities.

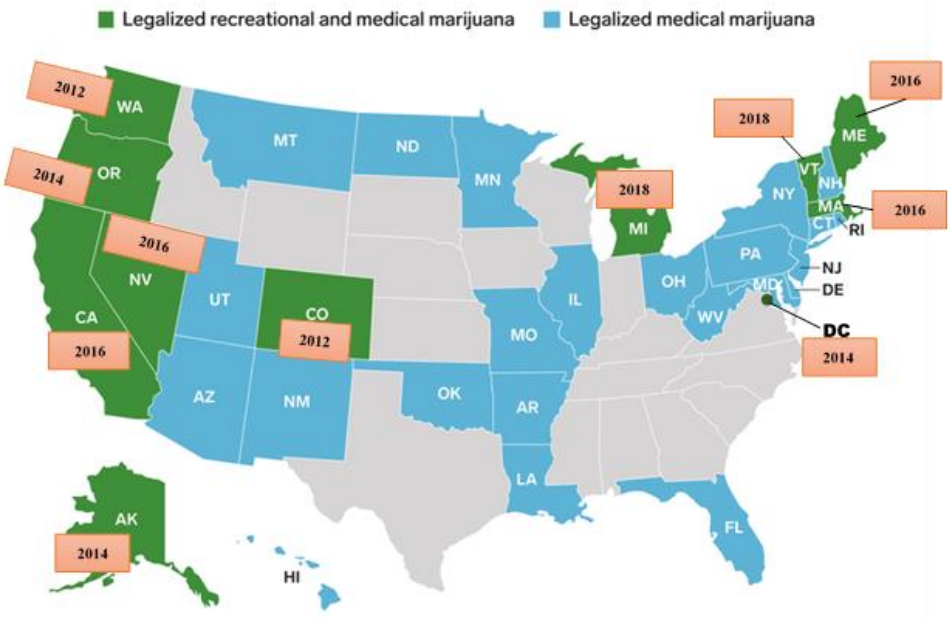
4. Data assets of other legalized jurisdictions

Key points in this chapter:

- 13 jurisdictions, including Canada, have legalized non-medical cannabis
- Data assets exist and have rich publicly available files that will be useful in the future to complete pre-post legalization trend analyses
- Using these data assets, we demonstrate that past-year use of cannabis has continued the same linearly increasing trend in most jurisdictions except for those under 18 years of age where a continued decreasing trend is observed.
- The trends in use are different for females and males.

Besides Canada, twelve jurisdictions have legalized non-medical cannabis worldwide (Uruguay[46], Alaska, California, Colorado, Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, Washington State, and Washington DC[47]). Uruguay became the first country to legalize non-medical cannabis in 2013[46]. Even though non-medical cannabis consumption remains illegal at the Federal level in the United States of America (US), as of December 2018, ten states and Washington DC have legalized non-medical cannabis[47]. In the US, the timing of non-medical cannabis legalization varies by jurisdiction, with some jurisdictions voting for legalization at the same time as illustrated in Figure 4.1.

Figure 4.1. Year of non-medical cannabis legalization in US jurisdictions



Note: Map adapted from https://www.businessinsider.com/legal-marijuana-states-2018-1. Recreational marijuana AKA non-medical cannabis. DC corresponds to the municipality of Washington DC.

4.1 Models of Legalization

Table 4.1 presents an overview of key aspects of non-medical cannabis regulations in jurisdictions outside of Canada that have legalized it. A more detailed summary is presented in Appendix 2, table A2.1.

The minimum age of legal consumption is the same across jurisdictions from the US (i.e., 21 years of age or older). Uruguay has a lower minimum legal age of consumption of 18 years of age. In most of the US jurisdictions the maximum amount allowed for personal possession in public is one ounce (28.35 grams). However, in Washington DC, up to two ounces is allowed; in Maine and Michigan, 2.5 ounces is allowed. Growing marijuana for personal use is allowed in all jurisdictions except for Washington State. Retail sales and industrial cultivation is allowed in all the jurisdictions except in Washington DC where the legislation allows only growing plants for personal use. All jurisdictions have applicable tax rates for non-medical cannabis, with the exception of Uruguay which considers cannabis an agricultural product and does not apply taxes to it. In all jurisdictions, consumption in public places is prohibited, and it is considered a ticketable offense. Driving under the influence (DUI) of cannabis is not permitted. While most jurisdictions rely on standard field sobriety testing performed by Drug Recognition Experts (DRE), some jurisdictions have set a THC limit as DUI; one is piloting the use of oral fluid samples, and another one is proposing the use of oral fluid samples as a way of determining the presence of THC in the body. In the U.S. a blood test can be demanded. An important consideration to be made is that there is the lack of correlation between serum THC concentration and degree of cognition or driving impairments. Evidence suggests that chronic cannabis users can have THC in their serum, but display no evidence of impairment[48]. Additional research is needed to understand the most effective and efficient method of determining cannabis-related impairment when driving.

Table 4.1. Overview of Key Aspects of Legislations in non-Canadian jurisdictions

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited?	Commercial cultivation?	Retail licensing	Taxation
Uruguay[46,49-51]	18 +	40g/ month (10g/week). Annual cap 480g/ member of a cannabis club	X	X	Overseen by the Institute for Regulation and Control of Cannabis (IRCCA). Limited to pharmacies only	0% - categorized as an agricultural product.
Alaska[52-56]	21+	Up to 1 ounce	X	X	Overseen by the Marijuana Control Board	$50 per ounce of mature bud/flower, $25 per ounce of immature or abnormal bud, $15 per ounce of trim, $1 flat rate per clone
Colorado[57-60]	21+	Up to 1 ounce	X	X	Overseen by the Marijuana Enforcement Division (MED) of the Colorado Department of Revenue.	15% excise tax from cultivator to processors or retailers; 15% excise tax on retail, plus existing local or state sales tax. Local governments may impose additional retail taxes on cannabis.
Oregon [61-65]	21+	8 ounces at home; 1 ounce on person purchased at a retail store	X	X	Overseen by the Oregon Liquor Control Commission (OLCC).	State excise tax rate 17%. Municipalities may tax up to an additional 3%
Washington State[66-72]	21+	1 ounce of cannabis, 7 grams of concentrate/ extract for inhalation, 16 ounces of infused in solid form, 72 ounces of infused in liquid form	X	X	Overseen by Washington State Liquor and Cannabis Board (LCB)	37% excise tax
Washington DC [73,74]	21+	Up to 2 ounces	X		Not Applicable	Not Applicable- commercial sales/ cultivation not permitted
California[75-79]	21+	Up to 1 ounce of cannabis, up to 8 grams of concentrated	X	X	Overseen by the Bureau of Cannabis Control	15% Excise tax for retailers. Cultivation tax: cannabis flowers - $9.25 per dry-weight ounce, cannabis leaves - $2.75 per dry-weight ounce, fresh cannabis plant - $1.29 per ounce
Nevada [80-84]	21+	Up to 1ounce of cannabis; up to 1/8 of an ounce of concentrated	X	X	Overseen by The state Department of Taxation.	10% excise tax on retail sale paid by retail store; 15% excise tax on wholesale sale paid by the cultivator; additional retail sale tax at the local rate
Maine [85]	21+	Up to 2.5 ounces	X	X	Currently drafting the laws	10% sales tax ; $130/ lb of marijuana flower or mature plants; $36.29/ lb of marijuana trim; f $1.50

Jurisdiction	Age for legal consumption	Amount allowed	Public consumption prohibited?	Commercial cultivation?	Retail licensing	Taxation
						per immature marijuana plant or seedling; $0.30 per marijuana seed
Massachusetts[86-92]	21+	Up to 1 ounce of cannabis or 5 grams of concentrate. Up to 10 ounces at home	X	X	Overseen by the Cannabis Control Commission.	Sale tax 6.25%; Excise tax 10.75%; additional optional for municipalities up to 3%
Michigan[93-97]	21+	Up to 2.5 ounces. Up to 15 grams concentrate. 10 ounces at home. Amounts over 2.5 ounces properly stored	X	X	Overseen by LARA.	Proposed 10% excise tax at retail level plus the 6% state sales tax
Vermont[96 98-100]	21+	Up to 1 ounce	X	X	Will be overseen by the Cannabis Control Board	Proposed 20% excise tax, plus 6% sales tax, plus potential additional 1% in municipalities with a cannabis retailer. Proposed 9% sale tax instead of 6% for edible or infused products

4.2 Data Assets

We explored possible sources of open data available to analyze cannabis use, as well as the association between cannabis use and mental health pre- and post-legalization in jurisdictions outside of Canada. We found three main data sets in the US. Table 4.2 presents an overview of the data sets. A more detailed summary can be found in *Appendix 2*.

In Uruguay, the National Board on Drugs (JND) collects data on drug use using two national surveys: the National Household Survey on Drug Use -2016[101] , and the National Survey on Drug Use in High School Students[102]. Since the data is not open to the public, information on pre-post legalization of non-medical cannabis trends can only be obtained from publicly available reports. Information on cannabis use for 2017 can be obtained from a report from the Monitor Cannabis Uruguay Organization[103].

In the following section, we present trends on cannabis use pre and post-legalization using one of the identified US surveys, and information from public reports in Uruguay. Given the timing of legalization in most jurisdictions, we did not explore the association between cannabis use and mental health.

Table 4.2. Overview of Open Data Surveys Available in the US

Survey	Survey Execution		Frequency of Surveying	Survey Conducted by	Target Population	Excluded Population	Cannabis Variables						Mental Health			Unique Features
	First date	Last date					Ever use	Past year use	Current use	Frequency of use	Age first use	Risk level of consumption (Self-rated)	Self-rated mental health	Mental health disorders	Substance use disorders	
National Survey on Drug Use and Health (NSDUH)[3]	1971	Ongoing	Annually	Substance Abuse and Mental Health Services Administration (SAMHSA)	US civilian population 12 years + living in 50 states and the District of Columbia	Military personnel on active duty, institutionalized individuals, and homeless who do not use shelters	X	X	X	X	X	X		X	X	Tool for online analysis available at SAMHSA website
Youth Risk Behaviour Surveillance System (YRBSS)[104]	1991	Ongoing	Biannual	Centers for Disease Control and Prevention (CDC)	National survey: students in grades 9-12 in public and private schools in the 50 states and the District of Columbia. Jurisdictional survey: grade 9-12 students enrolled in public schools. Some also include middle school students	National survey: students from the US territories. Jurisdictional survey: Not all jurisdictions collect data biannually	X		X	X	X			X		Surveillance system includes a cross-sectional national US survey collected by the CDC; and a series of surveys collected by state, territorial, local education and health agencies, and tribal governments.
Behavioral Risk Factor Surveillance System (BRFSS)[105]	1984	Ongoing	Monthly	US State Health Depts with assistance from CDC	18 years of age or older living in the 50 states, District of Columbia, and three US territories	Living in territories not included; with no landline or cellphone			X	X				X		

4.3 Trends in Cannabis Use Pre- and Post-legalization

4.3.1 Data used

For the analyses in the US, we used data from the National Survey on Drug Use and Health (NSDUH) [3]. Details are available in Box 4.1. The NSDUH is available for public use through the Substance Abuse & Mental Health Data Archive (SAMHDA) website[106]. We conducted the analysis using the online analysis tool for the NSDUH: 2 Year Restricted-use Data Analysis System (RDAS) [106]. Detailed information on how to use the online tool could be found at SAMHDA's website[106].

Non-medical Cannabis data in Uruguay were obtained from the published reports of the VI National Household Survey on Drug Use -2016[101] , the VII National Survey on Drug Use in High School Students[102], and the report by the Monitor Cannabis Uruguay Organization[103]. Details on the VI National Household Survey on Drug Use -2016[101] , the VII National Survey on Drug Use in High School Students[102] can be found in Box 4 and 5 respectively.

Past-year cannabis use was the main outcome measure. Only jurisdictions where non-medical cannabis was legalized in 2014 or prior were included in the analyses.

Box 4.1.
National Survey on Drug Use and Health (NSDUH)[3]

Overview: cross-sectional national US survey administered annually by the Substance Abuse and Mental Health Services Administration (SAMHSA) in 50 states and the District of Columbia (Washington DC) since 1971.

Objective: To provide information on illicit drugs, alcohol, and tobacco use and mental health in the US at a national, state, and sub-state levels.

Target Population: US civilian population 12 years of age or older. Excluded from the survey are institutionalized individuals, homeless who do not use shelters, and military personnel on active duty.

Sampling: A multi-stage area probability sample within the 50 states and the District of Columbia was used to select the sample.

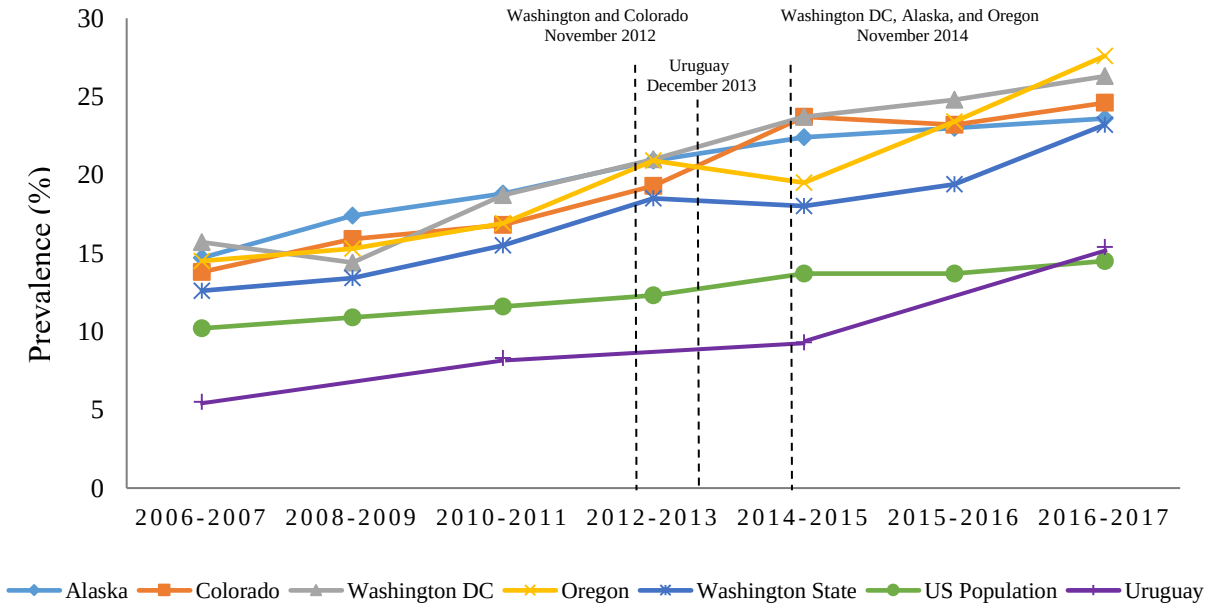
Data Collection: computer-assisted personal interviews and audio computer-assisted self-interviews. Since 2002, respondents get a participation incentive of US $30.

4.3.2 Past-Year Prevalence of Cannabis Use Pre-Post Non-Medical Cannabis Legalization-Overall

The past-year prevalence of cannabis use in the US general population 12 years of age or older shows an approximately linear increase over time (Figure 4.2). The pre- and post-legalization prevalence in Alaska, Colorado, Washington DC, Oregon, and Washington State is higher than the one observed for the US general population. Compared to the US general population, Uruguay seems to have lower prevalence of past-year cannabis use pre-legalization. However, the post-legalization estimate is similar to the one for the US general population.

The overall pattern of past-year cannabis use pre-post legalization seems to be similar for most of the jurisdictions, with the exception of Oregon, and Uruguay. In Oregon and Uruguay, there is the suggestion that the rate of increase may be greater post-legalization (Figure 4.2). However, additional data points are needed to confirm this. Generally, the pattern resembles that reported for past-year use in Canada (pre-legalization of non-medical use), where the increase is roughly linear. In most jurisdictions, there is no clearly discernable change in the rate of increase at the time of legalization.

Figure 4.2. Prevalence of past year cannabis use pre-post legalization in 7 jurisdictions



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS). Population 12 years or older. Data for Uruguay based on report VI National Household Survey on Drug Use -2016, and the Monitor Cannabis report. Population 15 to 65 years.

4.3.3 Past-Year Prevalence of Cannabis Use Pre-Post Non-Medical Cannabis Legalization- by Sex

The trends of past-year prevalence of cannabis use for males and for females are presented in Figure 4.3 and Figure 4.4 respectively. The prevalence of past-year cannabis use for both males and females in the US general population shows a slowly increasing linear trend from 2006 to 2017. The results for males suggest an increase in prevalence of past-year cannabis use post-legalization in Uruguay and in Oregon. An increase was noticed in Colorado in the first two years post-legalization; however, the prevalence went down and remained the same after that. In Washington DC, the pattern suggests an increase in past-year prevalence of cannabis use in the two years prior to legalization, followed by a decrease in the first year, and did not change after that. Statistical analyses would be required to determine whether these changes are greater than chance. The overall impression is that of a gradual, approximately linear, increase in all of these jurisdictions over time. The frequency is higher in men than women, and is higher in the legalized states than the general US population, both before and after legalization.

The results for females suggest a gradually increasing prevalence of past-year cannabis use post-legalization, similar to that seen in men, but at slightly lower frequencies. In Alaska, the past-year prevalence of cannabis use suggests a decrease in the estimate post-legalization for 2016-2017.

Figure 4.3. Prevalence of past-year cannabis use pre-post legalization for males

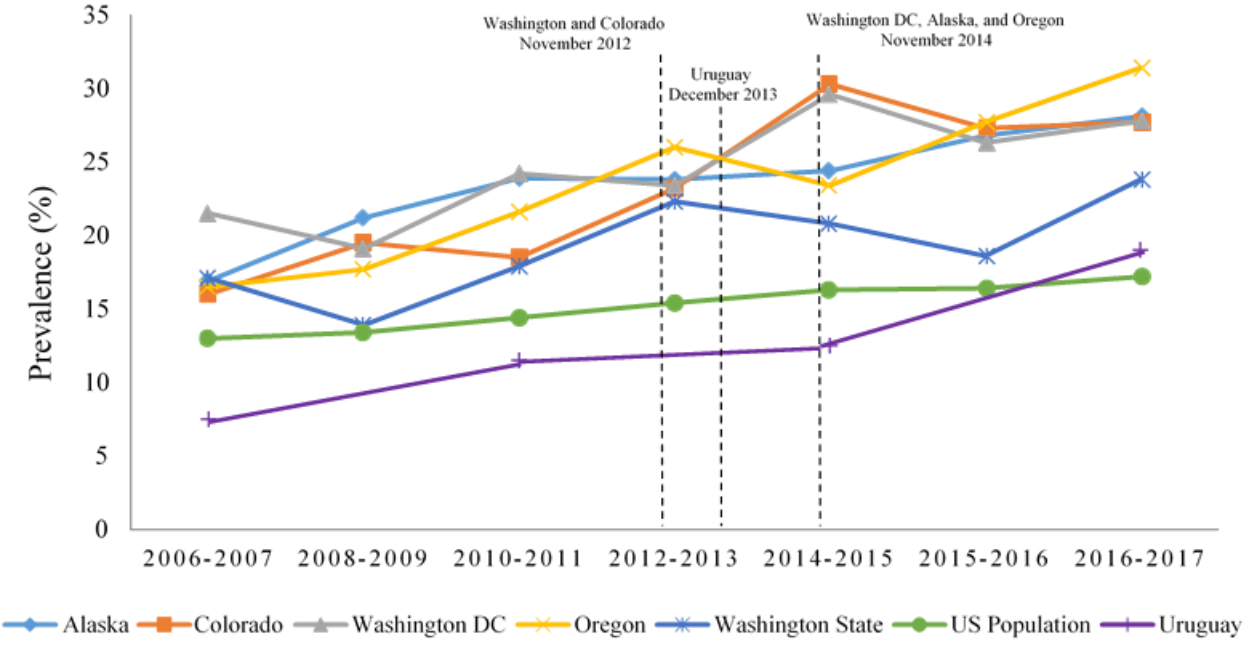
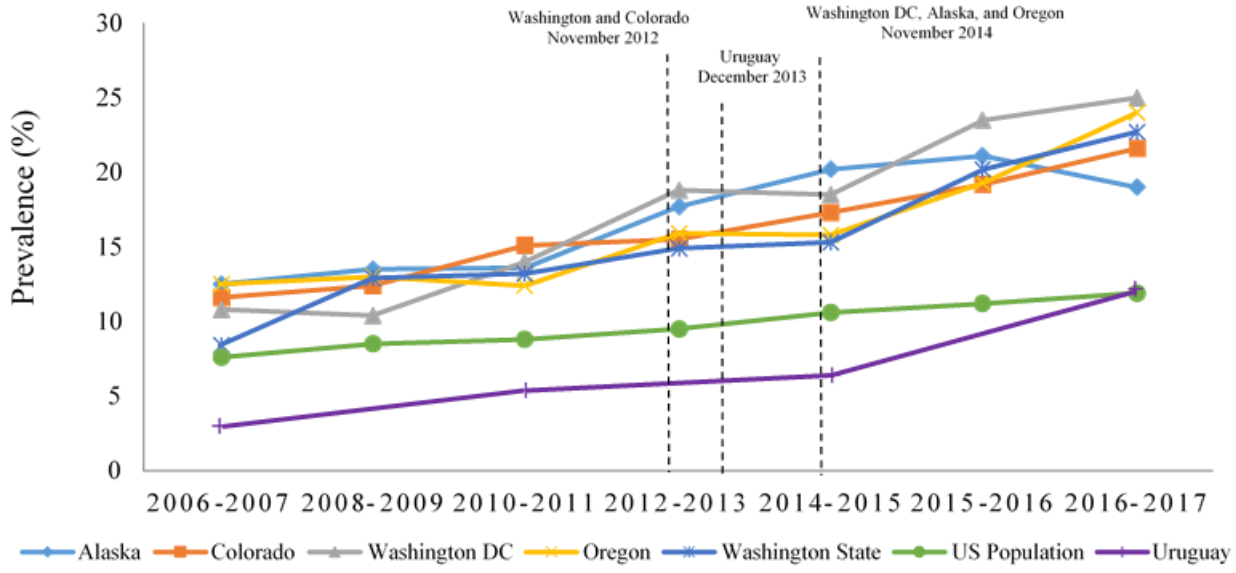


Figure 4.4. Prevalence of past-year cannabis use pre-post legalization for females



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS). Population 12 years or older. Data for Uruguay based on report VI National Household Survey on Drug Use -2016, and the Monitor Cannabis report. Population 15 to 65 years.

4.3.4 Past-Year Prevalence of Cannabis Use Pre-Post Non-Medical Cannabis Legalization- by Age Categories

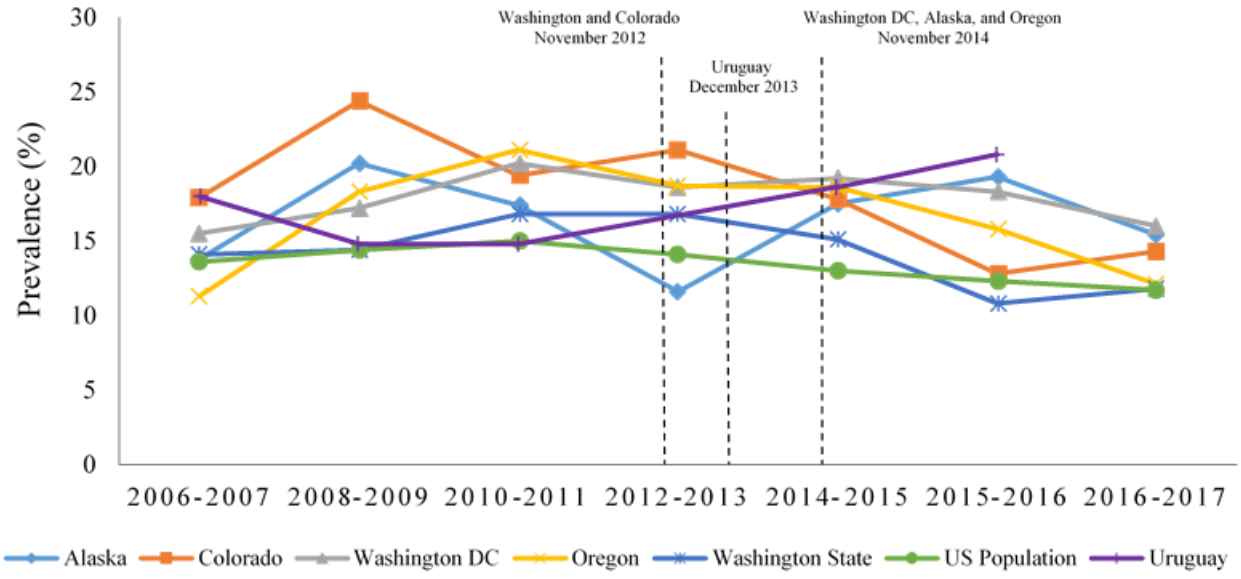
The estimates of the prevalence were obtained for the following age categories: Under 18 years of age (12-17 in the US and 13-17 in Uruguay); 18-25 years old; 26-49 years old; and 50 plus years old. Data for Uruguay was available only for the Under 18 age category.

For the category Under 18 years of age (Figure 4.5), the pattern suggests a decrease in the prevalence of past-year cannabis use post-legalization for Oregon, Washington State, Washington DC, and in Colorado. In Alaska, the past-year prevalence went down in 2012-2013 (period prior to legalization); then it went up right after legalization. However, the estimate for 2016-2017 suggests that the past-year prevalence of cannabis consumption is going down in that state. In Uruguay, the pattern suggests an increase in past-year prevalence of cannabis use post-legalization.

For the age category 18-25 (see *Appendix 3 Figure A3.1)*, an increase in the past-year prevalence of cannabis use post-legalization is suggested for Oregon; and a decrease is suggested for Alaska. The pattern for the other jurisdictions is similar pre-post legalization.

For the age category 26-49 (see *Appendix 3 Figure A3.2*), an increase in the past-year prevalence of cannabis use post-legalization is suggested only for Oregon. The pattern for the other jurisdictions is similar pre-post legalization.

Figure 4.5. Prevalence of past-year cannabis use pre-post legalization by age: US 12-17; Uruguay 13-17 years old

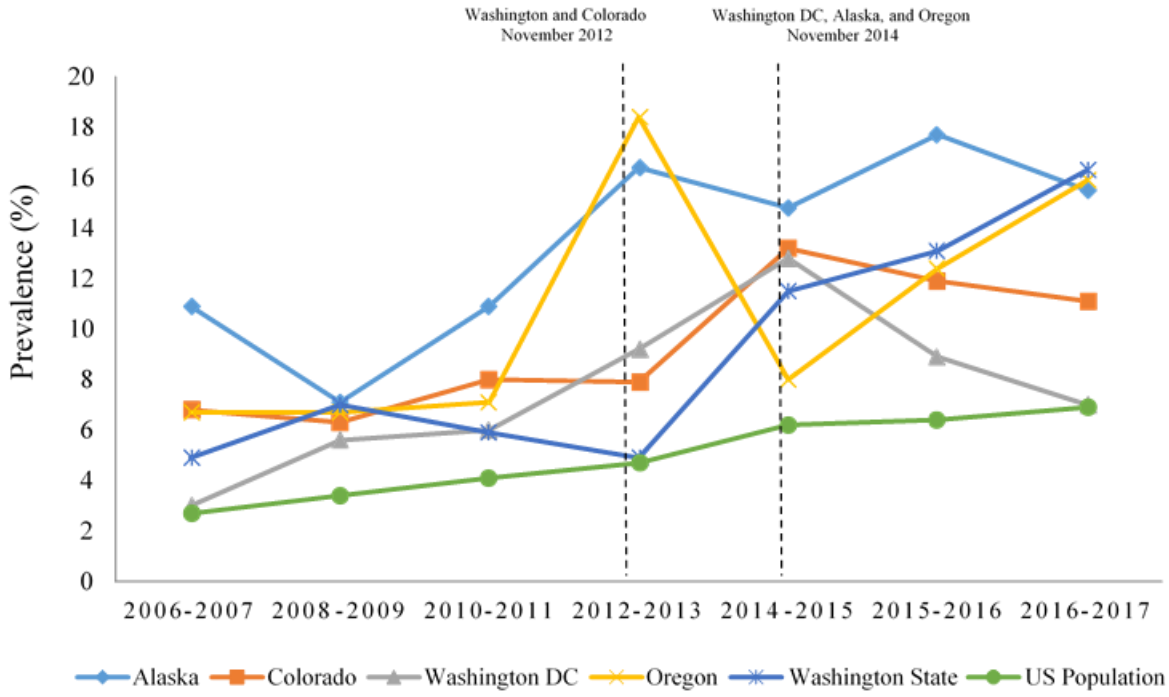


Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS). Data for Uruguay based on report from the VII National Survey on Drug Use in High School Students.

For the age category 50 years or more (Figure 4.6), the rates appear to be unstable, with a large extent of year-to-year variability in some jurisdictions. This instability in the estimates suggestions that they are vulnerable to random variation, possibly due to inadequate sample sizes. These estimates should therefore be interpreted with caution. Overall, the data suggest an increase pattern of prevalence of past-year cannabis use in the US population. At the jurisdiction level, an increase in the past-year prevalence of cannabis use post-legalization is suggested in Washington State and Colorado. The pattern for the other jurisdictions is similar pre-post legalization.

The reduction in use in the under 18 age range, with increases occurring in other age groups, mirrors the patterns reported in Canada in the first section of this report, where the data all precede legalization of non-medical use. This suggests that timing of legalization does not have a particularly large impact on trends in the prevalence of past-year use.

Figure 4.6. Prevalence of past-year cannabis use pre-post legalization by age: 50 years or older



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS).

4.3.5 Past-Year Prevalence of Cannabis Use Pre-Post Non-Medical Cannabis Legalization- by Age and Sex Categories Combined

The data available only allows for the analysis of past-year prevalence of cannabis use for both males and females under 18 years of age; and for both males and females 18-25 years of age. Data for Uruguay was available only for the under 18 years of age category.

The results for males under 18 years of age (Figure 4.7) indicates a decrease in the prevalence of past-year cannabis use post-legalization for Colorado and Washington State. A tendency towards a decrease in prevalence post-legalization was observed for Alaska, Washington DC and Oregon. However, an increase in prevalence of past-year prevalence of cannabis use was observed in Uruguay. At the US general population level, the pattern indicates a decrease in the prevalence of past-year cannabis use for males in this age category.

The results for females under 18 years of age (Figure 4.8) indicates an increase in past-year prevalence of cannabis use in Uruguay. No change was observed in the pre-post legalization prevalence for the US general population for females in this age category. Similarly, no change was observed among females for the jurisdictions in the US included in the analysis.

Figure 4.7. Prevalence of past-year cannabis use pre-post legalization for males under 18 years of age. US: 12-17 years old; Uruguay: 13-17 years old

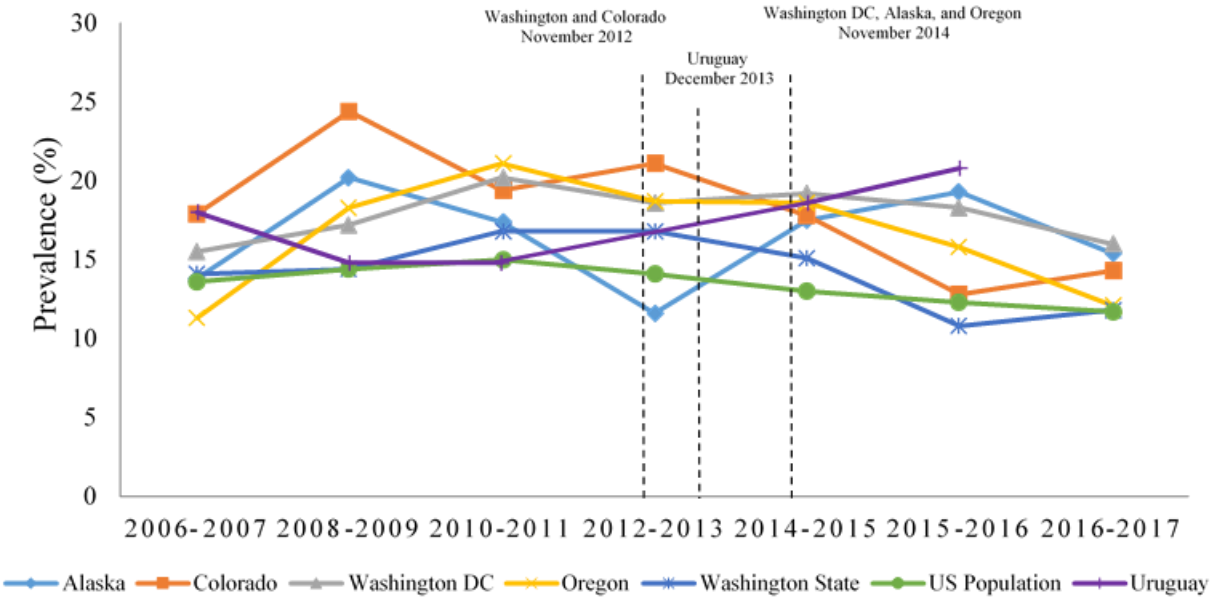
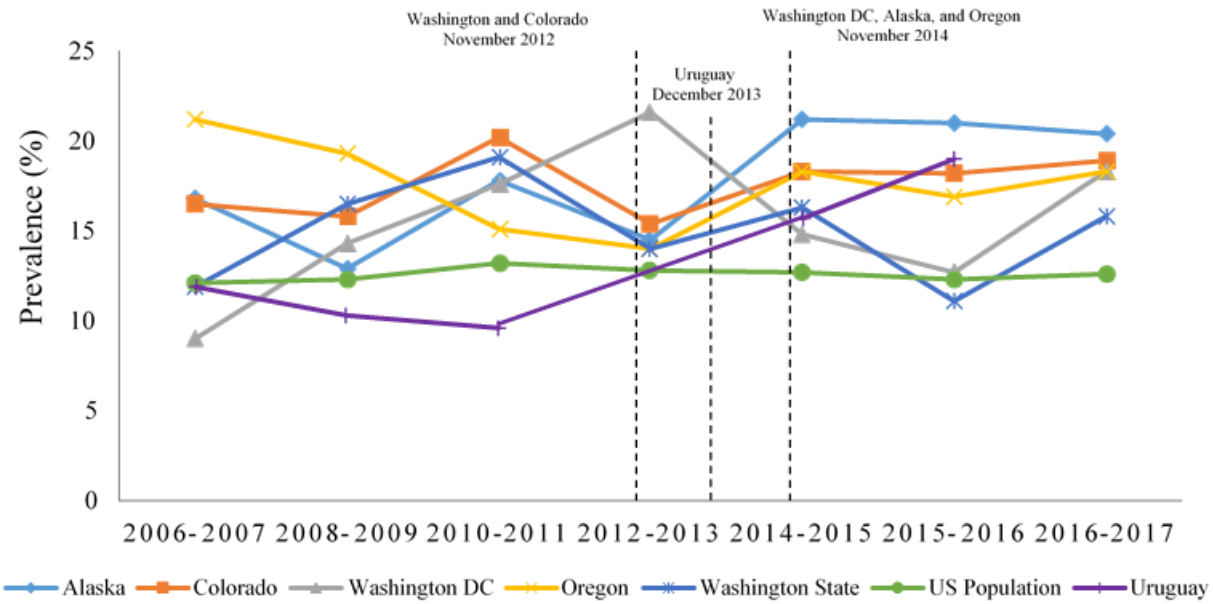


Figure 4.8. Prevalence of past-year cannabis use pre-post legalization for females under 18 years of age. US: 12-17 years old; Uruguay: 13-17 years old



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS). Data for Uruguay based on report from the VII National Survey on Drug Use in High School Students.

For males 18-25 years old, the results suggest no changes in the pattern of past-year prevalence of cannabis use over time (Figure 4.9).

For females 18-25 years old (Figure 4.10), the results suggest an increase in the pattern of past-year prevalence of cannabis use post-legalization for Oregon and Washington DC. No changes in pattern pre-post legalization was observed for Colorado, Washington State, and Alaska.

Figure 4.9. Prevalence of past-year cannabis use pre-post legalization, males 18-25 years old

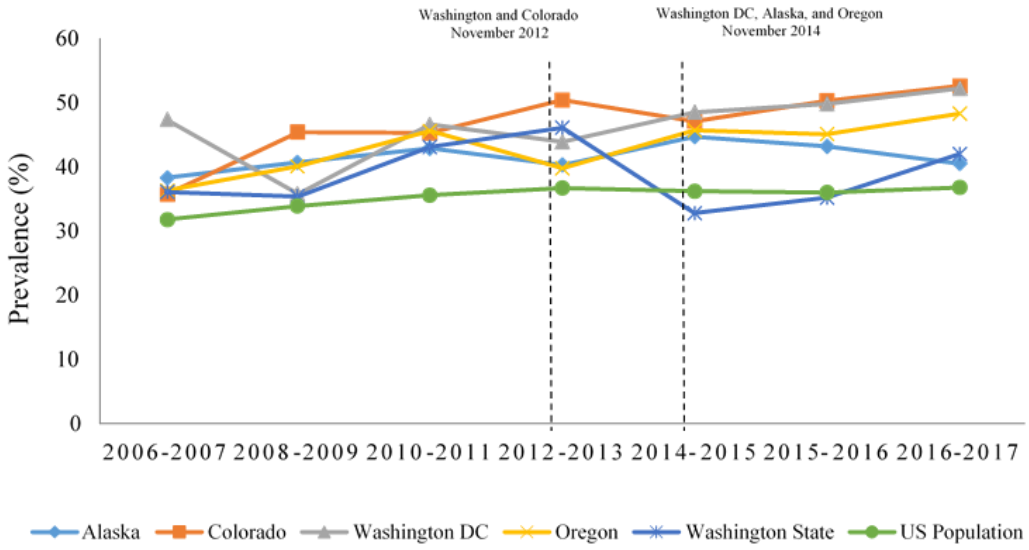
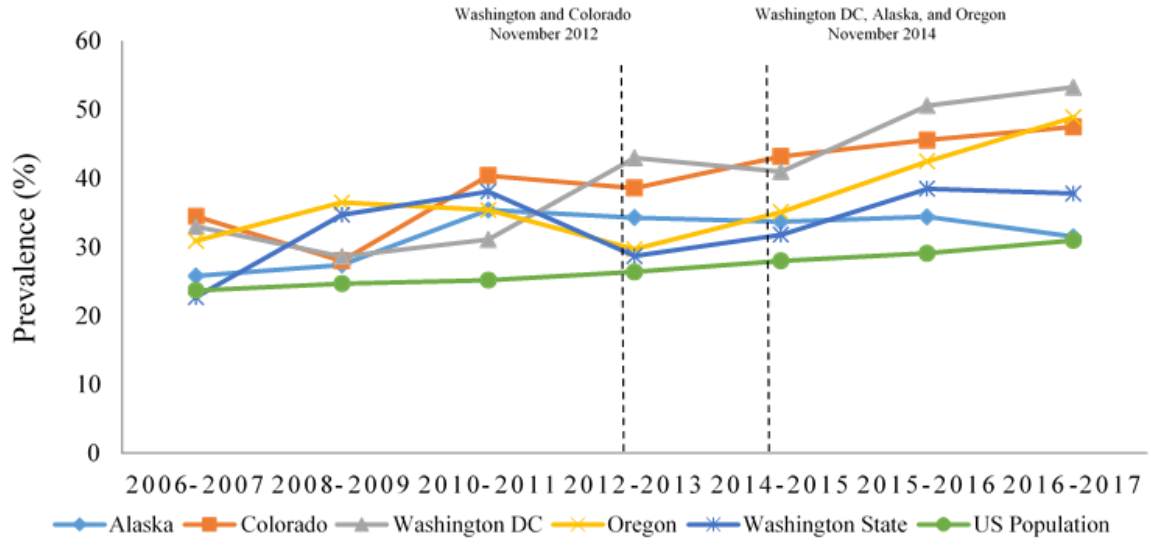


Figure 4.10. Prevalence of past-year cannabis use pre-post legalization, females 18-25 years old



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS)

5. Scoping Review

Key points in this chapter:

- A rigourous scoping review, including multiple disciplines of science, identified 1047 studies assessing cannabis use and mental health
- Preclinical animal studies (n=177) predominantly assess THC administered though injection; this limits the generalizability of this literature to human application (section 5.3)
- While the human studies (n=870) are numerous, very few studies were able to establish the direction of the association between cannabis and mental health (section 5.4).
- Very few studies consider sex and gender, children, seniors, Indigenous peoples, IRER populations, 2SLGTBQ and ACE populations (section 5.4-5.8)

We conducted a scoping review to explore the current scientific evidence examining the associations between cannabis and mental health. The aim of this scoping review was to identify gaps in the current literature by examining: study design, mental health outcomes of interest, populations, type of cannabis and mode of cannabis administration used. The results of this scoping review can be used to inform decisions about future research to fill the gaps in understanding the effect of cannabis use on mental health

5.1 Methods overview

To identify relevant literature, a search strategy was executed in Embase, Medline, Cochrane, PsycInfo, and CINAHL databases (*Appendix 4*) following peer review by a second librarian using PRESS guidelines[107]. The PRISMA ScR Checklist (*Appendix 5*) was used to inform the methodology of the scoping review [108]. The search was broad in scope to capture human and animal studies that explored an association between cannabis and mental health with no time restrictions and limited to the English language. All studies identified from the literature search were initially screened by title and abstract (if available) before moving on to full-text screening. All includes full texts were then screened in duplicate for inclusion (Inclusion/Exclusion criteria in *Appendix 6*). Briefly, the inclusion and exclusion criteria for both animal and human studies were: 1) cannabis (or cannabis extract) as the exposure, 2) mental health outcomes or an assessment of mental health (e.g. diagnosed mental health disorder, therapeutic benefits, chemical, functional or physical changes in the brain) were the outcome(s), 3) synthetic cannabis and endocannabinoid agonists were not used, and 4) a comparative design was employed (comparison groups could include no cannabis abuse and/or no cannabis use as defined by authors). Qualitative studies were not required to have a comparison group. Descriptive statistics were used to summarize the data.

The included studies were further categorized into 1) Preclinical (animal or human) and 2) Human populations. Studies were then further categorized based on the subjects and outcomes of

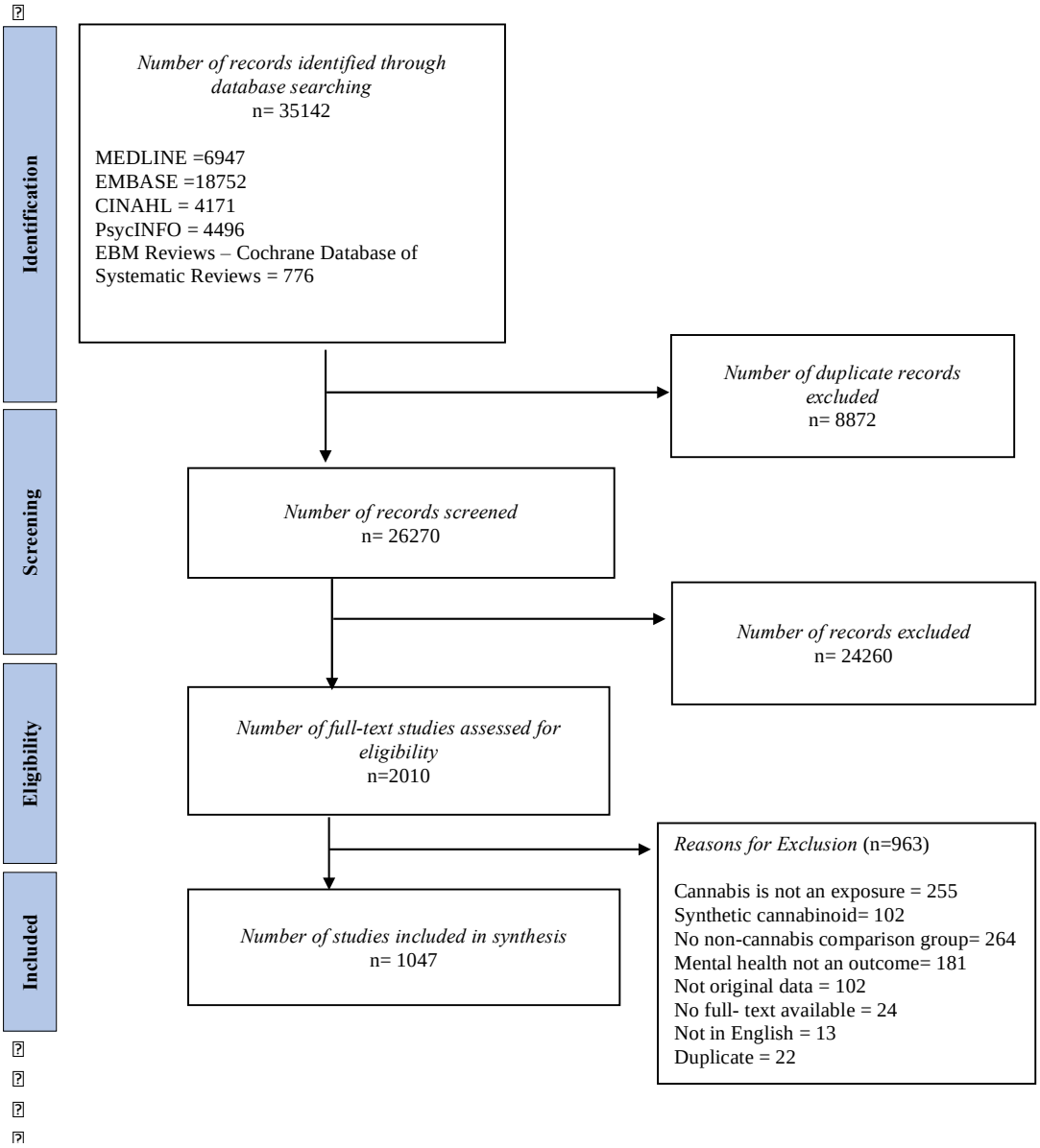
the studies. A single article could be categorized within more than one category if the study reported more than one outcome. The categories were:

1) Wild-type animal studies: animal studies that use unaltered animals
2) Animal models of human disease: animal studies that use animals that were modified in an attempt to mimic human diseases such as schizophrenia or substance use disorder
3) Changes in the human brain: studies in humans that assess changes within the brain using imaging or behavioural approaches
4) Mental health in community populations
5) Mental health in clinical populations

5.2 Overview of included studies

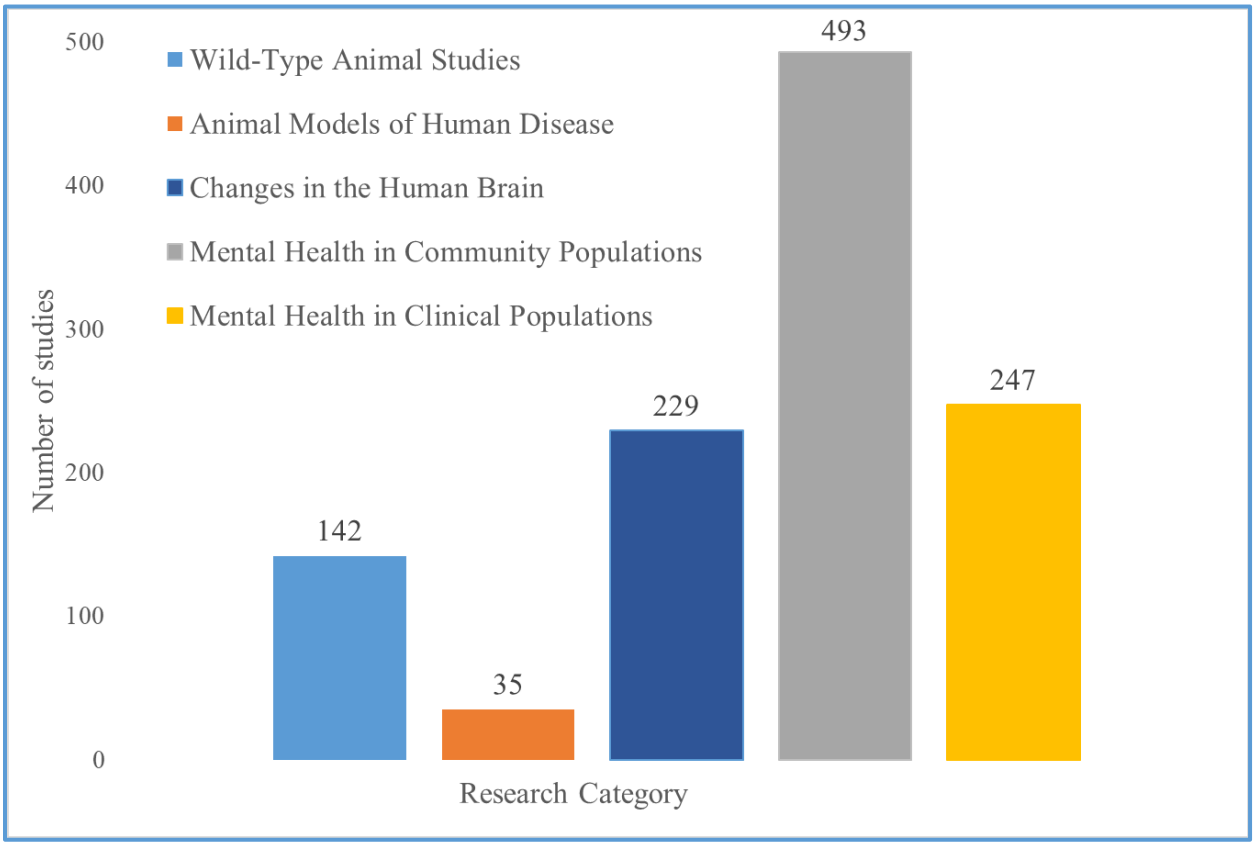
Following the initial literature search of all databases, 35,142 citations were identified. After the removal of duplicate citations, 26,270 unique titles and abstracts were screened for inclusion. Of these, a total of 2,010 articles met the abstract inclusion/exclusion criteria (listed above) and were included for full text screening. After full-text screening, a total of 963 studies were excluded. The most common reasons for exclusion were that cannabis was not assessed as the exposure (n=255) and the lack of a comparative group (n=264). 1,047 studies met our inclusion criteria and were included in our final dataset (Figure 5.1). A full list of papers included in each area of research category can be found in *Appendix 7*.

Figure 5.1. Flowchart of included studies in scoping review



The largest volume of research examined mental health outcomes among community populations (Figure 5.2). Many of the preclinical human studies, which measured changes in the brain as the primary outcome, also measured outcomes such as anxiety, depression and substance use to establish pre- and post-exposure measures for the study participants. These studies are captured in both the "Changes in human brain" and the appropriate population category (community or clinical).

Figure 5.2. Number of Studies in Each Research Category



Footnote: Studies could be included in more than one category

The majority of the research is being done in the US with significant amounts of literature produced in the UK, Australia, the Netherlands and Canada (Figure 5.3). In the majority of countries, research is most often conducted in the clinical outcomes category with the exception of Brazil where the majority of studies were preclinical. There has been an increase of studies examining the relationship between cannabis use and mental health, especially in the last 15 years (Figure 5.4).

Figure 5.3. Number of Studies per Country (research institute or study population), by Research Category

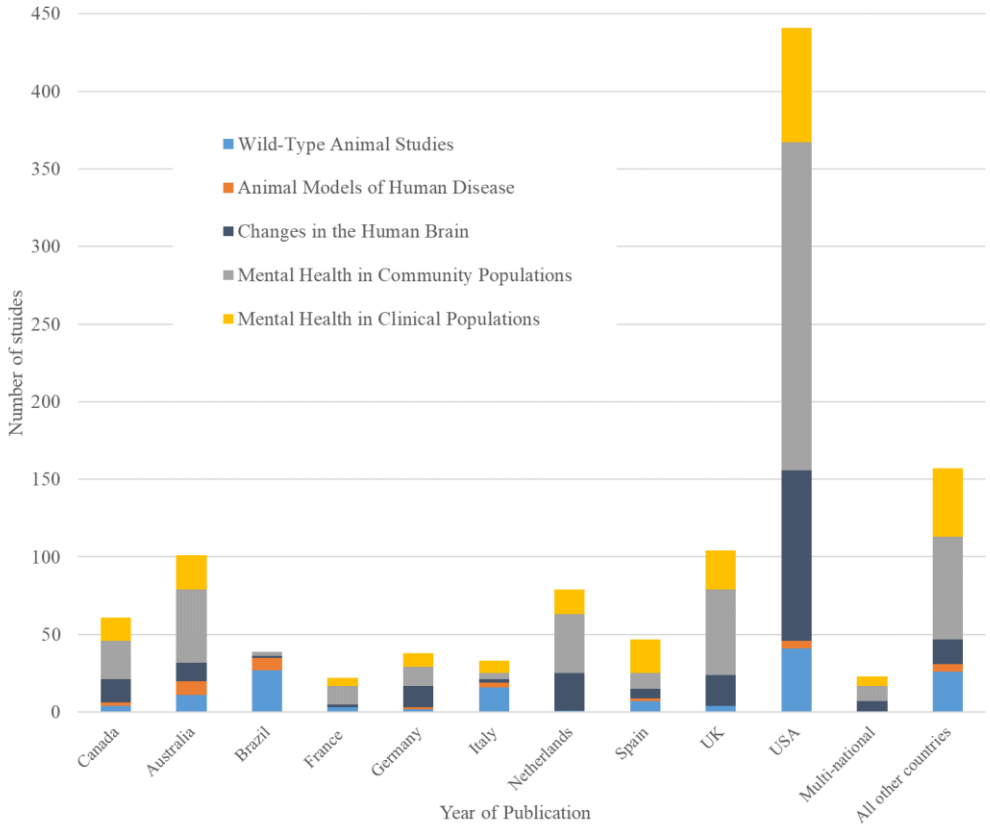
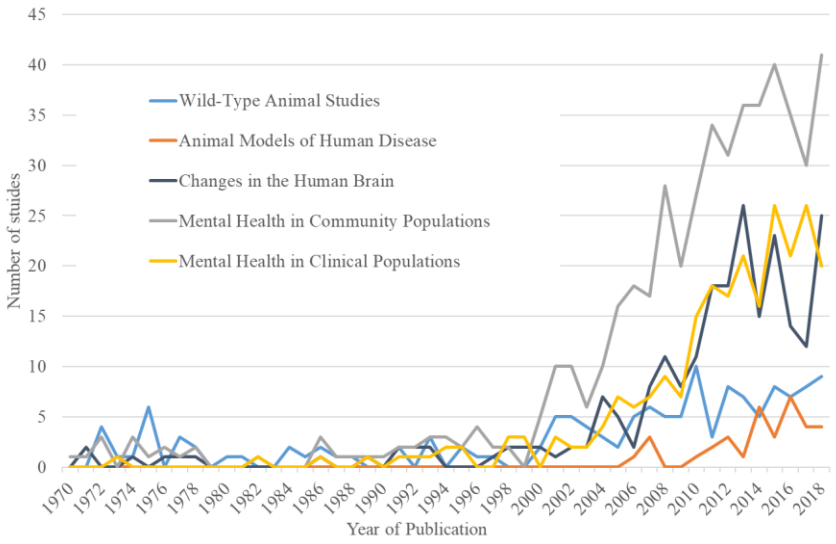


Figure 5.4. Number of Studies Conducted by Publication Year and Research Area Category



5.3 Preclinical Research

5.3.1 Preclinical Animal Studies

Preclinical animal studies examined the associations between cannabis and mental health outcomes in non-human subjects including mice, rats, and primates. Animal studies were further divided into: 1) Wild-type animals, which included unaltered animal subjects, and; 2) Animal models of human disease, which included animal subjects altered via genetic or chemical manipulation to model a human health disorder (e.g., depression, schizophrenia, anxiety, diabetes). There were a total of 177 animal studies, with the majority of studies being conducted in the USA (n=46), Brazil (n=35), and Australia (n=20). Six animal studies were conducted in Canada.

5.3.1.1 Wild-type Animals

There were 142 studies conducted on wild-type animals between the years 1972-2018. From 1972 to 1999, there was an average of two publications per year (n=35). Beginning in 2000, there was a substantial increase in publications, averaging six publications per year from 2000-2018 (n=107). Wild-type animal studies predominately tested the effect of THC only on mental health outcomes (Figure 5.5).

Additionally, the animal subjects used most often were mice and rats, with the majority of studies using groups of more than six animals. Using less than six animals per arm is a marker for low study quality (Figure 5.6). The mode of administration was injection in the majority of studies (n=124), with very few employing edible administration (n=10).

Figure 5.5. Type of Cannabis Extract Administered to Wild-type Animals

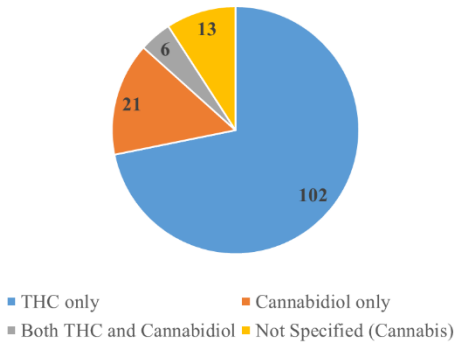
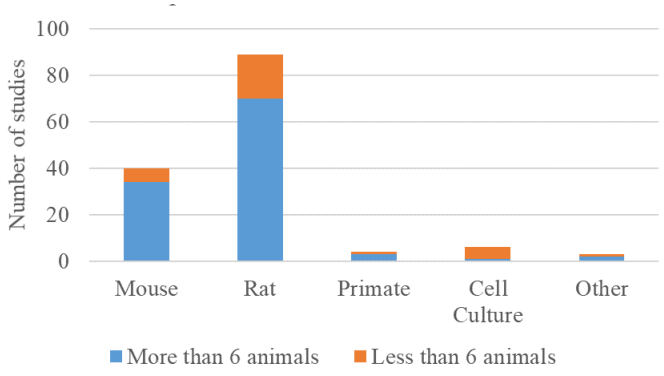


Figure 5.6. Number of Wild-type Animal Studies by Type and Number of Animal Subjects



5.3.1.2 Animal Models of Human Disease

There was a total of 35 studies conducted on animal subjects altered to model a human disease. The first study in this research category was published in 2006, reflecting when the field of preclinical research adopted formal titles for animal models of human disease (e.g., Schizophrenia) or dysfunction (e.g., impaired cognition).

Similar to the Wild-type Animal studies, rats and mice were used most often in the Animal Model of Human Disease studies, with more than six animals per group being used most frequently (Figure 5.7).

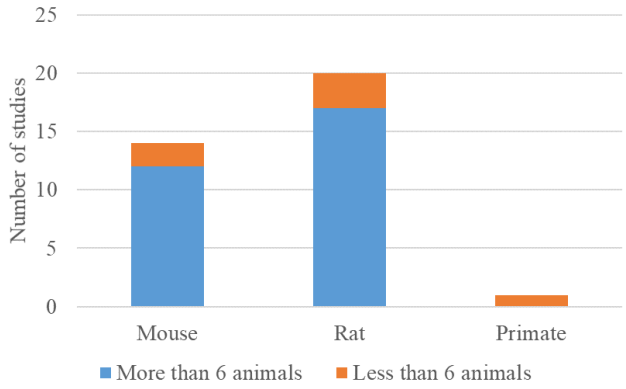


Figure 5.7. Number of Animal Models of Human Disease Studies by Type and Number of Animal Subjects

The human disease most often modelled in animals was schizophrenia (n=18), followed by substance use disorder (n=7; heroin in 3 studies, cocaine in 2 studies, morphine and cannabis in 1 study, respectively), and depression (n=3) (Figure 5.8). There were four studies that were classified as "other" models, which included modeling Alzheimer's disease, dementia, and cognitive impairment.

Unlike the wild-type animal studies, the effects of cannabidiol-only was tested as frequently as THC-only (Figure 5.9). This may be related to the more recent research exploring the therapeutic effects of cannabidiol on mental health.

Figure 5.8. Type of Human Disease Model Used in Animals

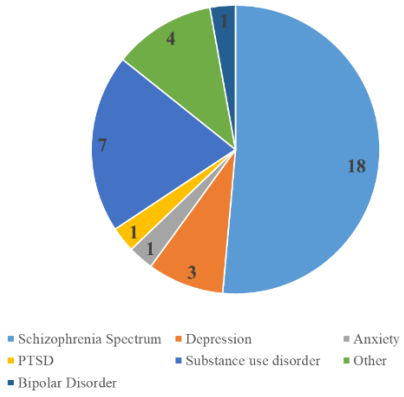
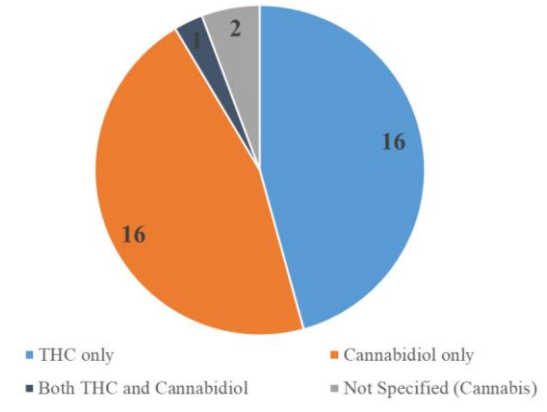


Figure 5.9. Type of Cannabis Extract Administered within Animal Models of Human Disease



5.3.1.3 Canadian Studies

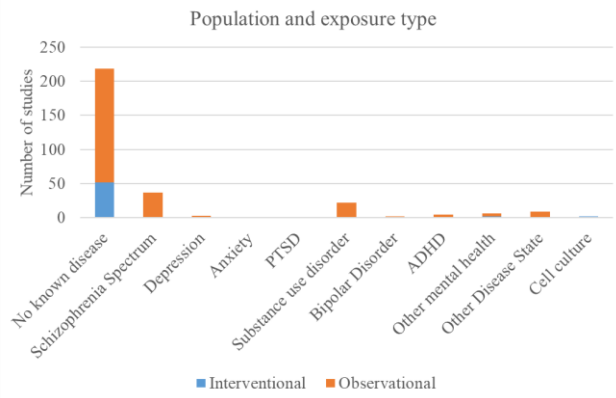
Within the preclinical studies, there were six conducted in Canada (Table 5.1). The four studies using wild-type animals were conducted at institutions in British Columbia, Alberta, and Ontario; the animal models of human disease studies were conducted in Quebec and Ontario. All Canadian studies administered cannabis via injection on rat subjects. The wild type animal studies tested THC-only in three studies, with the remaining study testing several cannabis extracts (e.g., THC-only, cannabidiol-only, and THC and cannabidiol combined). The two studies that used animal models of human disease tested cannabidiol-only in a schizophrenia model, and substance use disorder model. Tests of cognition, locomotion, and behaviour were often conducted to analyze differences between animals administered cannabis versus a control solution. Analysis of in vivo (i.e., live animal) brain activity was conducted using electrophysiology recordings in half of the studies. Brain tissue testing was conducted in five studies using protein extraction/isolation and blotting (n=3), perfusion and fixation (n=1), radioligand-binding assay (n=1), and protein isolation. The brain activity outcomes of interest included: receptor activation or binding (n=2), neurotransmitter activity (e.g., DAergic activity) (n=2), protein isolation (n=1), brain volumes (n=1). The behaviour outcomes of interest included: cognition (n=4), anxiety (n=4), pre-pulse inhibition (PPI) response (n=2), memory (n=2), psychomotor activity (n=1), and substance-seeking (n=1).

Table 5.1. Descriptive table of Animal studies conducted in Canada

Institute	Author	Year	Species	Testing	Lines of Inquiry
University of Western Ontario (Laviolette Lab)	Renard	2016	Rats	Cognition, behavioural, PPI, in vivo electrophysiological recordings, protein extraction and blotting	cognition, memory, anxiety, PPI, protein isolation
	Renard	2017	Rats	in-vivo electrophysiological recordings, protein isolation, and cognitive tests	receptor activation, social cognition, memory, subcortical DAergic hyperactivity , anxiety
	Renard	2016	Rats modelling schizophrenia spectrum disorder	in vivo single-unit neuronal electrophysiology recordings, locomotor activity, protein extraction and western blotting, PPI	DAergic neuronal activity, psychomotor sensitization, PPI inhibition
University of Lethbridge (McDonald Lab)	Keeley	2015	Rats	Perfusion and fixation; behavioural testing	cognition, brain volumes, anxiety
University of British Columbia (Winstanley Lab)	Silveira	2017	Rats	cognitive effort task, radioligand-binding assay	cognition and receptor binding
Concordia (Shalev Lab)	Mahmud	2017	Rats modelling substance use disorder	Behavioural testing; drug-seeking	substance seeking and anxiety

5.3.2 Preclinical Human Studies: Brain outcomes in Humans

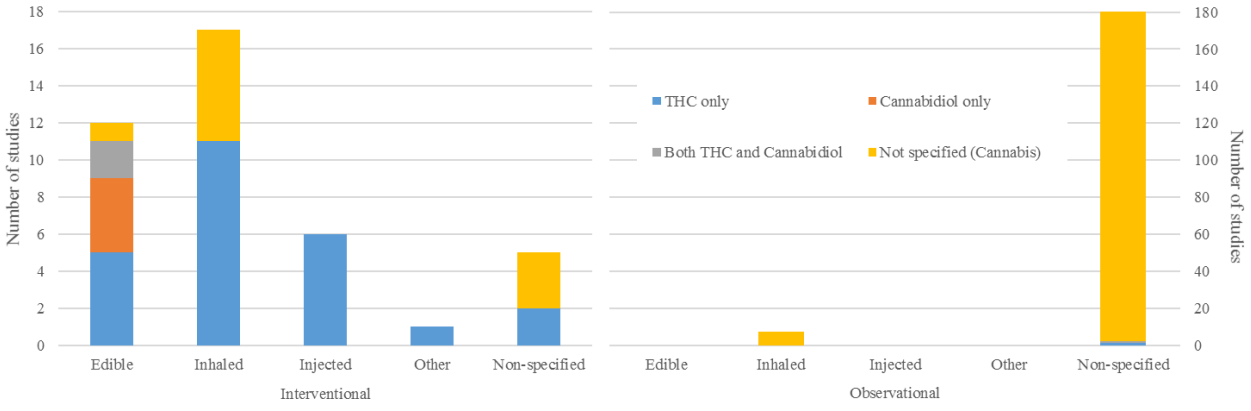
Figure 5.10. Populations studied in human brain studies



There were 229 studies included assessing the human brain. Studies in this category used brain imaging (e.g., fMRI, EEG, PET or PPI) to collect data on the associations between cannabis and brain structure, activity, and/or function. Studies were published steadily from 1970-1999, with a rapid increase in publication after 2010. Nearly half of the studies were published in the USA (n=110), followed by the Netherlands (n=24), the UK (n=20), and Canada (n=15). Of the 229 human brain studies, 188 were observational (e.g., cohort/longitudinal, cross-sectional, or correlational study design), and 41 were interventional (e.g., randomized or non-randomized control trials). Most of the studies used a sample of individuals without known disease (n=168). However, some studies assessed other populations such as people with diagnosed schizophrenia spectrum disorder (n=29) and substance use disorder (n=15) (Figure 5.10). Other populations considered less frequently include individuals with ADHD (n=4), depression (n=3), and bipolar (n=2). No studies assessed people with PTSD or anxiety.

The observational studies typically measured cannabis use by administering a questionnaire or by urine screening, both of which did not explicitly capture the type of cannabis extract used. For this reason, nearly all observational studies reported unspecified cannabis, with the exception of one study reporting THC –only, and one study reporting both THC and cannabidiol (Figure 5.11). In the interventional studies where cannabis was administered by the researchers (either randomly or non-randomly), THC-only was most often administered (n=25), followed by non-specified cannabis (n=10), and cannabidiol-only (n=4) (Figure 5.11). Mode of administration in the interventional studies was most frequently inhalation (n=17), followed by oral capsule (n=12). Nearly 15% of interventional studies administered THC via injection, an uncommon method of cannabis consumption in the general population.

Figure 5.11. Mode of Administration and Type of Cannabis, Stratified by Study design



5.3.2.1 Canadian Studies

Of the 229 human brain studies, 18 were conducted in Canada, and all were observational in design. All but two Canadian studies were published in the past six years (Table 5.2). Studies were conducted by institutions in various provinces including Ontario, Quebec, British Columbia, and Alberta. The populations considered in the Canadian context include diagnosed schizophrenia spectrum disorder, depression, clinically high risk for psychosis, and Multiple Sclerosis. Canadian researchers have focused on adult populations, though adolescent populations were considered in three studies.

The imaging/testing technology used most often is magnetic resonance imaging (MRI) or functional MRI (fMRI), followed by electroencephalogram (EEG), event-related potential (ERP), positron emission tomography (PET), and transcranial magnetic stimulation (TMS). The outcomes of interest were related to brain activation in various regions of the brain during various tasks (e.g., tasks related to memory, recognition, sensorimotor, or information processing). Other outcomes included brain volumes (e.g., cortical thickness), receptor function, neurotransmitter activity, and connectivity.

Table 5.2. Descriptive table of Human Brain studies conducted in Canada

Institute	Author	Year	Population	Imaging Technology	Lines of Inquiry	Sex or Gender lens
Carleton University	Smith[a]	2004	Ottawa Prenatal Prospective Study population	fMRI	brain activation	
Centre for Addiction and Mental Health	Goodman[b]	2017	Healthy population and diagnosed schizophrenia spectrum disorder population	TMS	cortical inhibition from motor cortex; receptor function	
	Mizrahi[b]	2014	High Risk for Schizophrenia Spectrum	PET	stress induced DA release, sensorimotor control task, binding potential	
	Mizrahi[a]	2013	Healthy recruited from community through online postings	PET	stress induced DA release, sensorimotor control task, binding potential	
McMaster University	Kiang[a]	2013	Healthy - recruited from community via newspaper and internet	ERP	Brain activation; semantic memory	
Rotman Research Institute	French	2015	Healthy adolescents (European, English, and Canadian cohorts). Canadian sample selected from the Canadian Saguenay Youth Study	MRI	cortical thickness; look at gene expression for schizophrenia	Report combined and stratified analysis

Simon Fraser University	Asmaro	2014	Healthy psychology students	EEG	brain activation	
Sunnybrook Health Science Centre	Romero	2015	Mulitple Sclerosis (MS) patients recruited from MS clinics	MRI	Grey and white matter volume correlated with cognitive deficits	
University of Alberta	Campbell	1971	Healthy adults	EEG	% abnormal EEG	
University of Calgary	Buchy	2015	Clinical high risk for psychosis and healthy controls from North American Prodrome Longitudinal Study (NAPLS-2)	fMRI	whole brain thalamic functional connectivity maps	
	Buchy	2016	Clinical high risk for psychosis and healthy controls from North American Prodrome Longitudinal Study (NAPLS-2)	MRI	brain volumes (thalamus, hippocampus, amygdala)	
University of British Columbia	Brooks	2018	Healthy - given course credit or cash to participate	EEG, ERP	Brain activation, perceptual encoding of stimuli	
University of Montreal	Bourque[b]	2013	Outpatient population with schizophrenia spectrum disorder, and healthy controls	fMRI	cerebral activation, blood oxygenation level	Males only
	Potvin[b]	2013	Outpatient population with schizophrenia spectrum disorder, and healthy controls	fMRI	brain activation,	Males only
University of Toronto	Pavisian[a]	2014	MS patients - no recruitment info	fMRI	lesions, brain tissue volume, diffusion tensor imaging metrics; cerebral activation while completing cognitive tasks	
	Pavisian	2015	MS patients - no recruitment info	MRI	brain activation	
University of Western Ontario	Ford[a,b]	2014	Adolescent healthy controls and Major Depressive Disorder patients recruited through the First Episode Mood and Anxiety Program	fMRI	functional brain activation	

	Osuch[b]	2016	People with depression, and healthy control groups - age group 16-23 years; recruited through community	fMRI	default mode network brain connectivity

Notes:
[a] secondary outcome also captured in Mental Health in Community Populations
[b] secondary outcome also captured in Mental Health in Clinical Populations
Abbreviations: Magnetic Resonance Imaging (MRI); Functional MRI (fMRI): Electroencephalogram (EEG); Event-Related Potential (ERP); Positron Emission Tomography (PET); Transcranial Magnetic Stimulation (TMS).

5.4 Mental Health Outcome studies

5.4.1 Mental Health in Community Populations

Studies in this category were those that examined the effects of cannabis on mental health outcomes in individuals or populations who were selected from the community. Mental health outcomes were either symptoms, diagnosis, or age of onset (Box 5.1). Specified mental health disorders were considered including Depression, Schizophrenia, Bipolar Disorder, PTSD, Anxiety, Substance Use Disorder; as well as other outcomes of interest including self-perceived well-being, quality-of-life, alcohol and tobacco use, and suicide ideation or attempt.

Populations of interest were identified based either on age at the time the study took place, or specific cohorts of people based on cultural identification if specified by the researcher (e.g., Immigrant, Refugee, Ethnocultural and Racialized (IRER) populations; members of the 2SLGBTQ community; cohorts that have experienced adverse childhood experiences (ACEs); other conditions such as Diabetes, Multiple Sclerosis).

Box 5.1:

Definitions of disease phase

Symptoms: Physical or mental features regarded as indicating mental illness. Examples include but are not limited to depressed mood, hallucinations, anxiety.

Diagnosis: Diagnosis of a mental illness based on DSM criteria-made by a physician, mental health professional, or a trained interviewer using a validated questionnaire (e.g., World Health Organization World Mental Health Composite International Diagnostic Interview). Examples would be diagnosis of Depression, Schizophrenia Spectrum Disorder or PTSD. The diagnostic terminology can be different (e.g., Depression or "Depressive Disorder"). Often studies will use a scale to assess the syndrome of Depression in a way that involves more than a single symptom without implying a diagnosis. For example, in DSM, a diagnosis requires a recognizable clinical syndrome but also other features (e.g., an abnormal emotional reaction, severe distress or dysfunction, or chronic pain).

Age of Onset: Age at which a diagnosis of mental health disorder was made.

A total of 493 studies examined the association between cannabis and mental health outcomes. The most frequently reported study design was a cohort or longitudinal design (Figure 5.12), identifying cannabis use and calculating the odds or risk of developing mental health outcomes. For example, a common study design was the selection a sample of adults, establishment cannabis use with retrospective questionnaires and then assess a present-day mental health outcome.

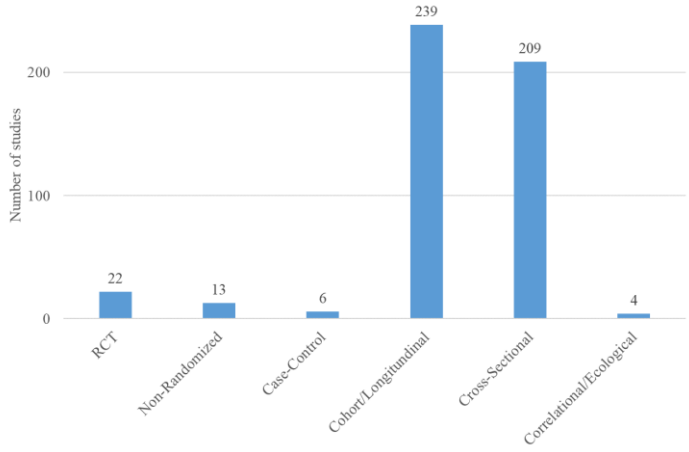
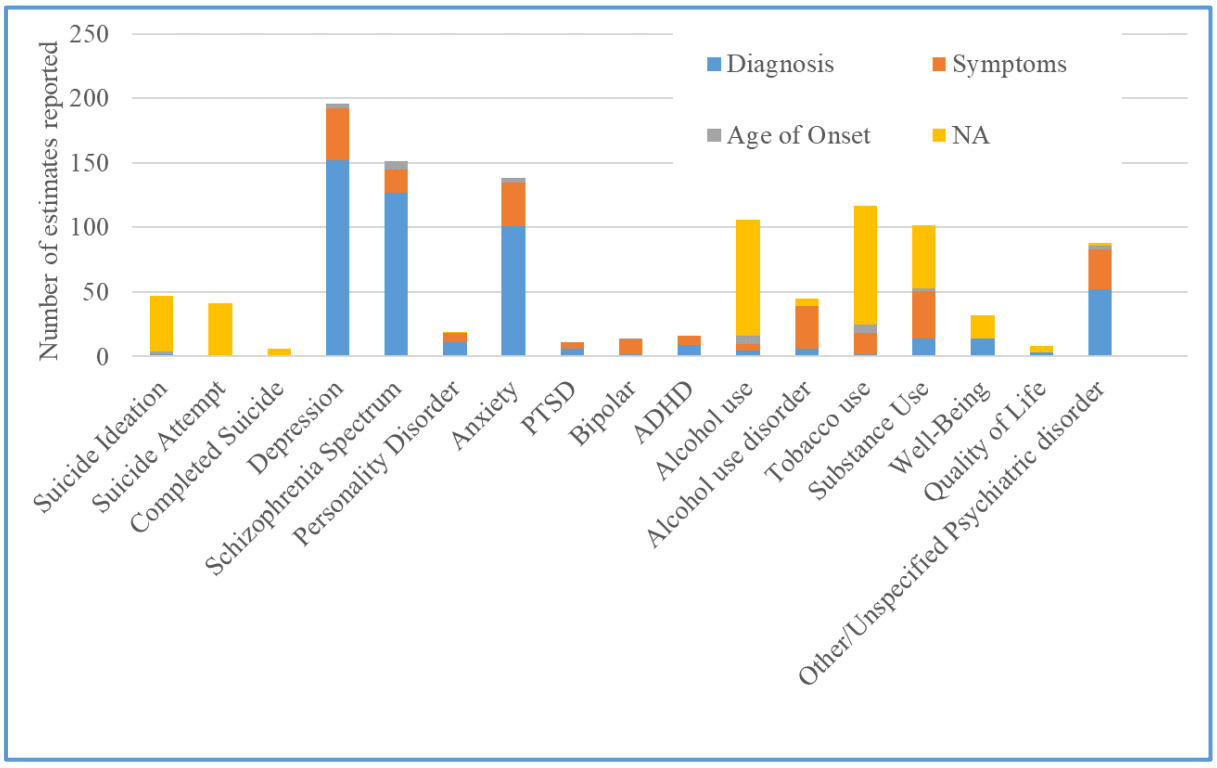


Figure 5.12. Number of Studies for Mental Health in Community Populations, by Study Design

Within the 493 studies, 1141 outcomes assessments were reported. The majority of studies examine the relationship between cannabis use and the diagnosis of Depression, Schizophrenia Spectrum Disorders and Anxiety Disorders (Figure 5.13). Symptoms of these disorders were also frequently examined. Other diagnosis assessed as outcomes include suicide ideation, suicide attempts, anxiety, PTSD, bipolar. Age at onset is the least commonly assessed relationship. This is likely due to the more complex study design required to assess this relationship (longitudinal).

Figure 5.13. Type of outcome assessed within a community population, by outcome type and timing of outcome



Many studies assessed the relationship between cannabis use and substance use (n=370). Some specifically examined alcohol use (n= 106) or tobacco use (n=117). However, more commonly, substance use, without specific substances identified, was assessed. It is important to note that the majority of these studies are cross-sectional, thus, the timing of onset and the direction of the relationship cannot be established.

Very few studies assessed well-being and quality of life (n=40). The majority of the literature frames cannabis use within a harm lens. Similar to the larger body of literature, these studies were predominatly cohort or longnitudal in nature.

When the outcomes assessed are plotted by population considered, the areas of high volume of research are identified (Table 5.3). In Table 5.3, colours represent the volume of literature within each cell with the exact number of studies identified. Blue presents very little research and the colours shade to green representing the highest number of research.

Eighty-seven percent of the research was completed within an adolescent population (aged 10-18 years, n=253), a young adult population (aged 19-25 years, n=187) and a general adult population (aged ≥18 years, n=560). However, there is a paucity of outcomes reported in other groups that are likely to require research into their unique needs. For example, there were only eight studies that considered an IRER population: two assessed the relationship between suicide ideation and cannabis; four assessed depression and cannabis use; and two assessed substance use and cannabis use. Of note, across all populations, very few considered personality disorder, PTSD, bipolar, wellbeing, or quality of life.

Table 5.4 presents the literature assessing the relationship between substance use and cannabis use among adolescents, young adults and adults more specifically. Substance use is broken down into alcohol use, alcohol use disorder, tobacco use and unspecified substance use. The majority of the literature assesses a general adult population, most commonly assessing alcohol use, tobacco use and substance use. The literature assessing alcohol use disorder is the most limited body of literature across all three populations.

Table 5.3. Mental Health Outcomes Heat Map for Community Populations. Green represents outcomes and populations reported most frequently, blue represents outcomes and populations reported least frequently

		Population										
		Children (<10)	Adolescent (10-18)	Young Adult (19-25)	Adult (18+)	Senior (65+)	Indigenous	IRER	2SLGBTQ	ACE	Other	**Total**
Outcomes	Suicide Ideation and/or Attempt and/or Completion	0	44	9	28	1	2	2	1	0	7	**94**
	Depression	1	48	34	87	0	5	4	1	0	16	**196**
	Schizophrenia Spectrum	0	18	23	93	0	2	0	0	3	12	**151**
	Personality Disorder	0	5	1	11	0	1	0	0	0	1	**19**
	Anxiety	2	27	21	69	1	2	0	2	0	15	**139**
	PTSD	0	1	1	7	0	0	0	1	0	1	**11**
	Bipolar	0	2	3	9	0	0	0	0	0	0	**14**
	ADHD	0	6	4	6	0	0	0	0	0	0	**16**
	Substance use and/or disorder	0	79	66	193	0	2	2	0	0	28	**370**
	Well-Being	1	3	5	19	0	0	0	1	0	3	**32**
	Quality of Life	0	0	1	3	1	0	0	0	0	3	**8**
	Other/Unspecified Psychiatric disorder	1	20	19	35	0	3	0	0	0	13	**91**
	Total	**5**	**253**	**187**	**560**	**3**	**17**	**8**	**6**	**3**	**99**	

Abbreviations: IRER = Immigrant, Refugee, Ethnocultural, and Racialized; 2SLGBTQ = Two Spirit, Lesbian, Gay, Bisexual, Transgender, Questioning/Queer; ACE = Experienced Adverse Childhood Events

Table 5.4. Substance use outcomes heat map for community populations of adolescents, young adults and adults. Green represents outcomes and populations reported most frequently, blue represents outcomes and populations reported least frequently

		Population			
		Adolescent (10-18)	Young Adult (19-25)	Adult (18+)	**Total**
Outcomes	Alcohol use	27	17	56	**100**
	Alcohol use disorder	7	9	21	**37**
	Tobacco use	25	16	68	**109**
	Substance Use	20	24	48	**92**
	Total	**79**	**66**	**193**	

5.4.1.1 Canadian Studies

Twenty studies examined the association between cannabis and mental health outcomes in community populations conducted by 15 different Canadian institutions from Ontario, Quebec, Alberta, Nova Scotia, British Columbia, and Manitoba. Half of the studies were cross-sectional and half were cohort or longitudinal in design (Table 5.5). Many of the outcomes of interest were symptoms and/or diagnoses of depression, anxiety, well-being, psychological distress and suicide ideation. Many of the studies analysed data from surveys and questionnaires, with three studies employing structured interviews. Data from two Statistics Canada surveys were utilized, including the Canadian Community Health Survey and the National Longitudinal Survey of Children and Youth. Most studies captured a sample of males and females; four studies stratified the results by sex, and two studies assessed only one sex (one assessing each sex).

Table 5.5. Study Characteristics for Canadian Studies completed within Community Populations

Institute	Author	Year	Population	Data Collection	Outcomes	Sex or Gender Lens
Carleton University	Fried	2005	Ottawa Prenatal Prospective Study (OPPS)	Questionnaire	Prenatal cannabis exposure, co-use of tobacco, alcohol	
	O'Connell	1991	Ottawa Prenatal Prospective Study (OPPS)	Questionnaire	Anxiety	
Centre for Addiction and Mental Health	Robinson	2016	Bisexual women in Ontario	Online survey of mental health and substance use	Depression, anxiety, PTSD symptoms	Females only
Dalhousie University	Childs	2004	Multiple Sclerosis	Cross-sectional questionnaire-5 point Likert Scales on range of symptoms	Symptom of relief/well-being	
	Rasic	2013	High School students	Survey	Depression, suicidal ideation following illicit drug use, with or without cannabis	
McGill University	Barett	2005	Rave attendees (age 16-47) recruited through advertisements	Structured Interview	Co-use or conversion to illicit drugs	

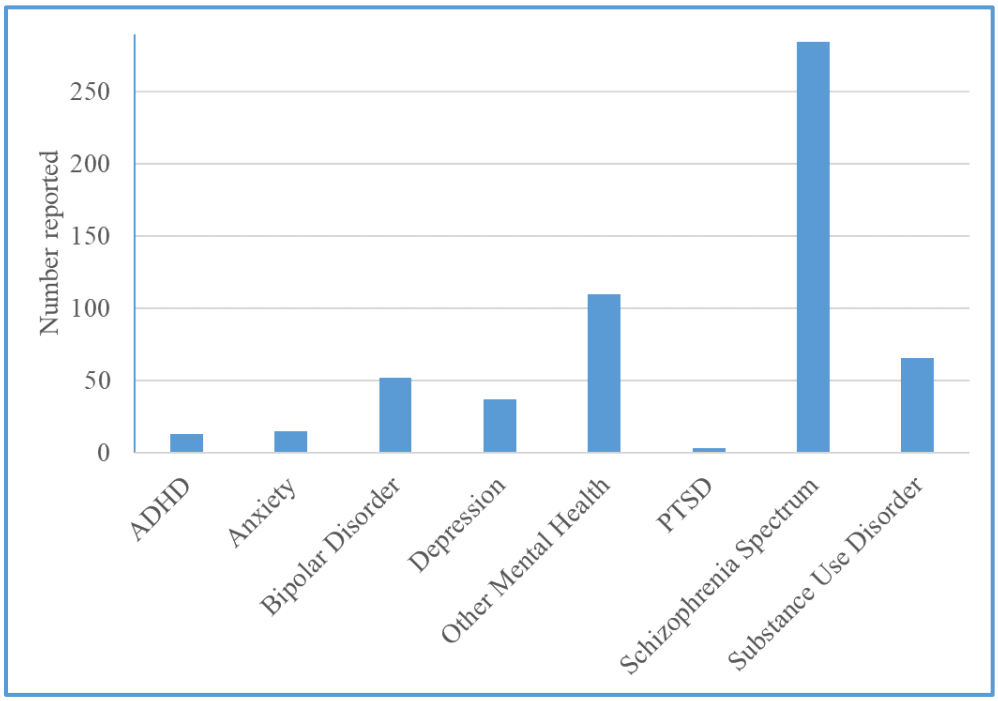
	Kirmayer	2000	Indigenous-Cree of James Bay	Population health survey in 1991	Psychological distress	Stratified by sex
McMaster University	Hallada	2018	Canadian Population	Stats Can: Canadian Community Health Survey's Mental Health Components	Depression, psychological distress	Stratified by sex
	Zhang	2018	Head and neck cancer patients	Quality of Life measures and system assessment surveys	Psychosocial and quality of life outcomes	
Ottawa Public Health	Sampasa-Kanyinga	2015	Ottawa high school students	Ontario Drug use and Health Survey	Suicide ideation and attempts	
St. Francis Xavier University	Thompson	2018	Adolescence in Canadian community	Victoria Healthy Youth Survey	Depression, anxiety, ADHD, co-use of tobacco and/or alcohol	
University of Montreal	Rioux	2018	Sample recruited from the Montreal Longitudinal and Experimental Study of boys	Scaled questionnaire (not validated); DSM criteria for abuse	Illicit drug use; co-use of tobacco and/or alcohol	Males only
University of Montreal	Bourque	2017	3 year follow-up on Grade 7 students	Web-based survey-Brief symptoms inventory	Depression, anxiety, schizophrenia spectrum disorder symptoms	
University of British Columbia	Allen	2014	Undergraduate students (young adults)	Questionnaires developed for study-drug use, wellbeing,	Well-being	

				and personality. Depression scale-validated.		
University of Calgary	Addington	2017	Youth from North American Prodrome Longitudinal Study	Diagnosis based on DSM, and survey questions regarding substance use	Conversion to diagnosis over time	
University of Lethbridge	Williams	2004	High schools in Alberta	Survey conducted at school-not validated	Emotional disorder symptoms	
University of Manitoba	Afifi	2007	Adolescents aged 12-13	Stats Can: National Longitudinal Survey of Children and Youth	Suicide	Stratified by sex
University of Toronto	Ghaffar	2008	Multiple Sclerosis	Structured Clinical Interview-DSM IV disorders	Emotional correlates of cannabis use	
	Honarmand	2011	Multiple Sclerosis	Structured Clinical Interview for DSM IV, and neuropsychological tests-Hospital Anxiety and Depression scale.	Depression and anxiety symptoms	
University of Victoria	Leadbeater	2018	Community sample of adolescents	Victoria Healthy Youth Survey	Depression and anxiety symptoms	Stratified by sex

5.4.2 Clinical Population Outcomes

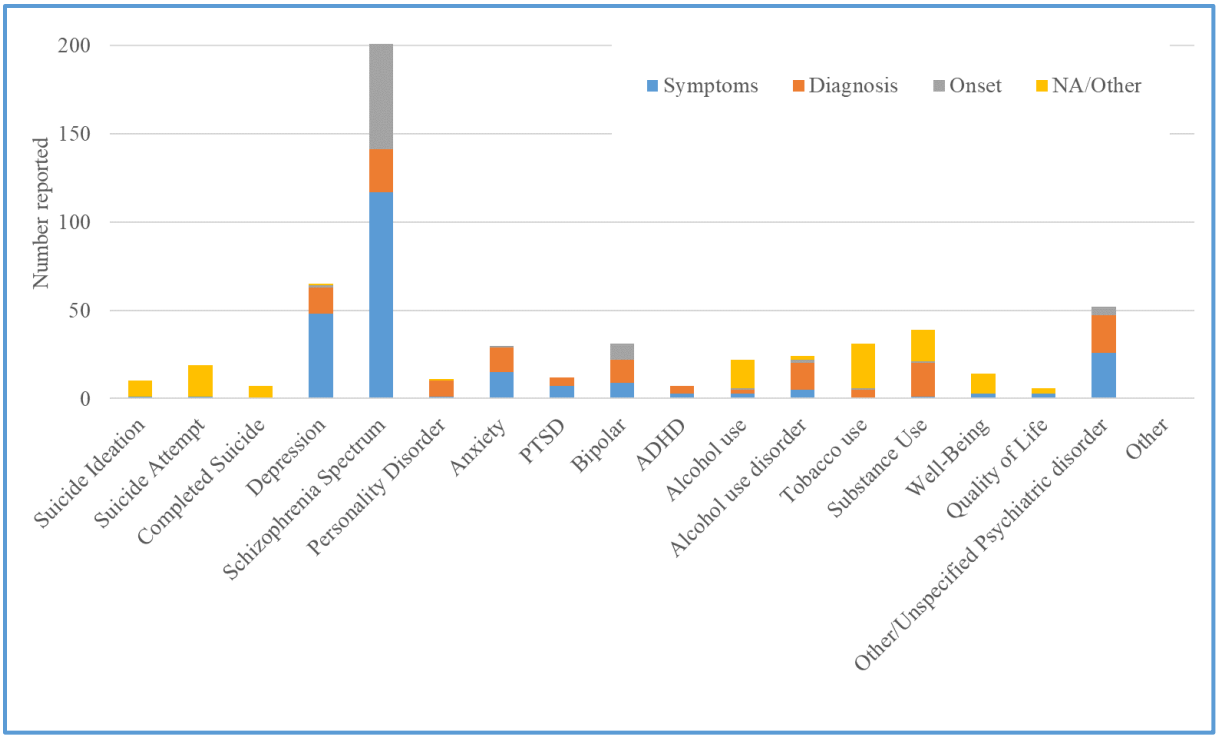
A total of 247 studies assessed the association between cannabis use and mental health outcomes in populations with a known disorder (a clinical population). Although there is research dating back to 1973, 182 of the studies were conducted in the last eight years. Many studies assessed multiple populations. The populations assessed varied with the most common being cohorts of people with schizophrenia spectrum disorder symptoms (n=285) (Figure 5.14). There was also a large number of studies (n=110) where the population examined was a cohort of people who were diagnosed with a mental disorder without specification of the type of diagnosis. Other commonly examined populations included cohorts of people with bipolar disorder (n=52), depression (n=37) and substance use disorder (n=66).

Figure 5.14. Description of Clinical Populations



Most of the outcomes reported are the effects of cannabis use on Schizophrenia Spectrum symptoms, age of onset, and depression symptoms (Figure 5.15). Within the studies assessing those with depression, there is approximately equal numbers of studies assessing the relationship between cannabis use and diagnosis and symptom severity; very few studies assess age at onset. A similar pattern is seen in those with bipolar, PTSD, anxiety and ADHD. Within the other clinical populations, the majority to not report on diagnosis, age of onset or symptom severity. There is a wide variety of other outcomes, sporadically reported across the studies, including outcomes such as suicide attempts, rates of substance use, and intensity of substance use.

Figure 5.15. Number and Type of Outcomes Assessed within Clinical Populations



When the outcomes assessed are plotted by population considered, the areas of high volume of research are identified (Table 5.6). In Table 5.6, colours represent the volume of literature within each cell with the exact number of studies identified. Blue presents very little research and the colours shade to green representing the highest number of research.

Approximately 30% of the total outcomes assessed are among those with Schizophrenia Spectrum disorder and assess an outcome of Schizophrenia Spectrum disorder. Other commonly assessed outcomes within this population are substance use and/or disorder, depression and suicide ideation or attempt. The smallest body of literature is reported for people who are diagnosed with PTSD; there are 3 studies in this population with 1 assessing PTSD related outcomes and the other 2 assessing substance use and /or disorder outcomes.

Of note, almost half of the outcomes reported are among the population "Other Mental Health" (n=110). This body of literature is generally studies where a cohort of patients is sampled from a psychiatric treatment facility, without specifying the diagnosed mental health disorder. This lack of specificity limits the usability, relevance and generalizability of this large body of literature; the use of cannabis may have varying relationships with different mental health outcomes and disorders.

Table 5.6. Mental Health Outcomes Heat Map for Clinical Populations. Green represents outcomes and populations reported most frequently, blue represents outcomes and populations reported least frequently

		Populations								
		ADHD	Anxiety	Bipolar Disorder	Depression	PTSD	Schizophrenia Spectrum	Substance Use Disorder	Other Mental Health	**Total**
Outcomes	Suicide Ideation and/or Attempt and/or Completion	0	2	3	8	0	8	2	13	**23**
	Depression	1	2	6	11	0	24	11	10	**55**
	Schizophrenia Spectrum	2	0	2	1	0	174	7	15	**186**
	Personality Disorder	1	1	1	2	0	2	1	3	**8**
	Anxiety	1	2	2	3	0	7	9	6	**24**
	PTSD	1	1	0	1	1	0	6	2	**10**
	Bipolar	1	1	20	0	0	3	3	3	**28**
	ADHD	1	0	1	1	0	0	2	2	**5**
	Substance use and/or disorder	3	3	12	5	2	48	20	23	**93**
	Well-Being	1	1	1	3	0	3	1	4	**10**
	Quality of Life	0	0	0	0	0	4	0	2	**4**
	Other/Unspecified Psychiatric disorder	1	2	4	2	0	12	4	27	25
	Total	**13**	**15**	**52**	**37**	**3**	**285**	**66**	**110**	

Table 5.7 presents the literature assessing the relationship between substance use and cannabis use more specifically. Substance use is broken down into alcohol use, alcohol use disorder, tobacco use and unspecified substance use. The majority of the literature assesses people with Schizophrenia Spectrum disorder and outcomes of unspecified substance use. The literature assessing alcohol use is the most limited body of literature across all populations.

5.4.2.1 Canadian Studies

Nine studies examined the associations between cannabis and mental health outcomes in clinical populations, conducted by six different Canadian institutions from Ontario, Quebec, Alberta, British Columbia, and Newfoundland. Eight of these studies were conducted in the last six years, with the earliest study being conducted in 2004 (Table 5.8). Most of the Canadian studies were conducted in a sample of people with Schizophrenia Spectrum Disorder (n=6). The remaining three Canadian studies were conducted on people with substance-use disorder, anxiety, or depression. Three studies used structured interviews whereas six studies administered surveys, or used previously captured survey or medical chart data. Within these various diagnosed populations, symptoms of the disorder were always reported as an outcome (e.g., symptoms of psychosis were reported among a population of people experiencing early psychosis). All but one study used a sample of both males and females, with the remaining study using a sample of males only. However, none of the studies applied a sex or gender lens.

Table 5.7. Clinical Populations Mental Health Outcomes heat map with frequency of outcomes for each population. Green represents outcomes and populations reported most frequently, blue represents outcomes and populations reported least frequently

		Population								
		ADHD	Anxiety	Bipolar Disorder	Depression	PTSD	Schizophrenia Spectrum	Substance Use Disorder	Other Mental Health	**Total**
Outcomes	Alcohol use	0	1	1	1	0	11	3	5	**22**
	Alcohol use disorder	0	0	4	1	1	8	5	5	**24**
	Tobacco use	2	0	2	1	0	17	4	5	**31**
	Substance Use	1	2	5	2	1	12	8	8	**39**
	Total	**3**	**3**	**12**	**5**	**2**	**48**	**20**	**23**	

Table 5.8. Study Characteristics for Canadian Studies completed within Clinical Populations

Institute	Author	Year	Population	Data Collection	Outcomes	Sex or Gender Lens
Centre for Addiction and Mental Health	Lev-Ran	2012	Cross-section data of representative AMERICAN population	National Epidemiological Survey of Alcohol and Related Conditions- Face to Face interviews	Quality of life in persons with anxiety disorders	
Memorial University of Newfoundland	Hadden	2018	Inpatients for early psychosis intervention program	Clinical characteristic assessment (substance use, symptoms)	Psychosis symptoms and outcomes	
University of British Columbia	Willi	2016	Recruited from ongoing study with past or present psychosis	Symptoms using PANSS (validated)	Substance abuse and symptomology	
University of Calgary	Stowkowy	2013	Recruited through North American Prodrome Longitudinal Study	Validated structured interview for symptoms	Genetic risk for psychosis with time of first use cannabis	
	Van Mastrigt	2004	Inpatients for early psychosis program	Symptoms using validated scale and substance use	Prevalence and correlates of substance use with first episode psychosis	
	Zhornitsky	2015	Patients with SUD- retrospective chart review	Retrospective chart review	Substance use induced psychosis symptoms	

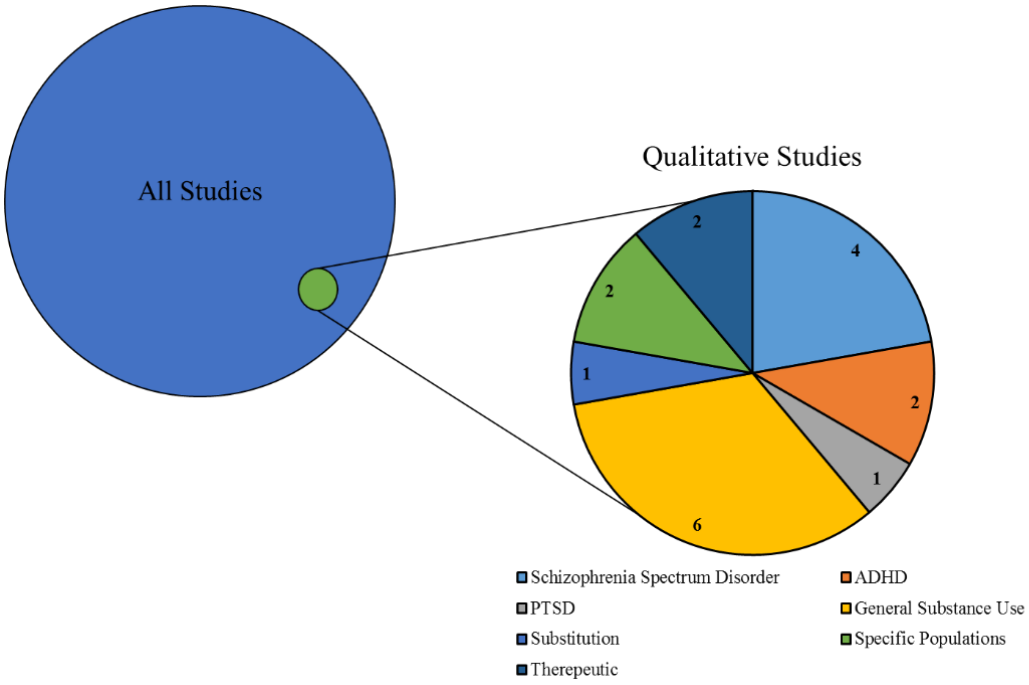
University of Montreal	Artenie	2015	Secondary data from Hepatitis Cohort (convenience sample of people who inject drugs)	interviewer-administered questionnaire	Suicide attempt, substance use, treatment for anxiety/depression, diagnosed mental health disorder	
	Ouellet-Plamondon	2017	Inpatients for first episode psychosis	Clinical characteristic assessment (substance use, symptoms)	Psychosis symptoms	
University of Toronto	Rabin	2013	Recruitment of schizophrenic population through-out patient	Questionnaires	Mental health disorder symptoms	Males only

Abbreviations: Positive and Negative Syndrome Scale (PANSS); Substance Use Disorder (SUD)

5.5 Qualitative studies within this Literature

The scoping review identified 18 articles that used qualitative methods alone, or in conjunction with quantitative methods in the context of a 'mixed methods' study on cannabis use, other substance use, and mental health outcomes (Figure 5.16; Table 5.9). While there was no central, coherent thread in this relatively small group of studies, all of the articles identified focused on cannabis and mental health by using qualitative data collection strategies such as interviews or focus groups methods that are designed as 'naturalistic inquiry' that can access people's firsthand accounts and experiences of use (i.e. user perceptions and perspectives, not measures of actual behaviours).

Figure 5.16. Visual representation of qualitative studies within all studies, by population. Included in "specific populations" is bisexual women, and cannabis use for cultural beliefs



The benefit of these types of studies is that they demonstrate how people who use cannabis understand, in their own terms, the connections between use and their mental health, and the need to better understand how use is shaped by cultural and social contexts.

Of note, there were only two qualitative studies from Canada, and many additional gaps in terms of qualitative research with diverse populations (i.e. youth, women, 2SLGBTQ+, and IRER groups), and their experiences of specific diagnoses or mental health concerns. Additionally, cannabis was often not the sole focus of many studies and was one of many areas of qualitative inquiry in the context of a broader focus on substance use and mental

health. There was a mix of qualitative studies exploring participants' experiences of use for either medical or non-medical purposes, and sometimes both types of use were included.

There was more than one paper identified on the topics of cannabis use in the context of a diagnosis of schizophrenia and psychoses, mental health outcomes associated with use by military personnel (veterans), cannabis substitution in the context of cocaine use, and use by people with a diagnosis of ADHD. The vast amount of cross-sectional data available makes it difficult to understand the direction of association cannabis has on mental health outcomes (e.g., if symptoms are improving or worsening). However, in the qualitative literature there is a focus not only on the harmful implications of cannabis use for mental health, but also on how users perceive or experience benefits. This speaks to a need for research to understand and meaningfully engage with perceptions of benefit – even where there is no 'gold standard' clinical evidence for benefit for users.

Given the small number of studies identified, there are many populations and areas of mental health and mental illness that could benefit from meaningful engagement and participatory and community-based research designs that fall under the banner of qualitative methodology.

Table 5.9. Study Characteristics of Qualitative Studies Captured in Scoping Review

Author ID	Year	Location	Topic	Method
Mikuriya	1970	United States	Cannabis substitution in alcohol addiction	Single interview (case report)
Way	1994	United States	Substance use in adolescence	Mixed methods
Ali	1998	Malawi	Marijuana use and 'traditional' cultural beliefs	Focus groups
Labigalini	1999	Brazil	'Therapeutic' use of cannabis, other substance use	Interviews
Nappo	2001	Brazil	User-reported changes in modes of cocaine use	Interviews
Page	2006	Canada	Medical cannabis and Multiple Sclerosis	Interviews
Bucher	2012	United States	Steroid, substance use among military personnel	Interviews
Sehularo	2012	South Africa	Cannabis use and Psychosis	Interviews
Thornton	2012	Australia	Substance use and psychotic disorders	Mixed methods; interviews
Okello	2014	Uganda	Mental health literacy among high school students	Focus group
Elliott	2015	United States	Cannabis use and PTSD among veterans	Interviews; Focus group
Pederson	2015	Norway	Cannabis users and ADHD	Interviews
Rebgetz	2015	Australia	Spontaneous cannabis cessation and Psychosis	Interviews
Robinson	2015	Canada	Bisexuality, anxiety and cannabis use among women	Mixed methods; Focus groups
Mitchell	2016	Online forums	Discussions of ADHD and cannabis online	Textual analysis of user posts
Rebgetz	2016	Australia	Cannabis cessation and Psychosis	Interviews
Mitchell	2018	United States	Substance use and emotional functioning	Mixed methods; interviews
Wagstaff	2018	United Kingdom	Substance use and Schizophrenia	Interviews

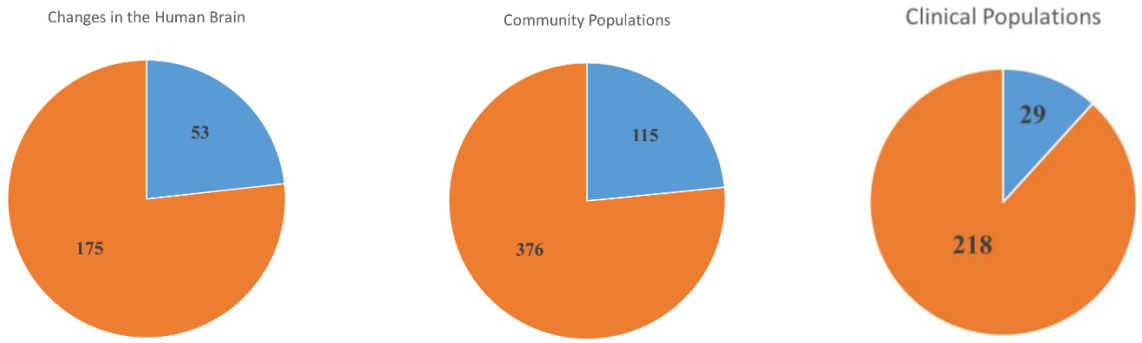
5.6 Sex and Gender within this Literature

Sex and gender are likely important mediators for the relationship between cannabis use and mental health outcomes. In addition, both are important social determinants related to public health outcomes. Throughout this work, we extracted whether sex and gender was applied as a lens within the individual research studies.

> **Sex:** a set of biological attributes in humans and animals. It is primarily associated with physical and physiological features including chromosomes, gene expression, hormone levels and function, and reproductive/sexual anatomy. Sex is usually categorized as female or male but there is variation in the biological attributes that comprise sex and how those attributes are expressed[109]

We adopted the CIHR definitions of sex and gender [109] (definitions in boxes). Within this literature, we were unable to determine in sex or gender was being studied as the concepts were used interchangeably and many of the data sources may be measuring gender but used the language of sex. Irrespective, in all three categories that studied outcomes in humans (changes in the human brain, mental health in community populations and mental health in clinical populations), the majority of studies **did not** apply a gender or sex lens (Figure 5.17).

Figure 5.17. Number of Studies with Sex and/or Gender Lens per Research Area Category



> **Gender** refers to the socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people. It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. Gender is usually conceptualized as a binary (girl/woman and boy/man) yet there is considerable diversity in how individuals and groups understand, experience, and express it[109]

Of the studies that do, there was seldom a comparison being made between sexes/genders, but rather stratification of results (i.e., conducting separate analyses for females/women, and males/men). Additionally, many studies that do have a sex lens only considered one sex, predominantly a male population. In future studies, a sex and gender lens, with care paid to the difference between the two, should be included.

5.7 Indigenous Peoples within this Literature

It is important to acknowledge that, as stated in the Tri-Council Policy Statement on Research Involving First Nations, Inuit and Métis, research involving Indigenous peoples in Canada has been defined and carried out primarily by non-Indigenous researchers, in ways that have not reflected Indigenous world views or benefited Indigenous peoples and communities. While the research team finds the harms and/or benefits of cannabis on the mental health of Indigenous peoples to be a crucial research gap worthy of additional attention, it was beyond the scope of this scoping review to provide the appropriate context to interpret this research and to explore other research, literature and knowledge related to substance use and mental health. Given the fact that research involving Indigenous peoples in Canada has historically been harmful and extractive, and given the fact that many Indigenous researchers, organizations and communities across Canada are leading important work in mental health services and research, we acknowledge that Indigenous researchers, organizations and communities would be best positioned to review and contextualize existing evidence. We include the below summary of the published literature identified within this review recognizing that an Indigenous-led literature review, which would be able to capture information beyond the scope of this research, is required.

Thirteen studies assessed with association of cannabis use and mental health specific considering cohorts of Indigenous peoples (Study characteristics are provided in *Appendix 8*). The studies examined Native American populations of the United States (n=7), Indigenous peoples in the Northern Territory of Australia (n=4), a Cree First Nation in Canada (n=1), and Māori people in New Zealand (n=1) (Figure 5.18). A majority of research has taken place in rural or remote settings (n=8). No studies found in this scoping review examine cannabis use and mental health in Métis and Inuit, and none of the research is Indigenous-led. Studies lacked consistency in design with varying exposures and outcomes examined. The majority (n=8) are cross-sectional studies (n=9). There were three longitudinal studies and one case-control study (Figure 5.19)

Figure 5.18. Number of studies examining cannabis and mental health in Indigenous peoples, by country.

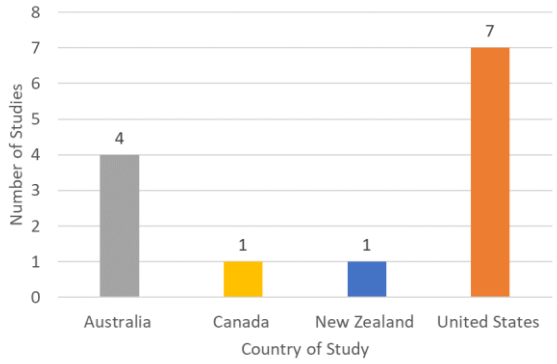
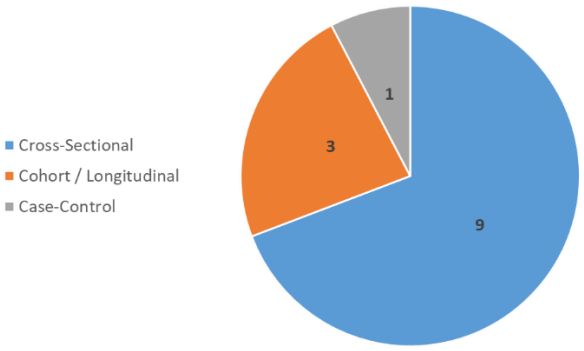


Figure 5.19. Number of studies examining cannabis and mental health in Indigenous peoples, by study design.



Studies were small in size and conducted targeting a specific community and population. Multiple studies were from the same two research groups in Australia (n=3) and the United States (n=4) investigating two Indigenous populations, limiting the generalizability of results. It is also challenging to generalize findings between Indigenous populations/communities globally and within Canada.

The only Canadian study examined substance use, including cannabis, and psychological distress in a Cree First Nation in the James Bay Region of Northern Québec[110]. Regression analysis found lifetime cannabis use was associated with higher levels of psychological distress ($\beta = 2.10$, $p = 0.05$). The authors received consent to conduct research from the First Nation through the Cree Board of Health and Social Services of James Bay.

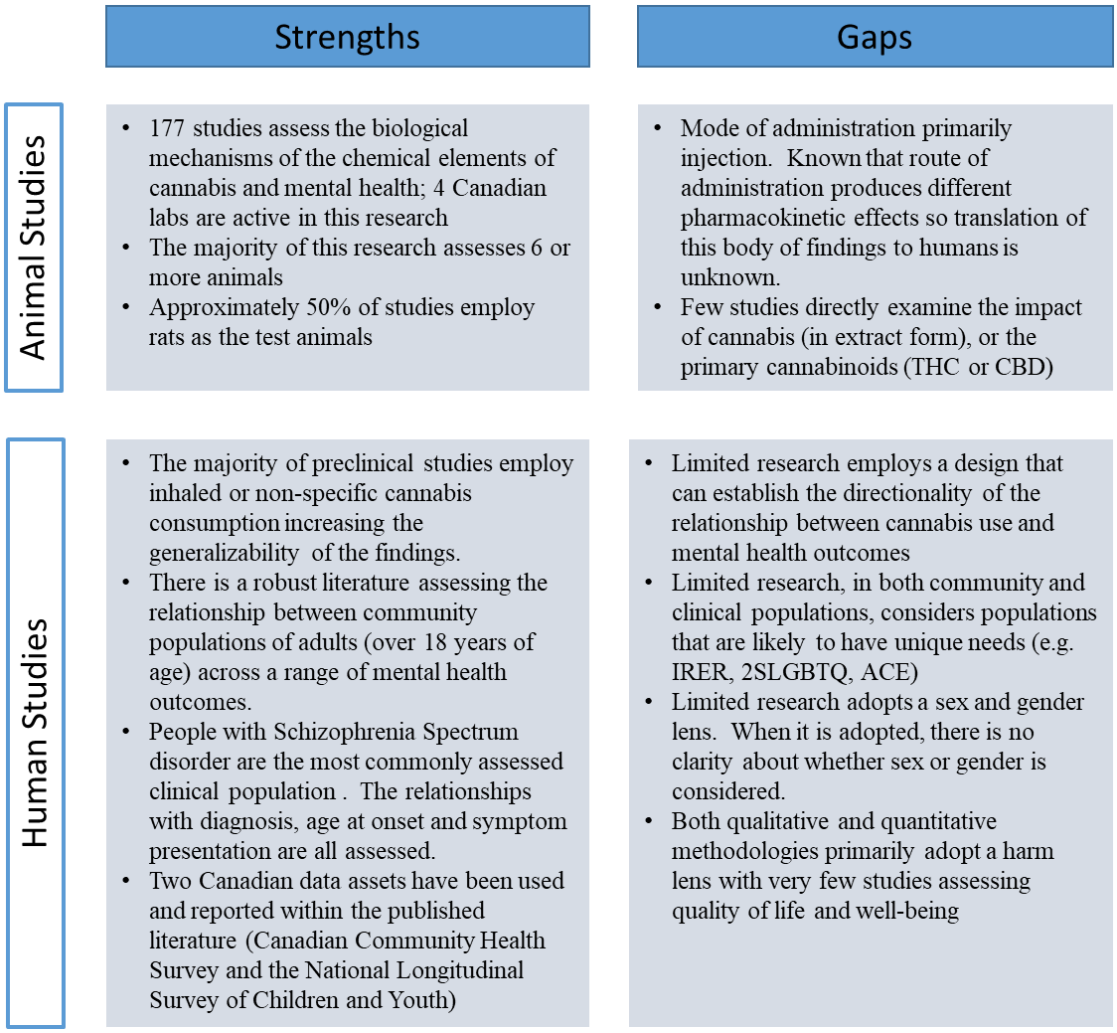
Along with examining the association of cannabis use and mental health illnesses, the majority of the studies (n=10) included other substances in their analyses, including alcohol, tobacco, and non-prescription use of sedatives and stimulants. The results varied with mixed measurement of outcomes. Studies (n=3) finding fewer negative mental health effects in participants that used cannabis when compared to use of alcohol or other substances.

There are limited published studies assessing the effects of cannabis on the mental health of Indigenous peoples globally and, in particular, in Canada.

5.8 Knowledge strengths and gaps

Figure 5.20 provides an overview of the strengths and gaps identified within this body of published literature.

Figure 5.20. Overview of Strengths and Gaps within the Published Literature



5.8.1 Preclinical Animal Studies

Interestingly, the mode of administration in the preclinical studies was overwhelmingly via injection (n=157) though this is an uncommon method of administration in the human population. When determining what information can be extracted from these studies, route of administration is an important variable to consider. It has been well established that a pulmonary route of administration of cannabinoids produce very different pharmacokinetic effects, than other routes of administration[111]. THC is converted to 11-hydroxy-THC through hepatic metabolism, which is largely bypassed in pulmonary routes of administration, and the impacts of this metabolite can be much more robust and long lasting, and more likely to trigger adverse reactions, than if taken through a pulmonary route[112]. This has been well exemplified in animal

work where it has been found that pulmonary administration of THC produces a rewarding effect while injected THC produces an aversive response[113]. In addition, injected doses of THC, especially those that are in the moderate range (anything over 1 mg/kg) will result in a mass bolus of THC that hits the brain at once, which is likely not consistent with the pharmacokinetics of inhaled THC through vapour or smoke. While the consideration of the pharmacokinetics of THC may seem trivial, it has become common practice in other fields studying the impact of drugs on the brain to model the appropriate route of administration (inhaled vapour for nicotine and drinking for alcohol) as opposed to just injecting these compounds because of the very notable differences seen between differing routes of administration. As such, while we may be able to glean some potentially relevant information regarding the effects of cannabis in humans from animal studies that have used injected THC, the generation of translationally relevant information from animal studies would benefit significantly if the field embraced the growing use of pulmonary routes of administration of THC or cannabis extract[114,115].

What can be taken from this review of the animal literature is very little work has directly examined the impact of cannabis (in extract form), or the primary cannabinoids (THC or CBD) with respect to animal models related to mental health. A significant amount of work done in the preclinical space has primarily used synthetic cannabinoid receptor agonists such as CP55,940, WIN55,212-2 or HU-210. Given that more recent biochemical studies have demonstrated that these synthetic agonists have very different pharmacological properties than THC, and often engage different intracellular signaling pathways than THC does[116], it brings to question if there is any translational value associated with these studies[115]. This is further exemplified by the fact that in recent years we have seen significant adverse health effects, including fatalities, associated with use of synthetic cannabinoids in humans[117], clearly illustrating that these compounds are fundamentally different then the effects of THC. As such, we have excluded evaluation of all studies using these compounds as we do not believe that this is informative or an accurate representation of what the effects of cannabis itself may be on the brain and mental health related outcomes.

5.8.2 Human Studies

There is large body of preclinical human studies examining changes in the brain structure, volume and activity using imaging techniques such as fMRI, EEG, PET or PPI. The majority of these are either observational in nature, where the participants reported using cannabis without specifying the mode of administration, or interventional where participants clearly smoked and inhaled cannabis. The common use of this mode of administration increases the generalizability of these findings to the wider population. However, as noted above, the mode of administration is known to modify the effects and impact of cannabis. Thus, as edible administration becomes legal and possibly more common, the lack of studies employing this mode of administration will be become an increasingly important knowledge gap.

There is a robust literature reporting the relationship between cannabis use and mental health outcomes in community populations. The most common population examined is adults (over the age of 18), accounting for approximately 40% of the studies. Examining the general adult population is likely to mask important mediators both within and between cannabis use and mental health outcomes such as sex, income, education level, adverse event exposure and other important factors. Given the very limited literature that assessed unique populations and sex

differences, the relationships between cannabis and mental health outcomes, as seen through these lenses, remain important knowledge gaps.

Very few studies considered wellbeing or quality of life as outcomes. Nearly all studies adopted a lens of harm for their outcome measurement. This change in framing will become more important as we continue to understand the possible benefits of both non-medical and medical use.

Within clinical populations, the most commonly assessed is people with Schizophrenia Spectrum disorders. This literature examines the relationship between cannabis use and diagnosis, symptom presentation and age at onset. However, for all other clinical populations included, the literature is limited with very few examining the age at onset and small bodies of literature generally within specific diagnoses. In addition, approximately 30% of the studies assess an unspecified general population with a mental health disorder. Given the likelihood that the relationship between cannabis use and specific mental health disorders varies and is likely bidirectional, the relevance of this literature reporting unspecified mental health disorders is limited.

We identified two studies that report findings from the nationally representative Canadian data assets. While disappointing that only 2 were identified, it is encouraging to see that the data infrastructure that are readily available are being utilized.

6. Moving Forward

Key points to move forward:

- All methodologies should be strengthened and supported within the Canadian research context. High-quality, fit-for-purpose studies are required to advance our understanding of the relationship between cannabis use and mental health. One key focus should be on understanding the directionality and causal nature of the relationship.
- Given the context of legalization, Canada has an opportunity to lead the research agenda across all methodologies. Promotion of growth through funding and increased partnership will amplify the research.
- The already established data assets in Canada and internationally provide a valuable platform for rapid analysis. Continued investment and development is required including continued production of robust datasets for research.
- Embedding the lived experiences of people who are using cannabis will enrich all methodologies.
- Understanding of the unique needs and possibly differential relationships between cannabis and mental health of various populations should be a focus, specifically: seniors, 2SLBGTQ, IRER and those who are indigenous.
- An increased focus on understanding the context of cannabis use is required. The general harm lens through which the current body of literature has been developed is not nuanced enough to disentangle the complex context within which cannabis use may occur (e.g. within the context of other substance use, exposure to traumatic events, overlapping health and social inequities). Importantly, the relationship between cannabis use and mental health outcomes must be placed, and interpreted, within this context.

There is a vast amount of information currently available regarding cannabis use and mental health outcomes, both in publicly available databases and within published academic journal articles. However, due to the variable quality, lack of longitudinal studies, and a limited amount of data associating cannabis use with mental health outcomes, interpretations and conclusions are difficult to make. All disciplines of science could be strengthened. A focus on high-quality, fit-for purpose research is required. The focus should cover the spectrum of scientific inquiry and all methodologies within each discipline. This broad focus across research methodologies is particularly required within human population science where both quantitative and qualitative methodologies are required.

There is a paucity of research available for specific populations that include specific age groups such as seniors, sex-based analysis, 2SLGBTQ and IRER populations and those who are indigenous. Given the very limited literature that assessed unique populations and sex differences, a focus on the unique relationship between cannabis and mental health outcomes applying these lenses is required.

In particular, embedding the lived experiences of people both using cannabis and experiencing mental health outcomes will increase the relevance and quality of research. This perspective will offer insight into the relevant areas of research, motivation of use and contextualize the findings resulting from research.

Very few studies were able to establish the direction of the relationship between cannabis use and mental health outcomes due to the cross-sectional study design. For example, a question about current use in a population of patients with schizophrenia spectrum disorder does not allow for any firm conclusions to be made regarding cannabis use causing the disorder, or cannabis use and the effects on symptoms. Without understanding the direction of association, health care providers and policy makers are unable to adequately implement guidelines, initiatives, protocols, and legislations to protect and promote the health of the population.

After reading several hundred studies assessing the relationship between cannabis use and mental health outcomes in both community and clinical populations, we observed the lack of nuance within the interpretations of studies. Cannabis use exists within a complex context often intertwined with other substance use, exposure to traumatic events and other social determinants of health. Within the body of literature, often cannabis use was assessed alongside some of these other factors and, based on our observations, commonly amongst the lowest strength associations when odds ratios of different factors are compared. As we move forward, the complex interplay between cannabis use and the multitude of other factors must be considered, analysed appropriately, and interpreted within this broader context.

Thus far, the majority of research completed has adopted a harm lens. Within the context of legal cannabis, the research community should balance this with an investment in understanding the benefits of cannabis use on well-being and quality of life. Currently, there is little research that assesses the motivation for use, the patterns of use and the possible positive benefits of casual, moderate cannabis use. Given that this use pattern may be the predominant use pattern that emerges (similar to the predominant use pattern of alcohol), it is important to understand how this will potentially shape health outcomes for Canadians, positively and negatively.

In addition, the lack of specificity in mode of consumption limits our conclusions. It is known that mode of consumption meditates the effects of cannabis. Among the observational human studies, consumption mode was not specified while in the preclinical animal studies generally injection was employed. Injection is a very uncommon mode of administration among humans and thus the translational relevance of the animal studies is limited. In addition, as edible consumption becomes legal in Canada in the coming year, understanding the differences between inhalation and edible consumption should be a priority.

Data that can be used to follow trends of use and mental health outcomes over time are currently readily available through the public use (accessible to the public) and master files (accessible to qualified researchers). In Canada, these data assets include useful information regarding trends of cannabis use over time, self-reported wellbeing among people who use and who do not, and reported use among those who are diagnosed with mental health disorders. Harnessing the power of this data infrastructure is an easily implementable research agenda and would capitalize upon the significant investment made into these data sources.

In addition, there are notable data assets publicly available from US jurisdictions that have legalized cannabis. While the generalizability to a Canadian context remains unknown, these

data assets can provide insight into what Canada may expect in the era o f legalized cannabis. Again, the breadth of data that are readily available allow for robust, relevant analyses that are possible to complete within a very timely manner.

One such observation is the decreasing cannabis use rates among those under 18 years of age, in comparison to increases trends in all other age groups. It will be important to disentangle this observation over time. For example, will this decreasing trend be maintained over time as those currently under 18 years of age graduate into older age groups (i.e. a cohort effect) or will the rates of use increase for this group as they age (i.e. an age effect)? Understanding this over time will shed light on how cannabis use rates may change within the context of legalization.

When considering the published preclinical research, there is much to be learned. There is a vast amount of research using synthetic cannabinoids and modes of administration that may lack generalizability to the human population. Our recommendations are that synthetic cannabinoids not be used in preclinical research. Additionally, studies in the future should focus specifically on either pulmonary vapour or oral ('edible') administration of THC, CBD or cannabis extracts to appropriately model the routes of administration actually used by humans. Recognizing some of the limitations associated with consistent standardization of product, an emphasis should be put on studies that directly use whole cannabis extract. There are dozens of terpenes, flavonoids and minor cannabinoids also present in cannabis, many of which have known biological activity and could influence the effects of THC. As such, if the focus of research in this area is to as closely model the impacts of human use of cannabis as possible, studies should begin using well characterized whole cannabis extracts to appropriately model the full biological impacts produced by all molecules in cannabis. Utilization of these approaches may be leveraged to provide relevant information regarding the impact of cannabis exposure during key developmental windows (such as prenatal and during adolescence), for which the current level of information would suggest neurobiological impacts may occur, however firm conclusions from these data must be taken cautiously given the constraints associated with how these studies were performed.

To conclude, there is voluminous published literature that is documented herein. However, there remain significant research gaps that Canada is uniquely positioned to address. As one of only two nations with legalized cannabis (Uruguay being the other), Canada's research community should be able to address questions that other jurisdictions are unable to tackle. With the support of funding, appropriate regulations and coalesces of multi-disciplinary teams, Canada is positioned to become a world-leader in cannabis and mental health research.

Appendix 1. Summary of Surveys Available for Analysis

Canadian Surveys

Statistics Canada has identified several surveys that can be used to determine prevalence of cannabis use, and to examine the association between cannabis use and health. A link to the documentation of each survey is available at Statistics Canada's Cannabis Stats Hub website[24].

This section provides a brief summary of some of the surveys, as well as the variables associated with cannabis, mental health, and demographics. Some of the surveys are available as Public Use Microdata File (PUMF). Some of the surveys described in this section have been recently added and are not yet available as PUMF. However, researchers could enquire to Statistics Canada for future availability of the surveys as PUMF or for analyses through the Research Data Centers.

Canadian Surveys available as Public Use Micro Files (PUMFs)

General Social Survey –Victimization (GSS)[31]

The GSS- Victimization is a cross-sectional survey collected by Statistics Canada every 5 years since 1999. The target population for the survey is Canadians 15 years of age or older living in the ten provinces and three territories. Excluded are institutionalized individuals. For the selection of the sample, Statistics Canada uses a stratified design (at the province/census metropolitan area (CMA)) employing probability sampling. Then, an individual is selected randomly from each household. The sampling frame used is a combination of landline and cellular phone numbers from the Census and several sources with Statistics Canada's dwelling frame. Phone interviews are used in the provinces using CATI; and phone (CATI) or face to face interviews are used in the territories to collect data.

The goal of the survey is to gather information on self-reported victimization and the way Canadians perceive the justice system. The GSS collects information related to cannabis use past-month and frequency of use-past month by the responder and his/her partner. Regarding social/ health related variables, the survey collects information on childhood experiences; abuse; discrimination; sense of belonging; isolation; self-rated health. Demographic variables include age, biological sex, sexual orientation, marital status, Indigenous status, education, employment, religion, and immigration status.

Canadian Addiction Survey (CAS)[32]

The CAS is a cross-sectional national Canadian survey administered by the Montreal-based research firm Jolicoeur & Associés on behalf of Health Canada and the Canadian Executive Council on Addictions in 2004. The CAS targeted Canadians 15 years of age or older. For the selection of the sample, a two-stage stratified random sampling technique was used. The

stratification was done at the province level based on 21 strata defined by CMA versus non-CMA. Households were determined via RDD. The sample frame used for household selection was based on all active telephone numbers area codes and exchanges in Canada. An individual was selected within a household based on most recent birthday. The data was collected by phone using CATI.

The CAS was conducted to determine alcohol and other drugs use; harms and consequences associated with use; and attitudes and beliefs associated with addiction policies. Cannabis related variables include: cannabis use (ever; past-year; past-3 months; past-30 days); age of first use; reason for starting using; frequency of use past-3 months; reasons for using cannabis (e.g. to relax, to forget worries, to be sociable, for medical purposes; etc.); place where used cannabis; with whom usually consume (e.g., alone, with friend, with co-worker, etc.); risk level for cannabis consumption; desire for using marijuana past-3 months; whether tried to control, cut down, or stop using without success; effects of cannabis use (use led to health, social, financial, or legal problems- ever; past-3 months); concerned expressed by family/ friend about use in past-3 months; buying behaviours (several variables: amount bought last time (number of joints, grams, ounces); who bought from); cannabis Alcohol Smoking and Substance Involvement Test (ASSIST) score; driven within two hours of cannabis use-past year; driven within two hours of both cannabis and alcohol use-past year. Variables related to attitudes about cannabis use: should possession of small amount of cannabis be against the law; should there be a penalty for using; should cannabis be legally available. Mental health related variables: general state of mental health; days in past-month mental health not good; frequent mental distress days; how helpful was the treatment or professional help received; wait time to begin treatment; whether the treatment was successful. Demographic variables: age, sex, marital status, education, income adequacy, household income, and occupation.

Canadian Tobacco Use Monitoring Survey (CTUMS)[33]

The CTUMS is a cross-sectional survey conducted annually by Statistics Canada on behalf of Health Canada since 1999. In 2013 the survey was replaced by the Canadian Tobacco, Alcohol and Drugs Survey (CTADS). The CTUMS surveyed Canadians 15 years of age or older living in the ten provinces. Excluded were residents of the three territories and institutionalized individuals. The sample was selected using a two-phase stratified random sample of telephone numbers. First, household were selected using Random Digit Dialing (RDD); then individuals within each household were selected to participate based on household composition. The CTUMS oversampled individuals 15 to 24 years of age. Data was collected using computer-assisted telephone interviewing (CATI).

The CTUMS was mainly collected to track changes in tobacco use with emphasis in at risk population (i.e. 15-24 years old). Regarding cannabis, the survey collects information on cannabis use – ever; frequency of use in past-year; and age of first use. Demographic variables include age, sex, marital status, and education.

Canadian Alcohol and Drug Monitoring Survey (CADUM)[34]

The CADUM is a cross-sectional national Canadian survey collected annually by the Montreal-based research firm Jolicoeur & Associés on behalf of Health Canada from 2008 to 2012. In 2013, the survey was replaced by the CTADS. The survey targeted Canadians 15 years of age or older living in a household with a landline in the ten Canadian provinces. Excluded were institutionalized individuals, residents of the three provinces, and people with cell phones only, or in households with no landline. The CADUM used a two-stage random sampling technique stratified by province for sample collection. First, a household was selected within each province using a random sample of telephone numbers. The sample frame based on all active telephone numbers area codes and exchanges in Canada. An individual from each household was randomly selected. The CATI was used to collect the data.

The CADUM's main objective is monitoring alcohol and illicit drug use and the harms associated with use. Regarding cannabis/ marijuana, the survey collects information on use (ever, past-year, past-3 months, and past-30 days); type of cannabis user; frequency of use past-3 months; cannabis ASSIST score; driving behaviour (used and driving, or being a passenger with driver under influence of cannabis; being in a motor vehicle accident); Age first use marijuana; ease to access marijuana; risk level for cannabis consumption; desire for using marijuana; whether tried to control, cut down, or stop using without success; effects of cannabis use (use led to health, social, financial, or legal problems- ever; past-3 months); concerned expressed by family/ friend about use in past-3 months; felt needed help in past-12 because of use; used services/ received help to deal with use of marijuana past-12 months. Mental health variable included in the survey is self-reported mental health. Demographic variables: age; sex; education; marital status; household income; Indigenous status; and employment status.

Canadian Tobacco Alcohol and Drugs Survey (CTADS)[28]

The CTADS is a cross-sectional Canadian general population survey collected by Statistics Canada every two years since 2013. The CTADS replaced CTUMS and CADUM surveys. Starting in 2019, the survey will be divided in 2 surveys: tobacco and nicotine; and Canadian Alcohol and Drugs Survey, which will be conducted alternatively starting with the Canadian Alcohol and Drugs Survey. The target population is individuals 15 years of age or older living in the ten Canadian provinces. Excluded are people living in the three territories, and institutionalized individuals. The survey sample is collected using a two-phase stratified random sample of telephone numbers. This method of selection also leaves out of the sample Canadians without landline or cell phone numbers. In the first phase, households are selected using RDD. The Household Survey Frame is used to select the telephone numbers. Individuals from the selected households were selected to participate based on household composition. Data was collected using CATI.

The CTADS's main objective is monitoring alcohol, tobacco and illicit drug use and the harms associated with use. Regarding cannabis/ marijuana, the survey collects information on use (ever, past-year, and past-3 months); frequency of use past-3 months; age of first use; cannabis WHO ASSIST score; risk level for cannabis consumption; frequency of desire of using marijuana (ever, past-3 months); failed to control cannabis use; tried to reduce/ stop marijuana use but unable (ever, past-3months); concerned expressed by family/ friend about use (ever, past-3

months); effects of cannabis use (use led to health, social, financial, or legal problems- ever; past-3 months). Mental health variable included in the survey is self-reported mental health. Demographic variables: age; sex; marital status; whether employee or self-employed; and Indigenous status (2017 only).

Canadian Community Health Survey- Mental Health and Wellbeing (CCHS-MH)[35]

The CCHS-MH is a cross-sectional national survey administered by Statistics Canada in 2002 and 2012. The target population are Canadians 15 years of age or older living in the ten provinces. Excluded are full-time members of the Canadian Forces, institutionalized individuals, residents of First Nation reserves, and individuals living in the three territories. Statistics Canada used a multi-stage stratified cluster design to select the sample. In the first stage, households are selected using the area probability frame of the Canadian Labour Force Survey. In each selected household, and individual is selected to participate using selection probabilities based on age and household composition. The computer-assisted interviewing system (CAI) was used to collect the data.

The CCHS-MH allows determining the factors and processes that contributes to mental health (both illnesses and positive mental health). The survey collected information on cannabis use (ever; ever excluding one time use; and past-year excluding one-time use). Variables related to mental disorders were collected in both cycles. However, there are differences between the surveys in the availability as well as the definitions of some of the mental health variables. The mental health variables described here correspond to the 2012 cycle available as PUMF. Major depression episode, generalized anxiety disorder, bipolar disorder, hypomania, mania, suicide thoughts, and cannabis use disorder are available lifetime and past-12 months. Has PTSD, has a mood disorder; has an anxiety disorder are self-reported. Demographic variables: age, sex; education, marital status, household income, employment status, race / ethnicity, and immigration status.

Aboriginal Peoples Survey (APS)[37]

The APS is a cross-sectional national Canadian survey conducted by Statistics Canada with funding from three federal departments. Five cycles of the survey have been conducted since 1991. However, only the 2017 cycle includes a cannabis variable. The target population are Canadians 15 years of age or older with Aboriginal identity (First Nations, Métis, and Inuit) living in private dwellings. Excluded are individuals living in certain First Nations communities in the Yukon and Northwest Territories, on First Nation reserves and Metis Settlements. The 2017 sample was selected using a multi-stage stratified sampling design. The sampling frame was based on respondents who reported Aboriginal identity or ancestry in the 2016 Canadian Census of Population. Computer assisted telephone interviews (CATI) were used to collect data in private dwellings in the ten provinces. Computer assisted personal interviews (CAPI) were used to collect data in the Northwest Territories (with the exclusion of some parts of Yellowknife), some part of the Yukon, and in Inuit regions.

The APS aims to provide information on employment, education, and health of First Nations peoples living off reserves, Métis and Inuit in Canada. Cannabis variable: Frequency of cannabis use –past 12 months, excluding cannabis for medical purposes. Mental health related variables: Self-reported mental health; have a mood disorder such as depression, bipolar disorder, mania or dysthymia; have an anxiety disorder such as a phobia, obsessive-compulsive disorder or panic disorder; have any emotional, psychological or mental health condition; how often are daily activities limited by this condition; have seen or talk to anyone about problems with emotions, mental health or alcohol or drug use; who did you talk to; seriously contemplated suicide; has this happened in past 12 months; seriously attempted suicide; has this happened in past 12 months. Demographic variables include: Aboriginal identity (several questions); labour market activities; labour force status; education module; personal income.

Canadian Surveys Not Available as Public Use Micro Files (PUMFs)

National Cannabis Survey (NCS)[38]

The NCS is a cross-sectional national Canadian survey administered by Statistics Canada quarterly since February 2018. The target population are Canadians 15 years of age or older living in the ten Canadian Provinces. Excluded are residents of the three territories and institutionalized individuals. The sample is selected using a two-stage design. First, a simple random sample of dwellings is selected within each province. Then, a person is selected to participate within the dwelling. The data is collected either using CATI or an electronic questionnaire (EQ). Sampling and bootstrap weights are provided to account for complexities on sampling and survey design.

The NCS was designed to understand and monitor cannabis use and behaviours specially post non-medical cannabis legalization. Cannabis questions include: ever used or tried cannabis; did you start using cannabis past-3 months; use or try cannabis for the first time because it is now legal; main reason for using cannabis; whether or not more likely to use non-medical cannabis now that is legal; ever had strong desired or urge to use cannabis; has cannabis use ever led to health, social, legal or financial problems; ever failed to do what was normally expected of you because use of cannabis; friend or relative or anyone else ever expressed concern about your use of cannabis; ever tried to control, cut down or stop using cannabis, but not able to do so. The following questions are related to past-3 months: frequency of use; where did get cannabis; whether intended to get cannabis from legal source but could not; reasons for not being able to obtain cannabis legally; how much money spent in cannabis; how much of different types of cannabis used (e.g. liquid concentrate; solid concentrate; cannabis oil cartridges or disposable vape pens; etc.); method most frequently used to consume; driven a vehicle within two hours of using cannabis; driven a motor vehicle within two hours of using both cannabis and alcohol; have been a passenger in a motor vehicle driven by someone who had been using cannabis in the previous two hours; have been a passenger in a motor vehicle driven by someone who had been using both cannabis and alcohol in the previous two hours. Mental health variable: Self-rated mental health. Demographic variables: age; gender; education; household income; main activity past-week; and marital status.

Canadian Health Survey on Children and Youth – (CHSCY) 2019[39]

The CHSCY -2019 is a cross-sectional national Canadian survey conducted by Statistics Canada. The target population are children aged 1 to 17 as of January 31st 2019 living in the ten Canadian provinces and the three territories. Excluded are children living in foster homes or institutions, residents of First Nation reserves or Metis Settlements. For sample selection, Statistics Canada uses a two-stage stratification method. The sample is first stratified by geography (i.e., province; territories are grouped in one stratum; and in Ontario, the strata corresponds to the province's Local Health Integration Networks). The Canadian Child Tax Benefit file is used as sampling frame. Then, three age groups (1-4 years old; 5 -11 years old; 12-17 years old) are used to further stratify the sample. The data will be collected using an electronic questionnaire to be completed by the respondent by March 31st, 2019. After that date, phone interviews would be used.

The CHSCY -2019 aims to explore issues associated with physical and mental health of children and youth. The survey collects data on cannabis consumption only on youth. Variables are: ever tried cannabis; age when first tried; frequency of use (past-12 months; past-3 months); risk perception (if using once in a while; if using regularly); how easy or difficult to get cannabis; how did usually get cannabis past- 12 months.

Mental health related variables: self-reported that have been diagnosed by health professional and lasted 6 months or more: mood disorder (includes depression, bipolar disorder, mania or dysthymia); anxiety disorder (includes a phobia, obsessive-compulsive disorder or a panic disorder); eating disorder (anorexia nervosa or bulimia). Other variables include: learning disabilities or learning disorder; attention deficit disorder or attention deficit hyperactivity disorder; Autism spectrum disorder; Fetal Alcohol Spectrum Disorder; age at diagnosis was asked for each of the conditions; require or received services for mental health issues past-12 months; experience difficulties accessing services for mental health (wait time too long; service not available; cost; child not eligible; other); self-rated mental health.

Demographic variables: age, sex at birth; gender; immigration status; aboriginal identity; sexual attraction (15-17 years old); sexual development (15-17 years old); household income; information about schooling (e.g., currently attending; grade; reason for never attending; etc.)

Ontario Child Health Study (OCHS) 2014[36]

The OCHS is a cross-sectional survey that was conducted by Statistics Canada on behalf of MacMaster University in 2014. The target population were households with children aged 4-17 years residing in Ontario, Canada. Excluded where household located in Reserves, and households living in collective dwellings. A three-stage sampling design was used to select the sample. First, neighbourhoods were selected; then, census tracts and dissemination areas selected; followed by the selection of dwellings with children aged 4 to 17. The data was collected face to face using CAI.

The OCHS was designed to collect information about mental health of children and youth in Ontario. The variables about cannabis and mental health were taken from the questionnaire for youth 14-17 years of age. Cannabis variables: Cannabis use ever; frequency of use ever; age at first use. Mental health related variables: have emotional or behavioral problems past-6 months; did you think need or needed help for emotional problems; did you see or talk to anyone from following places about mental health past- 6 months (e.g., family doctor or pediatrician; walk-in clinic; emergency room; etc.); to what extent people in those places where helpful; school mental help service received; reasons for not seeing or speaking to someone from school about mental health concerns; suicidal behavior (several questions); feeling and behaviours (several questions including: I am unhappy, sad or depressed; I am too fearful or anxious, etc.). Demographic variables: age; sex; grades (overall; by subjects); school grade; race/ ethnicity (includes Aboriginal/ First Nation).

US Surveys

In the US, the Marijuana and Public Health site of the Centers for Disease Control and Prevention (CDC)[118] provides a list of National Surveys that collect data on marijuana use. This section provides a description of some of the surveys that have open data available for analysis.

National Survey on Drug Use and Health (NSDUH)[3]

The NSDUH is a US national cross-sectional household survey administered annually by the Substance Abuse and Mental Health Services Administration (SAMHSA) since 1971. The NSDUH targets US civilian population 12 year of age or older living in 50 states and the District of Columbia (Washington DC). Excluded from the survey are military personnel on active duty, institutionalized individuals, and homeless who do not use shelters. For sample selection, a multi-stage area probability sample is used within the 50 states and the District of Columbia. The data is collected using computer-assisted personal interviews and audio computer-assisted self-interviews. Since 2002, respondents get a participation incentive of US $30. The survey is available as open data through the SAMHSA website[119] , and Data.gov[120]. Data from the survey can be downloaded for each year. However, the variable that identifies state is not available in those files. A system in the SAMHSA website allows online analyses of the survey. State-level estimates can be calculated using cross-tabulations or odd ratios. Sample weights are available to be included in the analysis.

NSDUH is considered the primary source of information on alcohol tobacco, and illegal drugs use and mental health in the general US general population (non-institutionalized), ages 12 and older. The variables described a continuation correspond to the variables available for analysis using the SAMHDA 2-year RDAS system. Cannabis related variables: Use (ever; past-12 months; past-30 days); age at first use; time since last use; number of days used (past-12 months; past-30 days); risk of using marijuana (once a month; once or twice a week); how difficult to get marijuana; set limits on marijuana use past 12 months; continue using marijuana despite (emotional problems; physical problems); drove under the influence of marijuana past-year; age last time used. For youth: students in same school grade that use marijuana; how feels about peer

using marijuana monthly; how parents feel about youth trying marijuana (ever; monthly); how close friends feel about youth trying marijuana (ever; monthly).

Mental health related variables: mental or emotional difficulties; last/ current treatment for marijuana; need treatment for use of marijuana past-12 months; received any mental health treatment in past year; received outpatient mental health treatment past-year; received inpatient mental health treatment past-year; type of mental treatment received; received prescription medication for mental health treatment past-year; marijuana dependence past –year; marijuana abuse past-year; marijuana abuse or dependence past-year; adult major depressive episode (MDE)(lifetime; past-year); saw health professional for MDE; impairments due to MDE(e.g., social life; ability to work; etc.); youth MDE (lifetime; past-year); youth used medication for MDE past-year; youth saw professional for MDE (several variables); youth impairments due to MDE(several variables).

Demographic variables include: age (categories); marital status; household income; current military status; ever on active duty in US military/ reserve; education; sexual attraction; sexual identity; immigration status; number of years/ months lived in the US; race/ ethnicity (includes Native American; Native Hawaiian); employment (several variables including how many hours worked last week; worked at any job past-12 months); state; county; health insurance.

Youth Risk Behaviour Surveillance System (YRBSS)[104]

The YRBSS is a surveillance system that includes a cross-sectional national US survey collected biennially by the Centers for Disease Control and Prevention (CDC) since 1991; and a series of surveys collected biennially by state, territorial, local education and health agencies, and tribal governments. The target population for the survey collected at the national level are students in grades 9-12 in public and private schools in the 50 states and the District of Columbia. Excluded are students from the US territories. The surveys collected by state, territorial, tribal governments, and health agencies target primarily grade 9-12 students enrolled in public schools in each jurisdiction. Some jurisdictions also collect data on middle school students. The CDC provides a standard questionnaire to use at the jurisdictions level; however, the content of the survey can be modified by each jurisdiction with the approval of CDC. The national YRBSS uses a three-stage cluster sampling design to select the sample. The data is collected using a computer scannable questionnaire responded directly by students[121] . It is important to note that the national survey cannot provide estimates at state level. In addition, not all the states collect data biennially; and some of the data from some jurisdictions might not be available for analysis if the CDC considers that the response rate achieved was not sufficient. Moreover, even though, data from the YRBSS is publically available at the CDC website some of the jurisdictions that collect data might not make it available.

The YRBSS was designed to monitor six categories of risk behaviors including alcohol and drug use. Cannabis use variables include: Ever used marijuana; age of first use; frequency of use –past-30 days; frequency driven when using marijuana –past-month; usual use of marijuana –past-30 days; frequency marijuana use at school –past-30 days; drove a car or other vehicle when using marijuana. Mental health related variables: self-reported suicidal thoughts/ plans/ attempts.

Demographic variables: age, sex, school grade, race (including American Indian/ Alaska Native; Native Hawaiian/ Other Pacific Islander)[122].

Behavioral Risk Factor Surveillance System (BRFSS)[105]

The BRFSS is a cross-sectional telephone survey conducted monthly since 1984 by the US State Health Departments with assistance from CDC. The BRFSS targets US citizens 18 years of age or older living in the 50 states, the District of Columbia, and three US territories. The BRFSS uses a disproportionate stratified sampling to select the sample of landline telephone numbers. For the cellular phone sample, respondents are randomly selected using equal probability of selection based on a sampling frame of confirmed cellular area code and prefix combinations[123]. Data from the survey is publically available at the CDC website[105] .

The BRFSS was designed to monitor risk behaviors, chronic conditions and use of preventive services in the US[124]. Cannabis variables include: Frequency of use past-30 days; primary mode of marijuana use – past-30 days; reason for using in past-30 days (i.e., medical, non-medical, both). Mental health related variables: Number of days in past-30 days when mental health was not good; how many days in past-30 days poor physical or mental health prevented doing usual activities; ever told you have a depressive disorder; during past-30 days how many days have felt sad, blue or depressed; during past-30 days how many days have felt worried, tense or anxious. Demographic variables: sex, age, race (including American Indian/ Alaska Native, Native Hawaiian), marital status, education, whether or not ever served in the Armed Forces, employment status, household income. The BRFSS is composed of core questions, optional modules and state-added questions; therefore, some of the variables might not be available in all the survey years.

Appendix 2. Cannabis Regulations in Other Jurisdictions where Non-Medical Cannabis is Legal

Table A2.1. Summary of cannabis regulations in jurisdictions where non-medical cannabis is legal

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
Uruguay[46, 49, 50, 51]	***Age for Legal Consumption:*** 18+ ***Amount Allowed:*** adults permitted 40g/ month (10g/week), annual cap 480g/member of a cannabis club ***Consumption:*** Follows tobacco regulation. Use at work or during the work day is prohibited ***DUI Definition:*** Detectable THC in the body	***Control Over Sale:*** Overseen by the Institute for Regulation and Control of Cannabis (IRCCA). Only sold at licensed pharmacies to registered individuals; adults permitted up to 10g per week from pharmacy ***Control Over Growing:*** Overseen by IRCCA. Licensed commercial growers allowed. Cannabis Clubs (15 to 45 members) limited to 99 plants. Personal grow-op allowed 6 plants ***Number of Licensed Cultivators:*** 2, but convocation open to add up to 5 more February 2019 ***Retail Licensing:*** Limited to pharmacies only ***Number of Licensed Retailers:*** 17 pharmacies ***Production Estimates:*** 2 tons per year from each licensed cultivator	***Taxation rate*:** 0% - categorized as an agricultural product; no luxury item tax (like there is with cigarettes and alcohol)

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		Sales Overtime: in pharmacies U$ 2.631.187	
Alaska[52-56]	***Age for Legal Consumption:*** 21 + ***Amount Allowed:*** One ounce at any time ***Consumption:*** Public consumption prohibited ***DUI Definition:*** Relies on field sobriety tests; may be ticketed for operating a vehicle with a motor, or any aircraft or watercraft with or without a motor	***Control Over Sale:*** Overseen by the Marijuana Control Board. Only sold at license retailers. Amounts permitted per single transaction: up to one ounce of usable marijuana; up to seven grams of marijuana concentrate for inhalation; or marijuana or marijuana products with a total content of less than 5,600 mg of THC. Personal transfer of up to one ounce and up to six immature marijuana plants without remuneration to an adult 21+ is permitted ***Control Over Growing:*** Overseen by the Marijuana Control Board. 6 mature plants/household for personal use; businesses may apply for cultivation licenses ***Number of Licensed Cultivators:*** 116 ***Retail Licensing:*** Overseen by the Marijuana Control Board. ***Number of Licensed Retailers:*** 73	***Taxation Rate*:** $50 per ounce of mature bud/flower, $25 per ounce of immature or abnormal bud, $15 per ounce of trim, $1 flat rate per clone

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		Production Estimates: 1,250 ponds of Bud or flower; 1,074 pounds of trim or other parts of plant sold or transfer in 2018	
		Sales Overtime: US $ 11,094,808 in tax revenue in 2018	
Colorado[57-60]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by the Department of Revenue. Only sold at licensed retailers; only one ounce is allowed to be purchase at one time	***Taxation Rate*:** 15% excise tax from cultivator to processors or retailers; 15% excise tax on retail, plus existing local or state sales tax. Local governments may impose additional retail taxes on cannabis.
	Amount Allowed: Up to one ounce		
	Consumption: Public consumption prohibited	***Control Over Growing:*** Overseen by the Department of Revenue which also has control over manufacturing, and labs. 6 plants/ person and up to 12/ household for home growth	
	DUI Definition: 5ng of delta-9 THC/mL blood		
		Number of Licensed Cultivators: 735	
		Retail Licensing: Overseen by the Marijuana Enforcement Division (MED) of the Colorado Department of Revenue. Each local authority can deny licensure requests by individuals within their jurisdiction	
		Number of Licensed Retailers: 549 stores, 282 product manufactures	

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		Production Estimates: 675,005 plants- 208.6 metric tons flower in 2017	
		Sales Overtime: $1.5 billion in 2017	
Oregon [61-65]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by the Oregon Liquor Control Commission (OLCC). Restrictions of sales/ adult at any one time within one day: 1 ounce of usable marijuana, 5 grams of cannabinoid extracts or concentrates, 16 ounces of cannabinoid product in solid form, 72 fluid ounces cannabinoid product in liquid form, 10 marijuana seeds, 4 immature marijuana plants	***Taxation Rate*:** State excise tax rate 17%. Municipalities may tax up to an additional 3%
	Amount Allowed: 8 ounces at home; 1 ounce on person from purchased at a retail store		
	Consumption: Public consumption prohibited		
	DUI Definition: Under the influence of cannabis. No limit level of THC. Relies on field sobriety test and police officer observation.	***Control Over Growing:*** Overseen by OLCC. 4 plants/ personal use	
		Number of Licensed Cultivators: 1,115 as of Feb 6 2019	
		Retail Licensing: Overseen by OLCC	
		Number of Licensed Retailers: 606 – as of Feb 6 2019	

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		Production Estimates: Not Found	
		Sales Overtime: $286,900,820 in 2016	
Washington State [66-72]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by Washington State Liquor and Cannabis Board (LCB). Only state-licensed retail stores	***Taxation Rate:*** 37% excise tax
	Amount Allowed: Adults can possess 1 ounce of cannabis, 7 grams of cannabis concentrate/ extract for inhalation, 16 ounces of cannabis infused product in solid form, 72 ounces of cannabis infused product in liquid form	***Control Over Growing:*** Overseen by LCB. Cultivation licenses grated initially from November 18 2013 to December 18 2013. These licenses are not currently available. Three different type of marijuana producers available. At-home cultivation illegal	
	Consumption: Public consumption prohibited	***Number of Licensed Cultivators:*** 1205	
	DUI Definition: More than 5ng THC/mL blood	***Retail Licensing:*** Overseen by LCB	
		Number of Licensed Retailers: 505	
		Production Estimates: 172,108 pounds in 2016	
		Sales Overtime: US$ 972,527,246 in 2018	

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
Washington DC [73,74]	***Age for Legal Consumption:*** 21 + ***Amount Allowed:*** Up to two ounces ***Consumption:*** Public consumption prohibited ***DUI Definition:*** Under the influence of cannabis. No limit level of THC. Relies on field sobriety test and police officer observation.	***Control Over Sale:*** No retail sales allowed. Transfer of up to one ounce to another person without payment of any kind is permitted ***Control Over Growing:*** Not industrial growing allowed**.** 3 mature plants/ person or up to 6 plants/ per household with multiple adults over 21 ***Number of Licensed Cultivators:*** None for non-medical marijuana ***Retail Licensing:*** Not allowed for non-medical marijuana ***Number of Licensed Retailers:*** None for non-medical marijuana ***Production Estimates:*** Only production for personal consumption allowed ***Sales Overtime:*** Not Applicable	***Taxation Rate*:** Not Applicable
California [75-79]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by the Bureau of Cannabis Control. Only in state-licensed retailers	***Taxation Rate*:** 15% Excise tax for retailers; cultivation tax: cannabis flowers - $9.25 per dry-weight ounce,

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
	Amount Allowed: Up to one ounce of cannabis and up to eight grams of concentrated cannabis. ***Consumption:*** Public consumption prohibited ***DUI Definition:*** Under the influence of cannabis. No limit level of THC. Relies on field sobriety test and police officer observation	***Control Over Growing:*** Overseen by California Department of Food and Agriculture. Different types of industrial licenses depending on way of production and size of premises. 6 plants allowed for personal growth ***Number of Licensed Cultivators:*** 6 active; 9,445 temporary licenses issued in 2018 ***Retail Licensing:*** Overseen by the Bureau of Cannabis Control. ***Number of Licensed Retailers:*** 640 ***Production Estimates:*** Not Available ***Sales Overtime:*** US $464, 666,667 based on excise and sales tax collected in 2018 second quarter	cannabis leaves - $2.75 per dry-weight ounce, fresh cannabis plant - $1.29 per ounce
Nevada [80-84]	***Age for Legal Consumption:*** 21 + ***Amount Allowed:*** Up to one ounce of cannabis; up to 1/8 of an ounce of concentrated cannabis	***Control Over Sale:*** Overseen by The State Department of Taxation. Sales allowed only on state-licensed retail store or dispensary	***Taxation Rate*:** 10% excise tax on retail sale paid by retail store; 15% excise tax on wholesale sale paid by the cultivator; additional retail sale tax at the local rate

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
	Consumption: Public consumption prohibited ***DUI Definition:*** 2 ng of delta-9- THC/mL blood; or 5 ng of 11-OH- THC THC/mL blood	***Control Over Growing:*** Overseen by The State Department of Taxation. Applications for cultivation license accepted from October 30th 2018 to Nov 13 2018. Personal growth, up to 6 plants per person; up to 12 plants/ household ***Number of Licensed Cultivators:*** 185 for medical marijuana. Not clear how many are also producing for non-medical ***Retail Licensing:*** Overseen by The state Department of Taxation. Initially, only existing licensed medical marijuana establishment were allowed to apply for retail marijuana license. Additional retail license applications opened from September 7 to 20th 2018 ***Number of Licensed Retailers:*** 63 ***Production Estimates:*** Not available ***Sales Overtime:*** US$424,892,020 based on excise and sales tax collected in 2018	
Maine. [85]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by the Department of Administrative and Financial Services**.** Allowed in licensed retail stores and Marijuana Social Clubs (to start in 2020)	***Taxation Rate*****:** 10% sales tax ; $130/ pound of marijuana flower or mature plants;

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
	Amount Allowed: Up to 2.5 ounces, or 2.5 ounces of marijuana and marijuana concentrate that includes no more than 5 grams of marijuana concentrate ***Consumption:*** Public consumption prohibited ***DUI Definition:*** Under the influence of cannabis. No limit level of THC has been stablished yet. Relies on field sobriety test and police officer observation	***Control Over Growing:*** Overseen by the Department of Agriculture, Conservation and Forestry**.** Personal growth 6 mature plants; up to 12 mature plants per parcel; some municipalities might allow up to 18 plants for personal use ***Number of Licensed Cultivators:*** N/A ***Retail Licensing:*** Currently drafting the laws ***Number of Licensed Retailers:*** N/A ***Production Estimates:*** N/A ***Sales Overtime:*** N/A	$36.29/ pound of marijuana trim; f $1.50 per immature marijuana plant or seedling; $0.30 per marijuana seed
Massachusetts [86-92]	***Age for Legal Consumption:*** 21 + ***Amount Allowed:*** Up to one ounce of marijuana or five grams of marijuana concentrate. Up to 10 ounces at home	***Control Over Sale:*** Overseen by the Cannabis Control Commission. Licensed retailers. Up to one ounce of marijuana or five grams of marijuana concentrate ***Control Over Growing:*** Overseen by the Cannabis Control Commission. Several licenses types depending on production	***Taxation Rate*****:** Sale tax 6.25%; Excise tax 10.75%; additional optional for municipalities up to 3%

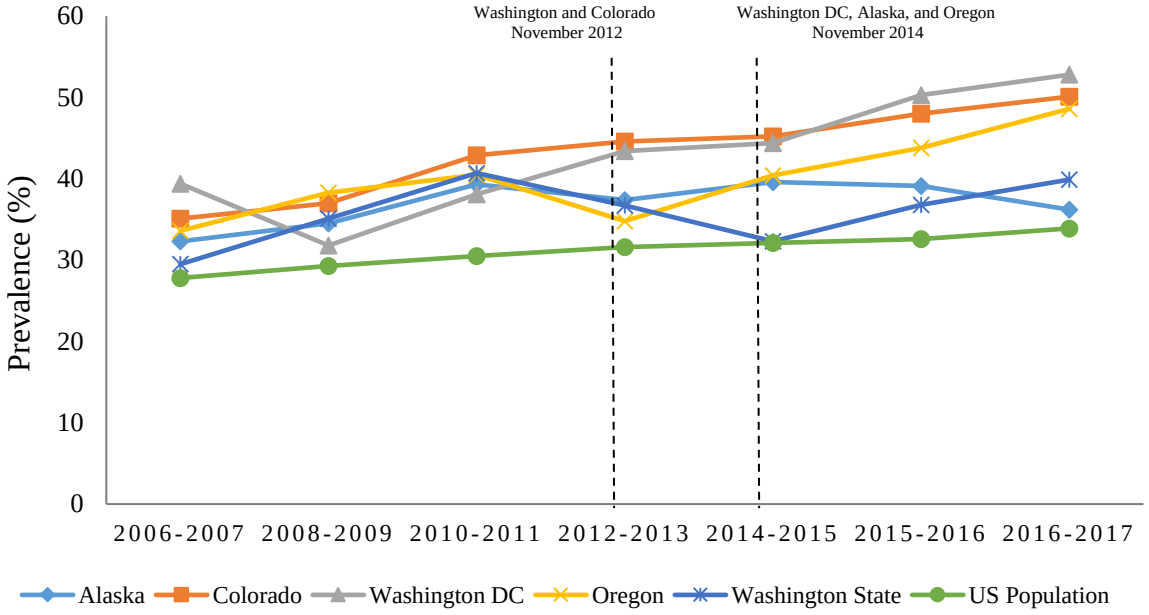
Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		capacity. Personal growth 6 plants at home, and up to 12 plants for 2 or more adults	
	Consumption: Public consumption prohibited		
	DUI Definition: Under the influence of marijuana. Relies on Standard Field Sobriety Test (horizontal gaze nystagmus test proposed)	***Number of Licensed Cultivators:*** 5	
		Retail Licensing: Overseen by the Cannabis Control Commission. First retail store opened in 2018	
		Number of Licensed Retailers: 9	
		Production Estimates: Not Available	
		Sales Overtime: US$27,904,786 from 11/202018 – 01/27/2019	
Michigan [93-97]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Overseen by the Michigan Department of Licensing and Regulatory Affairs (LARA). Sales allowed at licensed-retail establishments. Giving away or transferring without remuneration up to 2.5 ounces of marijuana, but not more than 15 grams of concentrate is allowed. Transfer or gift should not be advertised to the public.	***Taxation Rate*:** Proposed 10% excise tax at retail level plus the 6% state sales tax.
	Amount Allowed: Up to 2.5 ounces. No more than 15 grams of marijuana in the form of concentrate. 10 ounces within the person's residence. Amounts over 2.5 ounces should be properly stored		

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
		Control Over Growing: Overseen by LARA. 3 type of producers depending on number of plants allowed to grow: 100 or 500 or 2000 marijuana plants. Microbusiness allowed up to 150 plants. Applications for marijuana cultivation licenses will be open within 12 month of legalization. Personal growth of up to 12 plants per household	
	Consumption: Public consumption prohibited		
	DUI Definition: Under the influence of cannabis. Relies on standard field sobriety test and police officer observation. Pilot project undergoing in 5 counties to detect THC levels using saliva swap	***Number of Licensed Cultivators***: N/A	
		Retail Licensing: Overseen by LARA. Applications for marijuana establishments will be open within 12 month of legalization.	
		Number of Licensed Retailers: N/A	
		Production Estimates: Not available	
		Sales Overtime: Projected US$738 million in tax revenue from 2019-2023	
Vermont[96] [98-100]	***Age for Legal Consumption:*** 21 +	***Control Over Sale:*** Will be overseen by the Cannabis Control Board. Only licensed retailers allowed to sell to consumers.	***Taxation Rate*****:** Proposed 20% excise tax, plus 6% sales tax, plus potential additional 1% in municipalities with a cannabis
	Amount Allowed: Up to one once		

Jurisdiction	Regulation of Use	Regulation of Sales	Economic Regulation
	Consumption: Public consumption prohibited ***DUI Definition:*** Under the influence of cannabis. No THC limit stablished. Relies on standard field sobriety test and police officer observation. Proposed oral fluid sample to detect THC levels	***Control Over Growing:*** Will be overseen by the Cannabis Control Board. Application for licensing to open on or before Sept 15, 2020. Personal cultivation up to 2 mature marijuana plants or up to 4 immature marijuana plants per household ***Number of Licensed Cultivators:*** N/A ***Retail Licensing:*** Will be overseen by the Cannabis Control Board. Application for licensing to open on or before January 15, 2021 ***Number of Licensed Retailers:*** N/A ***Production Estimates:*** N/A ***Sales Overtime:*** N/A	retailer. Proposed 9% sale tax instead of 6% for edible or infused products

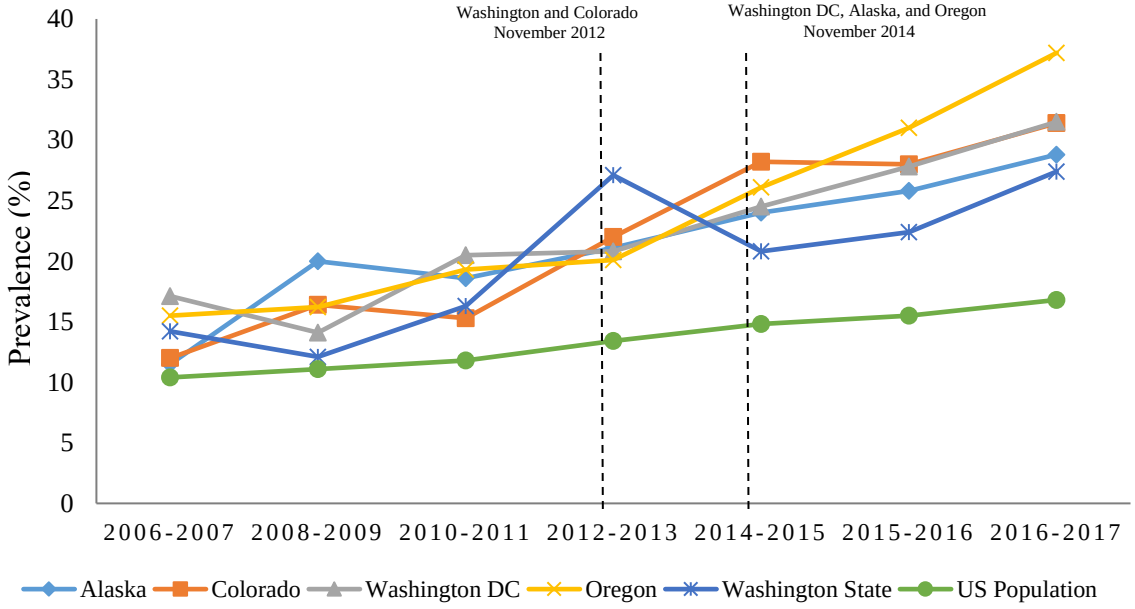
Appendix 3. Additional Pre-Post Legalization Figures

Figure A3.1. Prevalence of past-year cannabis use pre-post legalization by age: 18-25 years old



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS).

Figure A3.2. Prevalence of past-year cannabis use pre-post legalization by age: 26-49 years old



Note: Data for the US is from National Survey on Drug Use and Health (NSDUH): 2 Year Restricted-use Data Analysis System (RDAS)

Appendix 4. Search Strategy for Scoping Review

1. Cannabis/ or Medical Marijuana/ or exp Cannabinoids/

2. exp Mental Disorders/ or affective symptoms/ or exp aggression/ or depression/ or obsessive behavior/ or paranoid behavior/ or exp stress, psychological/

3. Marijuana Abuse/or alcoholism/

4. Mental Health/ or Substance Withdrawal Syndrome/

5. 2 or 3 or 4

6. 1 and 5

7. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw,kf.

8. 6 or 7

9. limit 8 to (english or french)

10. limit 9 to (case reports or comment or editorial or letter)

11. 9 not 10

12. limit 11 to "review"

13. 11 not 12

14. ((systematic or scoping or critical or evidence-based) adj3 (review* or overview* or synthes*)).tw,kf.

15. 11 and 14

16. 13 or 15

17.animals/ not human/

18. 16 not 17

Cannabis and Mental Health C

Cannabis and Mental Health Cochrane SR Database Nov 23 2018

1. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw,kf.

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1. cannabis addiction/
2. cannabis-induced psychosis/
3. 1 or 2
4. exp cannabinoid/ or "cannabis use"/ or cannabis smoking/
5. exp mental disease/
6. aggression/ or aggressiveness/
7. mental stress/
8. exp mental health/
9. 5 or 6 or 7 or 8
10. 4 and 9
11. 3 or 10
12. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw,kw.
13. 11 or 12
14. limit 13 to (english or french)
15. limit 14 to (conference abstract or editorial or letter)
16. 14 not 15
17. case report/
18. 16 not 17
19. limit 18 to "review"
20. 18 not 19
21. limit 18 to "systematic review"
22. ((systematic or scoping or critical or evidence-based) adj3 (review* or overview* or synthes*)).tw,kw.
23. "cochrane database of systematic reviews".jn.
24. 22 or 23
25. 18 and 24
26. 20 or 21 or 25

Cannabis and Mental Health EMBASE V 2 11000 Nov 23 2018

1. *cannabis addiction/
2. cannabis-induced psychosis/
3. 1 or 2
4. exp *cannabinoid/ or *"cannabis use"/ or *cannabis smoking/
5. exp mental disease/
6. aggression/ or aggressiveness/
7. mental stress/
8. exp mental health/
9. 5 or 6 or 7 or8
10. 4 and 9
11. 3 or 10
12. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw,kw.
13. 11 or 12
14. limit 13 to (english or french)
15. limit 14 to (conference abstract or editorial or letter)
16. 14 not 15
17. case report/
18. 16 not 17
19. limit 18 to "review"
20. 18 not 19
21. limit 18 to "systematic review"
22. ((systematic or scoping or critical or evidence-based) adj3 (review* or overview* or synthes*)).tw,kw.
23. 18 and 22
24. 20 or 21 or 23

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1. Cannabis/ or Medical Marijuana/ or exp Cannabinoids/
2. exp Mental Disorders/ or affective symptoms/ or exp aggression/ or depression/ or obsessive behavior/ or paranoid behavior/ or exp stress, psychological/
3. Marijuana Abuse/ or alcoholism/
4. Mental Health/ or Substance Withdrawal Syndrome/
5. 2 or 3 or 4
6. 1 and 5
7. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw,kf.
8. 6 or 7
9. limit 8 to (english or french)
10. limit 9 to (case reports or comment or editorial or letter)
11. 9 not 10
12. limit 11 to "review"
13. 11 not 12
14. ((systematic or scoping or critical or evidence-based) adj3 (review* or overview* or synthes*)).tw,kf.
15. 11 and 14
16. 13 or 15
17. "cochrane database of systematic reviews".jn. or systematic reviews.pt.
18. 11 and 17
19. 16 or 18
20. animals/ not human/
21. 19 not 20

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1. exp cannabinoids/ or exp cannabis/
2. exp MARIJUANA USAGE/
3. 1 or 2
4. exp mental disorders/
5. post-traumatic stress/ or psychological stress/
6. aggressive behavior/
7. Conduct Disorder/ or exp Oppositional Defiant Disorder/
8. exp sleep disorders/
9. cognitive impairment/
10. exp learning disorders/ or developmental disabilities/
11. mental health/
12. well being/
13. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
14. 3 and 13
15. ((bhang or bhangs or bhangstar or cannabinoid* or cannabutter or cannabis* or doobie* or ganga or gangas or ganja or ganjas or grass or hash* or hashish* or hemp or hemps or honeycomb or mary jane* or marihuana* or marijuana* or moon rock or pot or reefer* or roach* or shatter or weed) adj5 (addict* or aggression or aggressive* or anxiet* or anxious or ((alcohol or substance) adj (abus* or dependenc* or overdose*)) or anorexi* or ADHD or attention deficit* or bipolar or bulimi* or cognition or cognitive* or compulsive disorder* or delirium or delirious or dementia* or depression or depressive or developmental disorder* or dissociative disorder* or eating disorder* or insomnia or learning disorder* or mania or mental disorder* or mental health or mood or moods or mood disorder* or multiple personality disorder* or neurocognitive or neurodevelopmental disorder* or obsessive-compulsive or OCD or oppositional defiant disorder* or panic disorder* or paranoia or paranoid or personality disorder* or phobia* or posttraumatic stress or post-traumatic stress or PTSD or psychiat* or psycho* or schizophrenia or sleep disorder* or stress or suicid* or (trauma* adj1 stressor*) or "use disorder*" or wellness or withdrawal*)).tw.
16. 14 or 15
17. limit 16 to (english or french)
18. limit 17 to animal
19. limit 17 to (animal and human)
20. 18 not 19
21. 17 not 20
22. limit 21 to (abstract collection or bibliography or chapter or dissertation or editorial or encyclopedia entry or letter or obituary or poetry or review-book or review-media or review-software & other)
23. 21 not 22

Appendix 5. PRISMA-ScR Checklist[108]

Table. PRISMA-ScR Checklist

Section	Item	PRISMA-ScR Checklist Item
Title	1	Identify the report as a scoping review.
Abstract		
Structured summary	2	Provide a structured summary that includes (as applicable) background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.
Introduction		
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.
Methods		
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).
Summary measures	13	Not applicable for scoping reviews.
Synthesis of results	14	Describe the methods of handling and summarizing the data that were charted.
Risk of bias across studies	15	Not applicable for scoping reviews.
Additional analyses	16	Not applicable for scoping reviews.
Results		
Selection of sources of evidence	17	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.
Characteristics of sources of evidence	18	For each source of evidence, present characteristics for which data were charted and provide the citations.
Critical appraisal within sources of evidence	19	If done, present data on critical appraisal of included sources of evidence (see item 12).
Results of individual sources of evidence	20	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.
Synthesis of results	21	Summarize and/or present the charting results as they relate to the review questions and objectives.
Risk of bias across studies	22	Not applicable for scoping reviews.
Additional analyses	23	Not applicable for scoping reviews.
Discussion		
Summary of evidence	24	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.
Limitations	25	Discuss the limitations of the scoping review process.
Conclusions	26	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.
Funding	27	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy documents).

Appendix 6. Inclusion/Exclusion Criteria for Scoping Review

	Inclusion Criteria	Exclusion Criteria
Population	• Humans • Animals	• Main study cohort is non-cannabis users
Intervention (Exposure)	• Cannabis use ○ Recreational or medical	• Synthetic cannabinoids
Comparison	• Non-cannabis users defined by author • No cannabis use disorder	• Comparison group is different frequency of use (ex. chronic vs. frequent)

Outcomes	• Mental Health
	• Wellness
	• Mental Health outcomes (ex. schizophrenia, depression; symptoms and onset)
	• Therapeutic benefits (ex. decreasing mental health symptoms)
	• Substance abuse/dependence
	• Chemical, functional or physical changes in the brain (neurotransmitter levels, MRI scans, CT scans)
	• Tobacco use
	• Alcohol use
	• Alcohol use disorder
	• Substance disorder
	• Cognitive function/behavior (only in animals studies)
		• Non-mental health outcomes
		  • Ex: gastric outcomes, visual cortex, Parkinson's, lesions, multiple sclerosis symptoms,
		  • Cognitive outcomes in humans
		• Cancer or pain studies that do not include mental health outcome

Design	• Comparative studies
	  Examples:
	  ○ RCT
	  ○ Comparative cohorts
	  ○ Case/control
	  ○ Experimental
	  ○ Costing studies
	  ○ Comparison/Exposure
	  ○ Cross-sectional IF association of cannabis and mental health outcome established
	• Qualitative studies
	  Examples
	  ○ Focus groups
	  ○ Interviews
	  Key words to look for:
	  ○ Ethnography
	  ○ Phenomenology
	  ○ Grounded Theory
		• Excluded study designs:
		  ○ Conference proceedings
		  ○ Editorials or commentaries
		  ○ Reviews
		  ○ Summaries
		  ○ Predictive models
		  ○ Surveys
		  ○ Cohorts of single group (prevalence studies)
		• "Drug use" or "substance abuse" to be excluded unless cannabis is stratified somewhere.

	○ Document Review (ex. A public health agency puts out a summary of policies regarding mental health outcomes as the result of a document scan)	

Appendix 7. References of Included Studies in Scoping Review

Wild-type Animals

Abdel-Salam, 2013[125]
Abdel-Salam, 2016[126]
Ali, 1991[127]
Amal, 2010[128]
Aso, 2016[129]
Bac, 2002[130]
Bac, 2003[131]
Bhattacharya, 1986[132]
Bonnin, 1996[133]
Boucher, 2007[134]
Boucher, 2007[135]
Butovsky, 2006[136]
Campbell, 2001[137]
Campos, 2013[138]
Campos, 2012[139]
Campos, 2008[140]
Carlini, 1977[141]
Castaldo, 2010[142]
Chen, 1993[143]
Cheng, 2014[144]
Corchero, 1997[145]
Dalterio, 1984[146]
Downer, 2007[147]
Egashira, 2002[148]
Egerton, 2005[149]
El-Alfy, 2010[150]
ElBatsh, 2012[151]
Fadda, 2004[152]
Fagherazzi, 2011[153]
Fokos, 2010[154]
Frischknecht, 1985[155]
Goldman, 1975[156]
Gómez, 2003[157]
Harte, 2010[158]
Heyser, 1993[159]
Imam, 2017[160]
John, 2018[161]
Keeley, 2015[162]
Kilbey, 1972[163]
Kilbey, 1977[164]
Ladarre, 2015[165]
Lazenka, 2017[166]
Lazenka, 2015[167]
Leishman, 2018[168]
Leite, 1974[169]
Lepore, 1995[170]
Lichtman, 1995[171]
Long, 2010[172]
Long, 2013[173]
Luthra, 1975[174]
Mahgoub, 2013[175]
Malone, 2009[176]
Manning, 1972[177]
Martin, 1977[178]
Mato, 2010[179]
Matte, 1975[180]
McDonough Jr., 1972[181]
Miller, 2018[182]
Mishima, 2001[183]
Mishima, 2002[184]
Mishima, 2002[185]
Moore, 2010[186]
Morley, 2004[187]
Moss, 1978[188]
Muntoni, 2006[189]
Murphy, 2017[190]
Nardo, 2013[191]
Nava, 2000[192]
Nava, 2001[193]
Nazario, 2015[194]
Neto, 1975[195]
Newsom, 2008[196]
Ng Cheong Ton, 1988[197]
Nguyen, 2012[198]
Niyuhire, 2007[199]
O'Shea, 2005[200]
Oviedo, 1993[201]
Palermo Neto, 1972[202]
Palermo Neto, 1973[203]
Palermo Neto, 1975[204]
Patel, 2006[205]
Peres, 2018[206]
Pistis, 2002[207]
Pistis, 2001[208]
Puighermanal, 2009[209]
Quinn, 2008[210]
Raver, 2013[211]
Realini, 2011[212]
Renard, 2016[213]
Renard, 2017[214]
Resstel, 2006[215]
Reus, 2011[216]
Revuelta, 1978[217]
Roloff, 2009[218]
Rossignoli, 2017[219]
Rubino, 2008[220]
Rubino, 2015[221]
Rubino, 2009[222]
Rubino, 2009[223]
Rubino, 2007[224]
Rubino, 2008[225]
Rusznak, 2018[226]
Ryan, 2006[227]
Sales, 2018[228]
Sales, 2018[229]
Sandler, 2017[230]
Saravia, 2018[231]
Sarne, 2018[232]
Sartim, 2016[233]
Scallet, 1987[234]
Schiavon, 2014[235]
Sethi, 1986[236]
Sieber, 1980[237]
Silveira, 2017[238]
Solinas, 2004[239]
Sonego, 2016[240]
Spencer, 2013[241]
Steel, 2011[242]
Stern, 2012[243]
Stern, 2015[244]
Swartzwelder, 2012[245]
Taffe, 2012[246]
Takahashi, 1975[247]
Takahashi, 2003[248]
Todd, 2017[249]
Tortoriello, 2014[250]
Tournier, 2014[251]
Tournier, 2016[252]
Tselnicker, 2007[253]
Van Ree, 1984[254]
Verrico, 2014[255]
Verrico, 2003[256]
Verrico, 2012[257]
Wiley, 2010[258]
Wu, 2000[259]
Yoshimura, 1981[260]
Zamberletti, 2016[261]
Zamberletti, 2015[262]
Zamberletti, 2011[263]
Zanelati, 2010[264]
Zimmer, 2001[265]
Zuardi, 1991[266]

Animal Models of Atypical Mental Health or Function
Human Brain Science

Abdullaev, 2010[295]
Abush, 2018[296]
Albrecht, 2013[297]
Aloi, 2018[298]
Amen, 2017[299]
Amen, 1998[300]
Ames, 2013[301]
Ashtari, 2011[302]
Asmaro, 2014[303]
Batalla, 2018[304]

Aguilar, 2016[267]
Aso, 2016[129]
Boucher, 2007[134]
Bouche, 2007[135]
Cheng, 2014[144]
Fagherazzi, 2011[153]
Gomes, 2015[268]
Gonzalez-Cuevas, 2018[269]
Gururajan, 2011[270]
Khadrawy, 2017[271]
Levin, 2012[272]
Levin, 2014[273]
Linge, 2016[274]
Lloyd, 2018[275]
Long, 2010[276]
Long, 2012[277]
Maguire, 2016[278]
Mahmud, 2017[279]
Malone, 2006[280]
Marinho, 2015[281]
Markos, 2018[282]
Mayer, 2014[283]
Pedarazzi, 2015[284]
Peres, 2018[206]
Renard, 2016[285]
Rodriguez, 2017[286]
Scherma, 2016[287]
Segal-Gavish, 2017[288]
Shoval, 2016[289]
Spano, 2007[290]
Spencer, 2013[241]
Stopponi, 2014[291]
Tantra, 2014[292]
Valvassori, 2011[293]
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Battisti, 2010[305]
Bayazit, 2016[306]
Becerk, 2015[307]
Behan, 2014[308]
Bhattacharyya, 2015[309]
Bhattacharyya, 2012[310]
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Bosong, 2012[316]
Bossong, 2015[317]
Bourque, 2013[318]
Brooks, 2017[319]
Broyd, 2013[320]
Buchy, 2015[321]
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Campbell, 1971[323]
Campbell, 1971[324]
Chye, 2018[325]
Chye, 2017[326]
Colizzi, 2018[327]
Cortes-Briones, 2015[328]
Cousijn, 2012[329]
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Cunha, 2013[332]
Dekker, 2010[333]
Demirakca, 2011[334]
Dragogna, 2014[335]
Ehlers, 2010[336]
Ehlers, 2008[337]
Eldreth, 2004[338]
Enzi, 2015[339]
Epstein, 2014[340]
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Epstein, 2015[342]
Evans, 1974[343]
Feldstein Ewing, 2013[344]
Filbey, 2013[345]
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Filbey, 2018[348]
Fink, 1976[349]
Ford, 2014[350]
French, 2015[351]
Frissen, 2018[352]
Fusar-Poli, 2010[353]

Goodman, 2017[354]
Gorka, 2016[355]
Gruber, 2009[356]
Haller, 2013[357]
Harding, 2012[358]
Hartberg, 2018[359]
Herning, 2008[360]
Herning, 2003[361]
Hester, 2009[362]
Ho, 2011[363]
Ilan, 2004[364]
Jacobsen, 2004[365]
Jacobus, 2012[366]
Jager, 2006[367]
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James, 2011[369]
Kanayama, 2004[370]
Kiang, 2013[371]
Kim, 2011[372]
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Koenders, 2016[374]
Koenders, 2015[375]
Kuepper, 2013[376]
Kumra, 2012[377]
Laprevote, 2017[378]
Leon-Carrion, 1991[379]
Leroy, 2012[380]
Levar, 2018[381]
Leweke, 2007[382]
Li, 2005[383]
Liem, 2010[384]
Lisdahl, 2016[385]
Ilan, 2004[386]
Loberg, 2012[387]
Lopez-Larson, 2011[388]
Lorenzetti, 2015[389]
Ma, 2018[390]
Maij, 2017[391]
Malchow, 2013[392]
Manza, 2018[393]
Mashhoon, 2013[394]
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Mathew, 1993[404]
Matochik, 2005[405]
McQueeny, 2011[406]
Meade, 2018[407]
Medina, 2009[408]
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Medina, 2007[410]
Mizrahi, 2014[411]
Mizrahi, 2013[412]
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Moreno-Alcazar, 2018[414]
Morgan, 2013[415]
Nestor, 2010[416]
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Newman, 2016[418]
Nottage, 2014[419]
Obiorah, 2017[420]
O'Leary, 2000[421]
O'Leary, 2002[422]
O'Leary, 2007[423]
Onwuameze, 2013[424]
Orr, 2013[425]
Osuch, 2016[426]
Owens, 2018[427]
Padula, 2007[428]
Parkar, 2010[429]
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Pavisian, 2014[431]
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Peckys, 2001[433]
Pesa, 2012[434]
Peters, 2009[435]
Phan, 2008[436]
Potvin, 2013[437]
Prashad, 2018[438]
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Prescot, 2013[440]
Pujol, 2014[441]
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Rapp, 2013[444]
Rentzsch, 2011[445]
Riba, 2015[446]
Rigucci, 2018[447]
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Romero, 2015[449]
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Roser, 2018[453]
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Safont, 2011[455]
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Shollenbarger, 2015[462]
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Tervo, 2018[487]
Thames, 2017[488]
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Thijssen, 2017[490]
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Tomasi, 2015[492]
Torrence, 2018[493]
Troup, 2017[494]
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Van Hell, 2011[498]
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Vergara, 2018[502]
Vingerhoets, 2016[503]
Voytek, 2005[504]
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Welsley, 2011[509]
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Zhou, 2018[520]
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Adkisson, 2018[526]
Afifi, 2007[527]
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Agrawal, 2017[529]
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Agrawal, 2009[531]
Agrawal, 2008[532]
Agrawal, 2017[533]
Ahsan, 2018[534]
Albertella, 2017[535]
Albertella, 2016[536]
Alemany, 2014[537]
Allegri, 2013[538]
Allen, 2014[539]
Allshouse, 2015[540]
Alwan, 2011[541]
Anderson, 2014[542]
Andréasson, 1990[543]
Andréasson, 1987[544]
Arenliu, 2014[545]
Aspis, 2015[546]
Auther, 2015[547]

Hindocha, 2017[686]
Hollis, 2008[687]
Honarmand, 2011[688]
Houston, 2011[689]
Hujibregts, 2014[690]
Innamorati, 2008[691]
Jacobus, 2012[366]
Johnson, 2016[692]
Jones, 2018[693]
Jones, 2017[694]
Kahn, 2011[695]
Kaufmann, 2010[696]
Keith, 2015[697]
Kerlin, 2018[698]
Kiang, 2013[371]
Kim, 2011[372]
Kimbrel, 2018[699]
Kimbrel, 2017[700]
King, 2001[701]
Kirisci, 2013[702]
Kirmayer, 2000[110]
Kokkevi, 2006[703]
Konings, 2008[704]
Korn, 2018[705]
Korthuis, 2008[706]
Korver, 2010[707]
Kristensen, 2007[708]
Kuepper, 2011[709]
Lamers, 2006[710]
Lavik, 1986[711]
Lawn, 2016[712]
Le Strat, 2009[713]
Leadbeater, 2018[714]
Lee, 2008[715]
Lee, 2009[716]
Lee, 2018[717]
Leech, 2006[718]
Legleye, 2010[719]
Lev-Ran, 2012[720]
Liem, 2010[384]
Lin, 1996[721]
Linn, 1972[722]
Looby, 2007[723]
Lopez-Larson, 2011[388]
Lorenzo-Luaces, 2014[724]
Lovell, 2018[725]
Lu, 2017[726]
Lundholm, 2014[727]
Lynskey, 2012[728]
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Appendix 8: Published Literature on Indigenous Peoples

Author Year	Country	Study	Participants	Number of Participants	Results
Agrawal et al., 2007	United States	Examined the co-occurrence of substance abuse and dependence and test associations to drug classes and major psychiatric disorders.	Participants of the National Epidemiological Survey of Alcohol and Related Conditions. Stratified by race that includes Native American/Alaskan Native.	43,093 total participants, 0.8% Native Hawaiian/Pacific Islander, 3.0% Native American/Alaskan Native.	Native Hawaiians/Pacific Islanders and Native Americans/Alaskan Natives were found to have an increased risk of cannabis abuse and dependence. The presence of psychiatric disorders and cannabis use were not stratified by race, therefore analysis of the association between psychiatric and cannabis was not possible.
Clough et al., 2006	Australia	Medical record review in randomly selected cohort and interview in recruited cohort.	Randomly selected and an opportunistically recruited samples of Indigenous people in a remote community in the Northern Territory.	265 total initial participants. 161 in initial randomly selected cohort, 139 were followed-up. 104 in initial recruited cohort, 50 were followed-up.	No significant difference in the rates of anxiety-dependency, mood-vegetative, and psychosis between the baseline and follow-up interviews in participants that continued using cannabis. Decreased prevalence of adverse psychological symptoms with a reduction in cannabis use.
Dharmawardene et al., 2015	New Zealand	Semi-structured interviews of participants for diagnosis and categorization by researchers.	In-patients of an acute psychiatric unit. Patients were selected based on mental disorders and provided informed consent.	141 participant in-patients of an acute psychiatric unit, 59 (42%) were Indigenous Māori.	Māori ethnicity was associated with cannabis use disorder. Cannabis use disorder was strongly associated with schizophrenia in Māori participants.

Author Year	Country	Study	Participants	Number of Participants	Results
Dingwall et al., 2011	Australia	Survey with questions pertaining to substance use and psychological symptoms.	Indigenous students of secondary and tertiary education institutions and Indigenous patients of residential substance use residential rehabilitation centres in Northern Territories.	407 total participants. Included participants under 18 years of age.	Psychological symptoms were found to be associated with cannabis use.
Kirmayer et al., 2000	Canada	Analysis of data from Santé Québec Health Survey with consent of the Cree Board of Health and Social Services of James Bay. Interviews were conducted in survey, that was translated into Cree for unilingual Cree speakers.	Cree participants of James Bay, Québec.	Regression analysis of 1,111 participants aged 15 years and over.	Lifetime cannabis usage was 38.2%. Cannabis use in lifetime was found to be associated with psychological distress.
Lee et al., 2008	Australia	Cross-sectional study involving interviews of participants. Interviews were conducted in local Indigenous	Indigenous peoples from three remote outstations in the Northern Territory.	106 participants aged 13 to 42 years.	52 of 106 (49.1%) participants were assessed as heavy users. Of the heavy users, 17 (32.7%) had symptoms of moderate-severe depression, compared to 8 of 54 (14.8%) of the abstain, former, or lighter use participants. The adjusted

Author Year	Country	Study	Participants	Number of Participants	Results
		language and in English.			odds ratio for depression symptoms and cannabis was significant at 4.1 (1.3, 13.4).
Lee et al., 2009	Australia	Longitudinal study examining the prevalence of cannabis use, cannabis use dependence, and social factors.	Indigenous peoples from three remote communities and single-family outstations in the Northern Territory.	82 participants aged 13-36 at baseline.	49 (59.8%) participants used cannabis at baseline. 88% reported three or more dependence symptoms. High prevalence of dependence symptoms was consistent with the heavy users. 43 participants had data to assess cessation. 28% of participants had ceased cannabis use at follow up.
Subica et al., 2018	United States	A cross-sectional survey to examine the prevalence of health-risk behaviours across racial and ethnic groups for the leading causes of adolescent morbidity and mortality.	Participants were adolescents from different racial groups in the United States in the 2001-2015 Youth Risk Behaviour cross-sectional surveys	184,494 grade 9 to 12 youths across racial groups. There were 1,130 Native Hawaiian/Pacific Islander and 2,129 American Indian/Alaskan Native participants.	The Native Hawaiian/Pacific Islander and American Indian/Alaskan Native groups had significantly higher rates of cannabis use and associated depressed mood symptoms use in comparison to other groups. It was found that Native Hawaiian/Pacific Islander and American Indian/Alaskan Native participants that used cannabis did not have significantly greater odds ratios of serious suicidal thoughts, suicide planning, or suicide attempts.
Sumstine et al., 2018	United States	A cross-sectional survey to examine the prevalence of substance use across racial/ethnic groups in	First Nations were included in the "all other" cohort, which also included African	1,053 undergraduate students.	The study found that there were racial/ethnic differences in cannabis use with White students having a higher prevalence than all other categories.

Author Year	Country	Study	Participants	Number of Participants	Results
		undergraduate college students.	American, and multiracial participants.		Analysis for associations between cannabis use and mental health symptoms were not conducted in the category including to First Nations.
Gilder; Ehlers, 2012	United States	Interviews regarding lifetime substance use, lifetime substance use disorder, and psychiatric disorder symptoms and diagnoses.	Adolescents from eight neighbouring Southwest California First Native reservations.	202 participants aged 13 to 17 years.	Depression and cannabis use occur concurrently in late childhood and early adolescence in this sample. Boys suffered a higher association between depression and cannabis use than girls. Boys who with lifetime cannabis use had significantly higher rates of anhedonia, worthless/guilty feelings, poor concentration, and major depressive episodes.
Ehlers et al., 2007	United States	Questionnaire and interviews regarding conduct disorder, antisocial personality disorder, and anxiety/depressive disorders, and/or affective disorders. Diagnoses were made by a research psychiatrist/addiction specialist.	Participants from eight neighbouring Southwest California First Native reservations.	525 adult participants.	Early cannabis use was found to be associated with cannabis abuse and dependence. 173 (33%) met criteria for lifetime diagnosis of cannabis dependence and 58 (11%) for cannabis abuse
Ehlers et al., 2010	United States	Questionnaire and interviews regarding diagnosis of cannabis	Participants from eight neighbouring	626 adult participants.	204 (33%) of the participants met criteria for cannabis dependence.

Author Year	Country	Study	Participants	Number of Participants	Results
		abuse or dependence, conduct disorder, antisocial personality disorder, and anxiety/depressive disorders, and/or affective disorders. Diagnoses were made by a research psychiatrist/addiction specialist. Electroencephalograms (EEG) were conducted on participants to investigate the heritability association with cannabis dependence.	Southwest California First Native reservations.		Cannabis dependence was positively correlated with power and delta range at the right and left fronto-central-parietal leads.
Ehlers et al., 2008	United States	Questionnaire and interviews regarding diagnosis of cannabis abuse or dependence, conduct disorder, antisocial personality disorder, and anxiety/depressive disorders, and/or affective disorders. Diagnoses were made by a research	Participants from eight neighbouring Southwest California First Native reservations.	317 adult participants.	Increases in facial recognition latency were associated with a lifetime diagnosis of cannabis dependence.

Author Year	Country	Study	Participants	Number of Participants	Results
		psychiatrist/addiction specialist. Event-related potential (ERP) collected using a facial discrimination task using standardized stimuli to assess amplitudes and latencies in facial recognition.			

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