Cannabis use among individuals in inpatient psychiatry: Trends in use, factors associated with use, and risk of 30-day readmission

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Purpose: The Canadian Government has approved Bill C-45 to legalize and regulate the production, sale, and use of non-medical cannabis. Certain subpopulations, including those with psychiatric disorders, need to be uniquely considered during policy development and continually monitored as they may be particularly vulnerable to negative outcomes associated with cannabis use. This research was conducted to evaluate current prevalence and patterns of past 30-day cannabis use among individuals admitted to inpatient psychiatry in Ontario.

Methods: This study evaluated patterns of past 30-day cannabis use among individuals admitted to inpatient psychiatry in Ontario, Canada from 2006 to 2016 (n=160322). An individual's first admission during the study period (index admission) was used for the analysis. Prevalence rates were established, and trends were stratified by age, sex, and psychiatric diagnosis. Variables significantly associated with past 30-day use at the bivariate level were identified. Block modelling was carried out with significant variables to construct a logistic regression model that describes characteristics associated with past 30-day use. This process was repeated for 30-day readmissions. Cannabis was added to the final model to determine whether it remained significantly associated with readmissions after controlling for other variables. Factors associated with readmissions among past 30-day cannabis users and non-users were identified.

Results: Past 30-day cannabis use increased from 15.4% to 25.3% from 2006 to 2016. Although more males reported past 30-day cannabis use, non-males had a greater increase in use across the study period. Persons ages 18 to 24 had the highest rates of cannabis use. However, older age categories also had increases in rates of use over time. Younger individuals with substance-related and addictive disorders, males with schizophrenia and other psychotic disorders, and those with mood disorders all had greater odds of reporting past 30-day cannabis use, while a neurocognitive diagnosis was associated with reduced odds. Greater use was found among those with shorter lengths of stay, a history of violence, experiences of traumatic life events and financial hardship, poorer medication adherence, fewer lifetime psychiatric hospitalizations, and more severe symptoms and clinical measures (positive symptoms, social withdrawal, cognitive performance, mania symptoms, and indicators of addiction). After controlling for other variables, cannabis was significantly associated with readmissions for those exhibiting positive symptoms. Variables associated with readmissions for recent users were highly related to psychosis and may be associated with more complex and less compliant patients.

Conclusions: A steady increase in past 30-day cannabis use from 2006 to 2016 was found. Continual monitoring of psychiatric admissions following legalization is important to determine whether an increase in cannabis use is associated with increased admissions. Several characteristics describing past 30-day cannabis users in inpatient psychiatry mimic that of users in the general population. Additional variables associated with past 30-day cannabis use were identified for the inpatient population which can be used to follow this population. Past 30-day cannabis use was significantly associated with 30-day readmissions for those exhibiting positive symptoms. Appropriate education and care planning is crucial in order to improve clinical outcomes and reduce unnecessary readmissions.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACMPR	Access to Cannabis for Medical Purposes Regulations
BPRS	Brief Psychiatry Rating Scale
CADUMS	Canadian Alcohol and Drug Use Monitoring Survey
CBD	Cannabidiol
CCSA	Canadian Centre on Substance Abuse
CIHI	Canadian Institute for Health Information
CTADS	Canadian Tobacco, Alcohol, and Drugs Survey
DSI	Depression Severity Index
ECS	Endocannabinoid system
ED	Emergency department
IADL	Instrumental activities of daily living
LOS	Length of stay
MMAR	Medical Marihuana Access Regulations
MMPR	Marijuana for Medical Purposes Regulations
OMHRS	Ontario Mental Health Reporting System
PSS	Positive Symptom Scale
PTSD	Post-traumatic Stress Disorder
RAI – MH	Resident Assessment Instrument-Mental Health
RHO	Risk of harm to others
SAD	Social Anxiety Disorder
SUD	Substance Use Disorder
SWS	Social Withdrawal Scale
Task Force	Task Force on Cannabis Legalization and Regulation
THC	Tetrahydrocannabinol

CHAPTER 1: INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

The Federal government of Canada has passed legislation under Bill C-45, the *Cannabis Act*, that will legalize and regulate the production, sale, and use of non-medical cannabis. Although non-medical cannabis has been legalized in other jurisdictions, major Canadian political bodies and organizations, such as the Canadian Centre on Substance Abuse (CCSA) and the Task Force on Cannabis Legalization and Regulation (Task Force), have identified extensive knowledge gaps in cannabis research. This has contributed to a primarily precautionary approach being used to describe impending cannabis legislation. A number of research gaps need to be addressed to better anticipate and understand the potential individual and societal level impacts of legalization. This can help to measure and mitigate unanticipated consequences that may follow legalization.

To date, research on cannabis has been inconclusive and conflicting results have been produced in relation to mental health. Studies suggest that those with mental health conditions have higher rates of cannabis use than those without (1,2). Both the prevalence and impact of cannabis use among those with psychiatric illnesses have been shown to vary by both individual demographic and clinical characteristics, and between diagnostic groups. Despite high rates of use, use within this population may be problematic by exacerbating psychiatric symptoms and interfering with disease management. Overall, there is a general lack of understanding and clarity on the relationship between cannabis use and mental health outcomes.

This research aimed to better understand the relationship between cannabis use and mental health conditions and how it affects clinical outcomes among those in care. This research:

1) Explored trends in cannabis use amongst the general inpatient psychiatric population in Ontario, Canada from 2006 to 2016

2) Examined demographic and clinical characteristics associated with past 30-day cannabis use for individuals in inpatient psychiatry in Ontario

3) Determined whether 30-day hospital readmission rates differed for individuals in inpatient psychiatry by past 30-day cannabis use status

1.2 OVERVIEW

This thesis will be presented in six chapters. Chapter 1 has included a brief introduction of cannabis use and mental health and provides an overview of what is to come. Chapter 2 forms the literature review with subsections including: The Cannabis Sativa Plant: Botany and Pharmacology, Canadian Policy Context and Cannabis, Cannabis Use in The General Population, Cannabis Use and Vulnerable Populations, Cannabis Use and Clinical Outcomes, and Legalization in Other Jurisdictions. The study rationale is described in Chapter 3 to emphasize the importance of these research questions and the timely nature of this work. Chapter 4 includes a description of the methods used during the analysis. Chapter 5 outlines the results produced through statistical analyses. Finally, a discussion of the study findings is included in Chapter 6.

CHAPTER 2: LITERATURE REVIEW

2.1 THE CANNABIS SATIVA PLANT: BOTANY AND PHARMACOLOGY

2.1.1 Cannabinoids and the Endocannabinoid System

Cannabis is derived from the leaves, flowers, stems and seeds of the *cannabis sativa* plant. Over 400 bioactive molecules have been identified in the cannabis plant, with at least 60 of them being cannabinoids (3). Cannabinoids induce physiological changes in the body by interacting with receptors of the endocannabinoid system (ECS) (3). The ECS is made up of three major components: cannabinoid receptors, endogenous ligands that interact with cannabinoid receptors, and enzymes that synthesize or degrade the ligands (4). As the primary function of the ECS is to regulate homeostasis in the body, this system is involved in a multitude of physiological processes. When cannabinoids interact with receptors of the ECS, users experience a diverse array of effects (Table 1).

Table 1. The effects of tetrahydrocannabinol (THC) on the brain categorized by brain structure and function (5)

BRAIN STRUCTURE	REGULATES	EFFECT OF THC
Amygdala	Emotional response, fear	Panic/paranoia
Basal ganglia	Movement control	Slowed reaction time
Brainstem	Sleep and arousal, temperature regulation, motor control	Anti-nausea
Cerebellum	Motor coordination, balance	Impaired coordination
Hippocampus	Learning and memory	Impaired memory
Hypothalamus	Eating, sexual behaviour	Increased appetite
Neocortex	Complex thinking, feeling, and movement	Altered thinking, judgment, and sensation
Nucleus accumbens	Motivation and reward	Euphoria
Spinal cord	Peripheral sensation	Altered brain sensitivity

There are two primary cannabinoid receptors in the ECS termed CB1 and CB2 receptors. CB1 receptors are predominantly concentrated in the central nervous system, including the brain

and spinal cord, where CB2 receptors are located in immune cells and neurons located throughout the body (6). Tetrahydrocannabinol (THC) and other cannabinoids elicit their effects by interacting with at least these two receptors.

THC and cannabidiol (CBD) are the two cannabinoids that have been most extensively studied. THC is largely responsible for the psychoactive properties of cannabis, where CBD is a non-psychoactive constituent. The chemical structure of cannabinoids found in cannabis is similar to that of endocannabinoids, compounds found naturally in the body. Due to their structural similarity, cannabinoids are able to bind to the same receptors as endocannabinoids to elicit their respective pharmacological effects. For instance, when THC binds to cannabinoid receptors a sense of euphoria can be induced, or what users often refer to as a 'high', where CBD can produce a feeling of relaxation. Different strains of cannabis have differing ratios of THC and CBD meaning that the effects of cannabis vary by the strain of cannabis used (7). As THC and CBD are only two of many cannabinoids, much more research is needed to understand cannabis in its entirety.

2.1.2 Cannabis and the Brain

Knowing that the ECS is largely responsible for homeostatic regulation of the body, and that cannabinoids bind to the receptors of the ECS, we can begin to comprehend the array of effects experienced by cannabis users. When cannabis binds to receptors of the ECS, the homeostatic state of the body is interrupted. This can be explained by looking at how the ECS aids in regulating stress and emotion (8). Emotion is largely regulated in the hippocampal region of the brain. As many cannabinoid receptors are found in the hippocampus (9), cannabinoids can affect bodily processes regulated by this brain region. Thus, the effects of cannabis use on emotion may be explained by cannabinoids binding to the CB1 receptors found in the

hippocampus, ultimately affecting the homeostatic state of this area of the brain. As cannabinoid receptors are located in many brain regions and throughout the entire body, users experience diverse psychological and physiological effects.

Individuals with mental health disorders may have a dysfunctional or altered endocannabinoid system (10). Some researchers have proposed that deficiencies in natural levels of cannabinoids may contribute to a susceptibility of developing post-traumatic stress disorder (PTSD) and depression (10). Bluett, Baldi, Haymer, Gaulden, Hartley, Parrish, et al (10) experimented in mice that were particularly vulnerable to higher levels of stress. They found that administering a low dose of THC helped with stress resilience and reduced anxiety symptoms by interacting with endogenous cannabinoid 2-arachidonoylglycerol in the amygdala and CB1 receptors of the brain. Other researchers have contributed to this body of research and proposed that individual differences in the effects of cannabis on anxiety may be related to the availability of CB1 receptors in the right amygdala (11). Perhaps those with normal CB1 function experience adverse effects by hyperactivation of a normally functioning endocannabinoid system. Similar research should be conducted in distinct mental health conditions to explore the role that endocannabinoid dysfunction may play in psychological health outcomes, and to determine whether cannabis may help to restore normal function.

2.1.3 Potency

The effects of cannabis on an individual are dependent on multiple factors including the dose, the route of administration, use with other substances, the frequency of use, and the specific strain used (12). Over the past several decades the percentage of THC in cannabis plants has substantially increased. Some sources suggest a near tripling of THC percentage, from 4% to 12% (13), where other sources suggested even greater increases from 1% to 9% over the same

time period (14,15). These findings suggest that over time cannabis users have been exposed to increasing levels of THC. As the concentration of THC increases, so too does the magnitude of the psychoactive effects.

2.2 CANADIAN POLICY CONTEXT AND CANNABIS

Canada is shifting away from non-medical cannabis prohibition to a legal framework. Cannabis became a controlled substance in Canada in 1923 when it was added to the Confidential Restricted List under the Narcotics Drug Act Amendment Bill. In April 2017, the Federal Government of Canada tabled legislation that focused on legalizing and heavily regulating non-medical cannabis. This legal framework has been based on the premise to "promote and protect the health, safety and human rights of their populations," (16).

2.2.1 Medical Cannabis Policy

Cannabis for medical purposes was approved for use in Canada in 2001. Since its initial approval, several pieces of legislation have been implemented and reformed to regulate the growth, distribution, and use of cannabis for medical purposes. In 2001 the Canadian federal government established the Medical Marihuana Access Regulations (MMAR) which was replaced in 2014 by the Marijuana for Medical Purposes Regulations (MMPR). These regulations differed in that the MMPR allowed doctors to prescribe cannabis to their patients, rather than requiring government authorization. The MMPR also resulted in a shift from a single-producer system to a multi-producer system. In 2016 these regulations were again replaced with the current Access to Cannabis for Medical Purposes Regulations (ACMPR), which allowed cannabis to be obtained in additional forms to the dried marijuana plant (16). Although the government has allowed doctors to write medical documents (similar to a prescription), which permits patients to obtain cannabis for medical conditions, it is important to acknowledge that

Health Canada has not approved cannabis for therapeutic use (17). This has been mainly due to a lack of clarity on how safe and effective cannabis is for treating certain ailments. Thus, physicians have been left to prescribe a drug where no clear guidelines exist. As of December 2017, there were 269,502 client registrations[1] with medical licenced producers (18) and 115 licensed producers that supply cannabis to users (19).

Typically, cannabis has been used for physical health disorders including glaucoma, pain management, arthritis and cancer. Although greater skepticism has been expressed towards cannabis being used for psychological disorders, emerging research has begun to suggest that CBD concentrates, specifically, may help with psychiatric symptoms in those with mental health disorders (20,21). It is important to gain further clarity for how cannabis interacts with specific mental health conditions, so that if it is found to beneficial, appropriate and clear guidelines can be given to users. It is imperative that the public is adequately informed about this research including what strains (e.g., pure CBD) may be beneficial for symptom management, and what diagnostic categories may benefit from CBD use versus those that may have adverse experiences. Failure to communicate this information may lead to individuals self-medicating with inappropriate cannabis strains that exacerbate, rather suppress, psychiatric symptoms.

2.3 CANNABIS USE AND THE GENERAL POPULATION

Cannabis is the most commonly used illicit drug in Canada. Results from the most recent Canadian Tobacco, Alcohol, and Drugs Survey (CTADS) show that 44.5% of Canadians aged 15 and older report using cannabis at least once in their lifetime, 12.3% report using in the past year, and 8.8% report using in the past 3 months (22). Within the Canadian population, prevalence and

[1] An individual can be registered with multiple licensed producers suggesting that some people may be double counted.

patterns of use have been shown to vary by individual-level factors. Use has been found to be more common among younger age cohorts; young adults aged 18 to 24 are the greatest users with approximately 30% reporting past year use, relative to 15 to 17-year olds (18%), 25 to 44 (18%), 45 to 64 (7%) and 65 and older (1.6%) (23). Past-year use tends to be higher among males (15%) than females (10%) (23), and among individuals with a single relationship status (24). Although some Canadian surveys report that cannabis use has decreased over time (25), others have found an overall increase in cannabis use prevalence despite there being marked periods of decline (23).[2] Consideration needs to be made when understanding trends in past 30-day cannabis use in the general population as survey methods that collect information on substance use behaviours have changed considerably throughout time.

2.4 CANNABIS AND VULNERABLE POPULATIONS

2.4.1 Youth

Use of cannabis at younger ages, particularly among those with high rates of consumption, has been associated with poorer health and social outcomes (26,27). As the brain continues to develop well into a person's twenties (28), initiating cannabis use at a younger age may lead to lifelong biological changes. Patton, Coffey, Carlin, Degenhardt, Lynskey, and Hall (29) found cannabis use in early life to be associated with an increased risk of developing poor mental health in young adulthood; a dose-response relationship was established with heavier users having the poorest mental health outcomes. Other research has suggested that those who use cannabis in youth are also more likely to experience adverse social outcomes. For instance,

[2] These patterns were assessed by combining results from a number of Canadian national surveys used over time to capture substance use behaviours. The decreasing trend was found with the CAS and CADUMS surveys, while an increasing trend was found with results from nine different national surveys spanning from 1985 to 2015 (23).

Hall, Renstrom, and Poznyak (30) found that individuals who used cannabis daily in youth had poorer academic achievement, cognitive impairment, were more likely to use other illicit drugs, had an increased risk of depression, suicidal ideation and behaviour, and both psychosis and schizophrenia. These findings suggest that cannabis use among youth should be avoided. However, as demonstrated by 2015 CTADS results, younger cohorts make up the majority of cannabis users within the broader Canadian population. As research demonstrates that use among youth can have adverse lasting psychosocial implications, it is crucial that impending legislation informs the public about the risks and aims to protect this vulnerable population.

2.4.2 Mental Health

The relationship between cannabis use and mental health has been widely explored but is not well understood; studies often report conflicting results and results that are incomparable due to varying study designs and methods. It is crucial to better understand whether those with mental health conditions as a whole are at risk of adverse effects, whether only certain diagnostic groups or individuals experience adverse effects, and what adverse effects might be experienced by cannabis users.

2.4.2.1 Cannabis use and psychosis

There is robust research exploring the relationship between cannabis use and psychosis. Cannabis use has been found to be higher among individuals with psychosis relative to rates of use in the general population. In a study examining individuals with psychosis, 66.2% reported using cannabis in their lifetime (31). This figure suggests that those with psychosis may have greater rates of use than the general Canadian population (see Section 2.3). Additionally, consistent evidence suggests that those who begin using cannabis earlier (32), who have heavier use (33), and who have a genetic predisposition (34) are at an increased risk of developing

psychosis. In those who already have an increased risk, cannabis users may also develop psychosis earlier compared to non-users (31).

Recent research controlling for socio-environmental and genetic factors has begun to support a causal relationship between cannabis and schizophrenia (35). These findings point to the idea that those who have an increased risk of schizophrenia should not be using cannabis. However, as evidenced by the high rates of reported use in a study by Foti, Kotov, Guey, and Bromet (31), those at risk of schizophrenia and other psychotic disorders are significant users of cannabis. Preventing use in those with or those at risk of psychotic disorders, and better understanding how use among this population relates to clinical outcomes, is vital for both disease prevention and disease management.

2.4.2.2 Cannabis use and non-psychotic disorders

The relationship between non-psychotic disorders and cannabis use is less clear than findings for psychosis. There are inconsistencies regarding the strength and direction of the relationship between cannabis use and current and/or future risk of anxiety, depression and bipolar disorders. The prevalence of cannabis use among those with non-psychotic disorders has also not been established; studies have mainly focused on the prevalence of psychiatric illnesses among cannabis users, rather than on the prevalence of cannabis use among those with psychiatric illnesses.

A study by van Laar, van Dorsselaar, Monshouwer, and de Graaf (36) found that 18 to 64-year olds who used cannabis had a greater risk of subsequent major depression (OR 1.62, 95% CI: 1.06-2.48) and bipolar disorder (OR 4.98, 95% CI: 1.80-13.811). However, after controlling for confounders, they did not find any significant relationship between cannabis use at baseline and future anxiety disorders. A prospective study by Blanco, Hasin, Wall, Flórez-

Salamanca, Hoertel, Wang, et al (37) found similar results with findings showing no relationship between cannabis use at Wave 1 and anxiety or mood disorders three years later at Wave 2. However, in a meta-analysis of prospective longitudinal studies, Lev-Ran, Roerecke, Le Foll, George, McKenzie and Rehm (38) found that cannabis use, particularly heavier use, was associated with the development of depression. Cannabis users had 1.2 times greater odds of developing depression than non-users, and heavy users had 1.6 greater odds of developing later depression compared to non-users and light users.

In contrast to the previous studies, a prospective cohort study that examined cannabis use among Australian school children, Degenhardt, Coffey, Romaniuk, Swift, Carlin, Hall, et al (39) found cannabis use to be associated with anxiety but not depression. Cross-sectional analyses showed that those who used cannabis were 2.5 times more likely to report symptoms of anxiety (95% CI: 1.2-5.3). Individuals who used at least weekly during adolescence and who continued to use throughout the study period were also found to have greater odds of anxiety disorders (OR 3.2, 95% CI: 1.1-9.2). However, no significant relationship was found between cannabis use and risk of current or future depression.

Additional research has explored the relationship between cannabis use and PTSD (40). Individuals with PTSD have consistently been found to have increased rates of cannabis use and cite symptom relief as a reason for use. Those with a lifetime or current PTSD diagnosis have been found to be greater lifetime users of cannabis are more likely to be daily users (41-43). Mixed research has been produced on the efficacy of cannabis for treating PTSD. Some studies report that individuals with PTSD who use cannabis have self-reported improvements in their clinical symptoms (44). However, other researchers have criticized studies stating that the evidence quality is low due to uncontrolled study designs, non-representative and small samples,

lack of long-term follow-up, and potential confounding with pharmaceutical treatment (45,46). In summary, although those with PTSD have been found to be greater cannabis users, it is unclear whether it is suitable for first-line treatment.

2.4.2.3 Summary

Together, findings on the relationship between cannabis and anxiety, depression, bipolar disorders and PTSD have been inconsistent and are often in direct confliction with one another. This may, in part, result from varying study designs including the analysis of different study populations, types of mental health measures, definitions of cannabis use, and varying follow-up times. Additionally, these findings demonstrate the complexity and heterogeneity of specific diagnoses within broader psychiatric categories. For instance, the effects of cannabis on psychiatric outcomes may depend on the spectrum of diagnosis for some diagnostic categories (e.g., anxiety). A study by Zvolensky, Lewinsohn, Bernstein, Schmidt, Buckner, Seeley, et al (47) found cannabis to be associated with an increased futuristic risk of developing a panic disorder while other research found a beneficial relationship with social anxiety disorders (SAD) by other researchers (48).

The relationship between cannabis and mental health has been shown to be complex and dependent on a number of factors. Some findings suggest that the effects of cannabis use on an individual may vary by demographic factors, such as by sex and/or gender. Patton, Coffey, Carlin, Degenhart, Lynskey and Hall (29) found that those who used cannabis in adolescence had increased odds of developing later depression and anxiety. However, females who used daily had approximately 5 times greater odds (OR 5.6, 95% CI: 2.6-12) of reporting current depression and anxiety relative to males. These findings point to the importance of exploring these relationships not just at a population level, but also that demographic factors need to be considered.

Additionally, the conflicting evidence presented provides grounds for why studies with comparable study designs need to be produced; it can allow a better understanding of whether cannabis contributes to adverse mental health outcomes, or if there is no relationship at all.

2.4.3 Theories for cannabis use

Several theories have been proposed to explain why cannabis use is generally higher among those with mental health conditions than in the general population. The self-medication hypothesis proposes that individuals with mental conditions use cannabis as a means of symptom management; it states that higher rates of cannabis use are due to people with mental illnesses using cannabis for some specific reason, rather than cannabis inducing mental health conditions (symptom exacerbation hypothesis) (49). Studies have been conducted to evaluate the self-medication hypothesis and have found that individuals with mental illnesses commonly report using cannabis to seek relief from their clinical symptoms. Schofield, Tennant, Nash, Degenhardt, Cornish, Hobbs, et al (50) found that the most common motivators for cannabis use in 49 individuals with psychosis included boredom, a social activity with friends, to aid with sleep issues, reducing anxiety and agitation, and to manage negative psychotic and depressive symptoms. Although some individuals have reported relief from cannabis, other research proposes that cannabis may induce adverse mental health states (49,51). Thus, although cannabis may be beneficial for some individuals, it may be problematic for others. This is why some researchers have suggested that perhaps cannabis was originally used as a form of self-medication, but that prolonged exposure may actually exacerbate and worsen psychiatric conditions (52).

Although cannabis has been understood to be related to worse clinical symptoms for some individuals, findings from emerging clinical studies suggest that cannabis may actually

have therapeutic benefits for mental health conditions. A study by Crippa, Derenusson, Ferrari, Wichert-Ana, Duran, Martin-Santos, et al (48) evaluated whether CBD could moderate anxiety in individuals with SAD. They found that those who took CBD, rather than a placebo, had lower levels of state anxiety prior to engaging in an anxiety-provoking situation. While these types of studies are somewhat novel, and the relationship is not entirely understood, the relief of clinical symptoms may be due to cannabis modulating dysfunction of the endocannabinoid system (53). As there may be some therapeutic potential of cannabis for those with mental health conditions, it may not be necessary to suggest that all individuals with mental health conditions entirely avoid cannabis. Further research is needed to evaluate the types of strains that may be beneficial, and whether this positive relationship is only seen for some diagnostic groups.

Individuals who self-medicate with cannabis may not have a prescription and may obtain strains from unregulated sources (54). Self-medication with non-medically prescribed cannabis raises concern as it may pose a threat to symptom management. Cannabis from unregulated sources may interfere with an individual's ability to obtain a strain with elevated CBD levels, and reduced THC content. Using the correct strain when trying to manage psychiatric symptoms is critical as higher CBD content has been noted to help with suppressing anxiety symptoms, while higher THC content may induce anxiety symptoms due to its known psychoactive properties (16). Medical cannabis prescribed by a physician may have more potential to aid with depression and anxiety as users have greater control over strain selection, while cannabis obtained from illegal markets may exacerbate undesirable symptoms due to reduced CBD content and ever-increasing THC percentage. It is imperative that the relationship between strains of cannabis and mental health outcomes is understood further and this information is used

to inform both policy and the general public to ensure that individuals are not self-medicating with unsuitable strains.

2.5 CANNABIS USE AND CLINICAL OUTCOMES

Various studies have evaluated how cannabis relates to clinical outcomes such as length of stay (LOS), relapse[3], severity of symptoms[4], and readmissions. However, many have been criticized for failing to adjust for confounders, thus raising questions about the reliability and comparability of results. Additionally, research looking at clinical outcomes has primarily been conducted on individuals with psychotic disorders. This raises the question of whether findings can be generalized to the non-psychotic mental health population. Findings from different studies will be presented to demonstrate how research has been unsuccessful in producing consistent results and to demonstrate that more research is needed.

2.5.1 Disease management: Treatment adherence and relapse

A systematic review by Zammit, Moore, Lingford-Hughes, Barnes, Jones, Burke, et al (55) evaluated 13 longitudinal studies to explore the relationship between cannabis use and clinical outcomes in those with psychosis. In this review, cannabis use was found to be consistently associated with increased rates of relapse and treatment non-adherence. However, they criticized many of these studies for failing to adjust for confounders. Barrowclough, Gregg, Lobban, Bucci, and Emsley (56) found partially conflicting results to this systematic review. They looked at the relationship between cannabis use and clinical outcomes including psychotic symptoms, affective symptoms, functioning, and relapse. They found no association between

[3] Many of these studies defined relapse as being a change in symptom severity from baseline to follow-up measured using the Brief Psychiatry Rating Scale (BPRS).
[4] Symptom severity is based on scales such as the BPRS and the Positive and Negative Syndrome Scale.

cannabis use and negative or positive symptoms, relapse or hospital admissions, but that participants who changed their cannabis status from user to non-user had improved patient functioning and improvements in anxiety scores. Barbeito, Vega, de Aźua, Saenz, Martinez-Cengotitabengoa, Gonzalez-Ortega, et al (57) also found that a change in cannabis status improves treatment adherence post-hospitalization in those with first-episode psychosis.

Some studies support the idea that cannabis users with mental illnesses are at greater risk of relapse. For instance, both Wade, Harrigan, Edwards, Burgess, Whelan, and McGorry (58) and Hides, Dawe, Kavanagh, and Young (59) found cannabis use to be associated with psychotic relapse in general. Among those specifically with schizophrenia, San, Bernardo, Gómez, and Peña (60) found cannabis consumption to be associated with relapse and abstinence from cannabis use to be protective against relapse. Schoeler, Petros, Di Forti, Klamerus, Foglia, Murray, et al (61) investigated medication adherence as a possible mediating factor between the use of cannabis and relapse among those with first-episode psychosis. They found that there was a strong relationship between continued cannabis use and the risk of relapse, number of relapses, length of relapse, and the time until relapse occurred. This relationship was found to be mediated by medication adherence. Those who relapsed throughout the study period were more likely to be continual cannabis users and to be non-adherent or irregularly adherent to their prescribed medication. This suggests that ensuring medication adherence may help to reduce the potential negative effects of cannabis use on clinical outcomes.

Together, the presented studies suggest that there is no clear answer for whether cannabis use can help or hinder treatment progression for those with mental health conditions. Exploring this relationship in a larger more representative sample is imperative in order to develop more concrete policy recommendations.

2.5.2 Length of Stay (LOS)

Consistent results have been produced in relation to hospital LOS for cannabis users. Studies have consistently concluded that cannabis users have shorter LOS than non-users. A study by Rylander, Winston, Medlin, Hull, and Nussbaum (62) found that cannabis users admitted to inpatient psychiatry had shorter LOS after adjusting for confounders when compared to those who did not use cannabis. Johnson, Wu, Winder, Casher, Marshall and Bostwick (63) found similar results among inpatients with schizophrenia, schizoaffective disorder or bipolar disorder with cannabis users having shorter LOS relative to non-users (10.9 days versus 15.9 days).

Although shorter LOS may suggest that cannabis users have improved clinical outcomes, LOS cannot be assessed in isolation from other outcomes. If LOS is shorter but all other clinical outcomes are worse among cannabis users (e.g., relapse, severity of symptoms, treatment adherence), this may suggest that individuals are not effectively managing their mental health condition leading to the need for a readmission. The Canadian Institute for Health Information (CIHI) (64) found that those with concurrent substance use disorders (SUD) and mental health diagnoses have increased health resource use overall as they cumulatively spend more time in hospital despite shorter individual stays. CIHI's study included all SUDs and therefore should be examined specifically in cannabis users and in those without SUDs.

2.5.3 Readmissions

Data from high-income countries including Europe, the USA, and Canada suggest that up to 13% of individuals in psychiatric inpatient units are readmitted shortly after discharge (65). However, not all individuals in inpatient psychiatry have an equal probability of being readmitted with certain demographic and clinical characteristics being more strongly associated

with risk of future readmission. Vigod, Kurdyak, Seitz, Herrmann, Fung, Lin, et al (66) and Perlman, Hirdes and Vigod (67) have identified several characteristics that independently predict an increased risk of readmission. These factors included having repeat admissions, having a history of harming oneself or others, the specific diagnosis including having a diagnosis of psychosis, bipolar and/or a personality disorder, having a secondary SUD diagnosis, having an unplanned discharge, the presence of a medical comorbidity, prior service use history, and length of hospital stay. Other characteristics associated with increased risk of readmission include being younger, having a forensic history, low familial support, more severe mental illness, acuity of symptoms at admission or discharge, and being discharged against medical advice (68). Although these characteristics were identified in general inpatient psychiatric populations, they may also predict the risk of readmission in the subpopulation of cannabis users.

It is uncertain how readmissions rates for cannabis users compare to that of non-users. However, some researchers suggest that cannabis users do not have an increased risk of readmission following discharge. Rylander, Winston, Medlin, Hull, and Nussbaum (62) looked at the relationship between cannabis use and inpatient psychiatric hospital outcomes. Cannabis use was measured using urine toxicology screening. They found no difference in 30-day readmission rates in users versus non-users. Johnson, Wu, Winder, Casher, Marshall and Bostwick (63) also support this finding as they found that cannabis use among those admitted to inpatient psychiatry with a diagnosis of schizophrenia, schizoaffective disorder or bipolar disorder was not associated with hospital readmissions rates.

2.5.4 Symptom Severity

Research has shown that cannabis use among those with psychosis complicates disease course. A study by Johnson, Wu, Winder, Casher, Marshall, and Bostwick (63) found that those

admitted to psychiatric inpatient units with a diagnosis of schizophrenia, schizoaffective disorder or bipolar who used cannabis were more likely to trigger the Positive and Negative Syndrome Scale. Fergusson, Horwood, and Swain-Campbell (69) also found that after adjusting for potential confounders, individuals meeting criteria for DSM-IV cannabis dependence had increased rates of psychotic symptoms compared to non-cannabis dependent individuals. However, Rylander, Winston, Medlin, Hull, and Nussbaum (62) found no difference in BPRS scores when looking at cannabis use among an inpatient psychiatric population. It is difficult to conclude whether cannabis affects psychotic symptoms as each of these studies used different scales to measure symptoms and included varying intensities of cannabis use. However, if individuals with psychosis who use cannabis have more severe symptoms, they may require greater support and come into contact with healthcare services more than non-cannabis users.

Each of the presented studies evaluated clinical outcomes among the inpatient population with psychotic disorders specifically. These studies cannot necessarily be generalized to the non-psychotic population as the inherent diagnoses vary at the biological level and with respect to disease management and care. It is imperative that clinical outcomes are also observed among the non-psychotic inpatient population to evaluate how cannabis affects disease management and contributes to healthcare needs, and to determine whether cannabis should be discouraged among this group.

2.6 LEGALIZATION IN OTHER JURISDICTIONS

Data from other jurisdictions that have recently legalized non-medical cannabis use can provide some insight into how this policy may impact rates of use among the general population. Research on the impact of legalization is limited due to the brief amount of time that has passed;

some researchers (70) note that there may be a 10-year gap between policy change and when changes in rates of use and harms of use can be accurately assessed.

2.6.1 Rates of Use

Findings from Colorado show an approximate 6% increase in the number of individuals reporting cannabis use from 2008/2009 to 2014/2015 when non-medical cannabis use became legalized (71). In American states that have changed their cannabis laws, changes in patterns of use have not been uniform for all demographic groups. For instance, use has decreased among youth aged 12 to 17 but has increased in older age groups (72). Although crude increases have been reported, it is not known whether these numbers reflect actual increases in use or whether more people are willing to be honest about their cannabis use behaviours now that non-medical use of the drug is legally permitted.

2.6.2 Public Health Impacts

The impact that the legalization and regulation of non-medical cannabis will have on mental health outcomes is largely unknown. Some findings from American states that have legalized non-medical cannabis seem to indicate potentially adverse mental and public health outcomes. For instance, in Colorado, where non-medical cannabis was legalized in 2014, the prevalence of emergency department (ED) visits for concurrent mental illness and cannabis use was five times higher than visits for mental illness without cannabis use (73). Once non-medical cannabis use was legalized in Colorado, the Colorado Hospital Association reported a near doubling of ED visits due to cannabis exposure. These visits were largely due to accidental exposure from cannabis edibles. After 2014, ED visits with cannabis-related billing codes significantly decreased (73) suggesting that people may have learned safer consumption habits

over time. Overall, research within the mental health context has been limited with much research focusing on exposure in other vulnerable populations such as children.

Early findings from other jurisdictions indicate that policy has insufficiently protected vulnerable populations from adverse effects of cannabis use. These results underscore the importance of monitoring the impact of Canadian cannabis legislation on vulnerable health populations, particularly those at risk or living with a mental health illness. Additionally, it demonstrates that more research is needed to understand how those who may be at increased risks of experiencing adverse effects from cannabis use can be protected.

CHAPTER 3: STUDY RATIONALE

Cannabis use has been identified as a potential risk factor that contributes to poor mental health outcomes and may complicate course of illness in those with a developed mental health condition. Within the Canadian population, prevalence of cannabis use across all mental illnesses has not been established. However, data from other jurisdictions have consistently found rates of cannabis use to be higher in individuals with mental illnesses relative to rates of use in the general population (1,2). It is crucial to understand how cannabis use relates to mental illness in the broad sense, but also how it relates to individual diagnoses so that this potentially vulnerable population can be protected.

A number of research and policy-related initiatives have helped to capture patterns and outcomes associated with cannabis use in the general population. For instance, information on cannabis use patterns are gathered annually using the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) and embedded CTADS surveys. These surveys have informed trends in cannabis use overtime and demographic profiles of those most likely to use cannabis at the population level. However, more research within the mental health population is needed as research has consistently identified this group as being more susceptible to experiencing adverse effects after cannabis use. Additionally, individuals with mental health conditions make up a large proportion of users within the general population. Exploring cannabis use amongst this population can give insight into how cannabis impacts not only individuals, such as by complicating disease course, but also broader society by contributing to higher healthcare needs and thus, higher healthcare costs.

Major organizations and political bodies such as the CCSA and the Task Force have identified areas for future cannabis research. In a document discussing the need to further

understand health impacts of non-medical cannabis use, the CCSA presented explicit areas where large gaps in the literature still exist (74). In developing their recommendations for the federal government, the Task Force also identified several research gaps that will need to be filled before and after non-medical cannabis is legalized. This research addresses some of the knowledge gaps identified by the CCSA, such as increasing our understanding of how the effects of cannabis differ between individuals by demographic and individual factors, exploring the effects of cannabis in poly-substance users, and establishing baseline figures of current cannabis use in Canada. Specifically, within the inpatient psychiatric population we will be able to determine the prevalence and relationship of concurrent cannabis use and mental health disorders.

Research Question 1 (RQ1): What are the trends in cannabis use amongst the general inpatient psychiatric population in Ontario, Canada from 2006 to 2016?

The first research question will establish baseline prevalence and patterns of past 30-day cannabis use within the broad inpatient psychiatric population. This will have important implications for tracking the prevalence of cannabis use among individuals using mental health services following cannabis legalization. These figures can be used to evaluate whether patterns of use and prevalence of use change following legalization. Changes in patterns of use can be explored in more depth, such as by demographic and clinical factors, to determine whether changes in patterns of use are concentrated within particular subpopulations, and whether these changes have any adverse impacts.

Research Question 2 (RQ2): What demographic and clinical characteristics are associated with past 30-day cannabis use for individuals in inpatient psychiatry in Ontario?

The second research question identifies demographic and clinical characteristics of individuals in inpatient psychiatry most likely to be a past 30-day cannabis user. This population

can be evaluated to determine whether specific clinical features, demographics, or functional characteristics differ between those who use and do not use cannabis. Characteristics of individuals in inpatient psychiatry most likely to be users of cannabis can be monitored to evaluate whether these features change after legalization. If individual profiles change, it is important to monitor the impact on admissions and clinical outcomes. If cannabis is considered to be problematic in those most likely to be users, targeted interventions and policy efforts that aim to reduce use can be developed.

Research Question 3 (RQ3): Do 30-day hospital readmission rates differ for individuals in inpatient psychiatry by past 30-day cannabis use status?

There have been inconsistent findings for how cannabis use influences clinical outcomes. Some findings suggest that use within the inpatient population negatively affects treatment outcomes and disease course, where others suggest that dimensions of care, such as LOS, are positively impacted (see Section 2.5). Research produced by CIHI (64) suggests that although those with concurrent SUDs and mental health diagnoses stay shorter in hospital per admission, relative to those with only a single mental health condition, they spend greater cumulative time in hospital due to more frequent readmissions. These relationships should be explored further, such as by examining cannabis users alone, as these findings cannot necessarily be generalized to this population due to the intensity of drugs included in this study (all drugs).

The third research question also identifies variables associated with readmissions in cannabis users and non-users. This information can be used to inform and develop targeted interventions that aim to reduce readmission risk in both of these subpopulations. Overall, reducing readmission rates and streamlining care is important to improve treatment outcomes and minimize unnecessary healthcare expenditures.

CHAPTER 4: METHODS

4.1 DESIGN

A population-based retrospective cross-sectional study was completed using Ontario Mental Health Reporting System (OMHRS) data collected from all inpatient psychiatric units in Ontario, Canada from January 1st, 2006 to December 31st, 2016.

4.2 DATA

A retrospective analysis of the OMHRS data was conducted. OMHRS is a central reporting system mandated by CIHI for all inpatient psychiatric units across Ontario. It includes comprehensive clinical information for each person admitted to inpatient mental health services from October 2005, until present. Facilities submit data to OMHRS in an encrypted format on a quarterly basis (75). CIHI is then responsible for assessing the data quality, producing quarterly reports summarizing the organizations' data, and sharing anonymized data with researchers (75). Logic checks on the data are conducted to assess quality, validity, and consistency; data that does not meet standard is rejected and returned to the submitting organization so that errors be can fixed (75). The University of Waterloo has a data agreement with CIHI which permits the use of OHMRS data for research purposes.

Data from inpatient psychiatry that is submitted to OMHRS is based on clinical assessments of inpatients that is captured using the Resident Assessment Instrument – Mental Health (RAI-MH). The RAI-MH is a comprehensive assessment tool composed of over 400 items. Information captured using the RAI-MH is used to inform care planning, conduct outcome measurement, measure quality of care, and determine resource allocation for individuals receiving inpatient mental health care (76). An interdisciplinary team of clinical staff overseeing the care of individuals admitted to inpatient psychiatry complete the RAI-MH. The assessment is

completed using information collected from the admitted individual and from other key informants including family members, first responders, and other clinical staff, such as nurses, social workers, occupational therapists, and physicians (77). The assessment is completed at admission and discharge, as well as, every 90-days for long stay patients[5]. Extensive assessment of the reliability, validity, quality and applications of the data has been published (76,78-80).

4.3 ETHICS

Ethics approval was given by the Office of Research Ethics at the University of Waterloo on April 10th, 2018 (ORE #22962). This research was conducted under a broader research project titled, "Cannabis Legalization and Mental Health Outcomes Monitoring Systems," led by Dr. Chris Perlman.

4.4 SAMPLE

The study sample was drawn from OMHRS data stored by CIHI. CIHI and the University of Waterloo have a data-sharing contract permitting the use of anonymized data for research purposes. Data included all RAI-MH assessments across all inpatient psychiatric units in Ontario, Canada from January 1st, 2006 to December 31st. 2016. The first available admission (index admission) for each inpatient in OMHRS was used.

4.5 VARIABLES

The variables considered for analysis are described below. Each is outlined further in Appendix A.

[5] Long-stay patients are defined as patients staying for 3 or more days. A shorter assessment is completed for individuals admitted for less than 3 days.

4.5.1 Dependent Variables

1) *Past 30-day cannabis use*: Measured on the RAI-MH in a section capturing substance use and excessive behaviours. Cannabis use is coded as: never of more than 1 year ago, within the last year, within the last 3 months, within the last month, within the last 7 days, and within the last 3 days. Past 30-day cannabis use was operationalized as a binary variable with presence indicating use in the past month and absence indicating no use in the past month. This dichotomization is commonly reported in the literature (81,82) and has been recognized as a potential indicator of more frequent/persistent use. For instance, criteria from the European Drug Monitoring Centre for Drugs and Drug Addiction use the past month cut off to indicate a current cannabis user, with past 30-day cannabis use defined as use within the past year but not in the past month, and experimental users to indicate lifetime users with no use in the past year (83).
2) *Readmissions:* Defined as having an admission to a psychiatric unit 30-days following an index discharge. This was calculated by subtracting the admission date of a second admission from the index discharge date. The outcome was dichotomized as having a 30-day readmission, or not having a 30-day readmission. Individuals whose reason for an index discharge was coded as "transfer to another psychiatric hospital" or whose living arrangement at discharge was another mental health residence, a psychiatric hospital, a long-term care facility (nursing home), a rehabilitation hospital/unit, a hospice facility/palliative care unit, or an acute care hospital were not coded as having a 30-day readmission.

4.5.2 Independent Variables

A different group of variables were analyzed for each research question (Table 2).

Table 2. Independent variables analyzed for each research question

RESEARCH QUESTION	VARIABLES ANALYZED	
Question 1	Sex Age Mental health diagnosis (DSM IV/V)	
Question 2	Year	
	Demographic Factors	Sex Age Marital status Education level Indigenous origin Residential stability Lived alone Employment status Risk of unemployment/disrupted education
	Substance Use	Past year substance use Past 30-day substance use Problematic alcohol use Smoking Misuse of medications
	Clinical Variables	Mental health diagnosis (DSM IV/V) Reason for admission Inpatient status at admission Length of stay (LOS)
	Clinical Indicators	Safety – harm to self, harm to others Social life – social relationships, interpersonal conflict, traumatic life events, criminal activity Financial hardship Autonomy –medication adherence history, psychiatric hospitalizations (past 2 years), psychiatric hospitalizations (lifetime) Health promotion – sleep disturbance, pain Symptoms and functioning – Positive Symptom Scale, Social Withdrawal Scale, Cognitive Performance Scale, Depressive Severity Index, Mania Scale, CAGE, Anxiety Scale
Question 3	Demographic Factors	Sex Age Marital status Residential stability Lived alone Employment status Risk of unemployment/disrupted education
	Substance Use	Past year substance use Past 30-day substance use

		Problematic alcohol use Smoking Misuse of medications
	Clinical Variables	Mental health diagnosis (DSM IV/V) LOS Contact with community mental health (past year)
	Clinical Indicators	Safety – harm to self, harm to others Social life – social relationships, interpersonal conflict, traumatic life events, criminal activity, support system for discharge Autonomy – medication adherence history, psychiatric hospitalizations (past 2 years), psychiatric hospitalizations (lifetime) Health promotion – sleep disturbance, pain Symptoms and functioning – Positive Symptom Scale, Social Withdrawal Scale, Cognitive Performance Scale, Depressive Severity Index, Mania Scale, CAGE, Anxiety Scale

4.5.2.1 Demographic Factors (Block 1):

1. *Sex:* Coded as female, male or other. Dichotomized as male or non-male.
2. *Age:* Calculated using the year of the index admission minus the year of birth (month and day of birth were not available for privacy reasons, resulting in an approximate age). Ordinal variable operationalized into 7 categories: <18, 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 and older.
3. *Marital status:* Coded as never married, married, partner/significant other, widowed, separated, or divorced. Operationalized as a categorical variable with 3 levels: never married; married/partner/significant other; and widowed/separated/divorced.
4. *Education level:* Coded as no schooling, 8 grades or less, 9 to 11 grades, high school, technical or trade school, some college/university, diploma/bachelor's degree, graduate degree, or unknown. Operationalized as an ordinal variable with 3 categories: less than high school, high school, and greater than high school.
5. *Indigenous origin:* Binary variable (yes/no) answered to the statement "Person's origin is Inuit, Métis or First Nations."

6. *Residential stability:* Binary variable (yes/no) answered to the statement "Prior to admission, most recent residence was temporary (e.g. shelter)."
7. *Lived alone:* This is based on an item assessing living arrangements, coded as lives alone, lives with spouse only, lives with spouse and other(s), lives with child(ren) (but not spouse/partner), lives with other(s) (not spouse or child(ren)), or lives in group setting with non-relative(s). Operationalized as a binary variable: lives alone or does not live alone.
8. *Employment status:* Current employment status coded as: employed, unemployed but seeking employment, unemployed and not seeking employment, other, or unknown. Operationalized as a binary variable: employed or not employed.
9. *Risk of unemployment/disrupted education:* Coded as yes, no, or not applicable to: increase in lateness or absenteeism over the last 6 months, poor productivity of disruptiveness at work/school, expresses intent to quit work/school, and persistent unemployment or fluctuating work history over the last 2 years. Operationalized as a binary variable as: at risk or not at risk/not applicable. A person was identified as being at risk if they were coded as 'yes' to any of the above questions.

4.5.2.2 Substance Use (Block 2):

1. *Past year substance use:* Substances captured (in addition to cannabis) include inhalants (e.g., glue, gasoline, paint thinners, solvents), hallucinogens (e.g., phencyclidine or "angel dust," LSD or "acid," "magic mushrooms," or ecstasy), cocaine and crack, stimulants (e.g., amphetamines such as "uppers," "speed," methamphetamine), and opiates (e.g., heroin). Coded as: used never or more than 1 year ago, within the last year, within the last 3 months, within the last month, within the last 7 days or within the last 3 days. Past year substance use

was defined as use of any of the above substances in the past year and was operationalized as a binary variable: used within the past year or did not use within the past year.

2. *Past 30-day substance use:* Includes measures on the same substances considered for past year substance use. Past 30-day substance use was defined as use of any of the same substances in the past month and was operationalized as a binary variable: recently used or did not recently use.
3. *Problematic alcohol use:* Ordinal variable with responses: none, 1, 2 to 4, or 5 or more to the question, "Number of drinks in any single sitting episode in the last 14 days." Operationalized as less than 5 drinks or, 5 or more drinks. This cut off was chosen as consuming 5 or more drinks in a single setting is commonly considered problematic drinking.
4. *Smoking*: Ordinal variable measuring daily smoking or chewing tobacco use. Ordinal variable coded as: no, not in the last 3 days but is a daily smoker, or yes. Dichotomized as a binary variable: not a daily smoker and either a daily smoker/usually a daily smoker.
5. *Misuse of medications:* Measures the intentional misuse of prescription or over-the-counter medication in the last 3 months. Defined as the use of medication for a purpose other than intended. Operationalized as a binary variable (yes/no) to, "Use of medication for a purpose other than intended in the past 3 months."

4.5.2.3 Clinical Variables (Block 3):

1. *Mental health diagnosis*: Captured with DSM codes recorded within the RAI-MH assessment. The DSM diagnoses are provided by a psychiatrist overseeing the care of the person at the time of assessment. DSM-IV codes were used in assessments from 2005 to 2015 and were replaced with DSM-V codes in the 2016 assessments. Codes were

crosswalked to allow for continuity of data, with DSM V being coded into DSM-IV categories (Appendix B). Primary, secondary, and tertiary diagnosis were considered. Discharge diagnoses were used (rather than diagnosis at admission) as admissions diagnostic codes are often provisional. All diagnostic categories that represented less than 5% of the study population were combined and labelled as 'other'. Diagnostic groups that were combined into the other category included: neurodevelopmental disorders; mental disorders due to general medical conditions; somatoform disorders; factitious disorders; dissociative disorders; sexual and gender identity disorders; eating disorders; sleep-wake disorders; disruptive, impulse-control and conduct disorders; adjustment disorders; obsessive-compulsive and related disorders; trauma- and stressor-related disorders; elimination disorders; sexual dysfunction; paraphilic disorders; other mental disorders; and medication-induced movement disorders and other adverse effects of medication. The 7 diagnostic groups that were analyzed for this research were: neurocognitive disorders, substance-related and addictive disorders, schizophrenia spectrum and other psychotic disorders, mood disorders (including bipolar and related disorders, and depressive disorders), anxiety disorders, personality disorders, and other disorders.

2. *Reason for admission:* Binary variable (yes/no) answered to each of the following: threat or danger to self; threat or danger to others; inability to care for self due to mental illness; problem with addiction/dependency; specific psychiatric symptoms (e.g., depression, hallucinations, medication side effects); involvement with criminal justice system, forensic admission; other; or forensic assessment. Multiple reasons for admission could be present. Each reason for admission was assessed separately.

3. *Inpatient status at admission:* Nominal variable captured as: application for psychiatric assessment (excludes forensics), voluntary, informal, involuntary, or forensic (including forensic assessment, unfit to stand trial, and not criminally responsible).
4. *Past-year contact with community mental health:* Measures the time since last contact with a community mental health agency or mental health professional (e.g. psychiatrist, social worker) in the last year. Ordinal variable operationalized into 3 categories: no contact in the last year, contact 31 days or more ago, contact within 30 days or less.
5. *Length of stay (LOS):* Continuous variable measured by taking the difference between the date of admission and the date of discharge for the index admission. Categorized into 5 levels: 3 to 14 days, 15 to 30 days, 31 to 60 days, 61 to 90 days, or greater than 90 days.

4.5.2.4 Clinical Indicators:

Items from the RAI-MH can be combined to form a number of clinical and risk indicators. These scales and items are used to assess safety, social life, financial hardship, autonomy, and health promotion. They can all be used to measure strengths and needs of an individual and therefore are used for care planning. In addition to these risk scales, items taken directly from the RAI-MH were used to evaluate clinical status by cannabis use status. Each item and scale is discussed further in Appendix A.

1. *Safety (Block 4):*
    a. *Harm to Others (RHO):* Evaluated using 2items:
        i. *History of violence:* Includes measures of 4 items: expressing violence towards others, intimidation of others including threatened violence, violent ideation, and history of sexual violence or assault as the perpetrator. The first 3 items are assessed with 6 different levels: never, more than 1 year ago, 31

days to 1 year ago, 8 to 30 days ago, 4 to 7 days ago, or in the last 3 days. This variable dichotomized as having a history (yes to any of the 4 items; 1), or not (0).

ii. *Aggressive Behaviour Scale (ABS):* Assessment of verbal abuse, physical abuse, socially inappropriate/disruptive behaviours, and resistance to care. This scale ranges from 0 to 12 with higher scores indicating greater levels of aggression. This variable was dichotomized as having a score of 2 or less (absence; 0), or greater than 2 (presence; 1). This scale has been tested for reliability and validity (84).

b. *Self-Harm:* Evaluated with 2 different items. These items were combined to create a dichotomous variable. Presence of self-harm was identified as having any history of either a suicide attempt or self-injury/behaviour.

i. *History of suicide attempt:* Categorical variable with 3 levels: No suicide attempt history, history of hurting oneself but not with intent to kill self, intent of self-injury was to kill oneself.

ii. *History of self-injury/behaviour:* Measured with 6 different levels assessing whether the most recent self-injurious attempt was: never, more than 1 year ago, 31 days to 1 year ago, 8 to 30 days ago, 4 to 7 days ago, or in the last 3 days.

2. *Social Life (Block 5):*

a. *Social relationships:* Assessed using 2 items:

i. *Social isolation:* Measured using 5 items: reports having no confidant (dichotomized: yes or no), participation in social activities of long-standing

interest (dichotomized: occurred within the past month, occurred greater than a month ago), withdrawal from activities of interest or from long-standing social relations (dichotomized: indicated in the past 3 days, not indicated in the past 3 days), reduced social interaction (dichotomized: indicated in the past 3 days, not indicated in the past 3 days), telephone or email contact with long-standing social relation/family member (dichotomized: occurred within the past month, occurred greater than a month ago). Social isolation was identified as present if an individual had no confidant and presence of one of the other 4 variables.

ii. *Dysfunction:* Operationalized as a dichotomous variable and is determined to be present if an individual reports any one of the following: a belief that relationships with immediate family members is disturbed or dysfunctional (dichotomized: belief not present, or either the person believes, family/friends/others believe, or both the person and family/friends/others believe), family/close friends report feeling overwhelmed by person's illness (dichotomized: yes or no), and conflict-laden or severed relationship, including divorce (dichotomized: history or no history).

b. *Support systems for discharge:* Operationalized as a dichotomous variable; coded as present if there is no individual available to help with activities of daily living/independent activities of daily living, child care, crisis support, supervision of safety post-discharge, if an individual is homeless following discharge, or who do not have an individual who views their discharge into the community as positive.

c. *Interpersonal conflict:* Operationalized as a dichotomous variable. Present if there is any of the following: belief that relationship(s) with immediate family members are disturbed or dysfunctional, reports of having no confidant, family/close friends report feeling overwhelmed by person's illness, is persistently hostile towards or critical of family/friends, is persistently hostile of others or staff, family/friends are persistently hostile towards or critical of person, staff reports persistent frustration in dealing with person, or if family/friends require unusual amounts of facility staff time.

d. *Traumatic life events:* Categorical variable with 3 levels. Present if there is concerns for immediate safety based on the presence of abuse in the past 7 days or concerns for personal safety, need to reduce the impact of prior traumatic life events including the presence of one of: serious accident or physical impairment; death of a close family member or friend; lived in a war zone or an area of violent conflict; witness to a severe accident, a disaster, an act of terrorism or violence, or abuse; victim of crime, victim of sexual assault or abuse; victim of physical assault or abuse; victim of emption assault or if there is past traumatic life events, and they state that this event has caused an intense sense of horror or fear.

e. *Criminal activity:* Operationalized as a dichotomous variable. Present if there is a past year history of violent or nonviolent criminal behaviour where there was police intervention.

3. *Financial Hardship and Autonomy (Block 6):*

a. *Financial hardship:* Operationalized as a dichotomous variable. Present if someone has a lifetime history of major loss of income or serious economic hardship due to poverty.

b. *Medication management:* Operationalized as a dichotomous variable. Present if there is need for some sort of assistance to manage medications (e.g., to remember to take medications, opening bottles, taking correct drug dosages, giving injections, applying ointments).

c. *Medication adherence:* Measures level of adherence to prescribed medications the month prior to admission. Recorded as: always adherent, adherent 80% or more of time, adherent 80% of time including failure to purchase prescribed medication, no medication prescribed, and unknown.

d. *Recent psychiatric admissions (past 2 years):* Categorical variable: no recent admissions, 1 to 2 recent admissions, or 3 or more recent admissions.

e. *Lifetime psychiatric admissions:* Categorical variable: no lifetime admissions, 1 to 3-lifetime admissions, 4 to 5-lifetime admissions, or 6 or more recent admissions.

f. *Independence:* Measured using the Instrumental Activities of Daily Living (IADL) Capacity Scale. Includes assessment of ability to conduct meal preparation, ordinary housework, ability to manage finances and medications, phone use, shopping, and transportation. Scores range from 0 to 42 with higher scores indicating lower capacity. Categorized into 3 levels based on the additive score: 0 to 2, 3 to 5, 6 or higher.

4. *Health Promotion (Block 7):*

a. *Sleep disturbance:* Assesses whether an individual is experiencing current sleep problems based on reported sleep problems (e.g., difficulty falling asleep, restless or non-restful sleep, interrupted sleep, too much sleep) in the past 3 days. Dichotomized as sleep disturbances are present or absent.

b. *Pain:* An ordinal variable that measures both the frequency and intensity of pain. Operationalized with 3 levels: expressing no pain, moderate pain, or severe pain.

5. *Symptom Severity (Block 8):*

a. *Positive Symptoms:* Measured with the Positive Symptom Scale (PSS) – short. This scale assesses hallucinations, command hallucinations, delusions, and abnormal thought processes. Scores range from 0 to 12, with higher scores indicating higher levels of positive symptoms. Dichotomized as presence (score >2) or absence (score ≤2). This scale has been found to have good internal consistency for the inpatient population (67).

b. *Social Withdrawal:* Measured with the Social Withdrawal Scale (SWS). Includes assessments of motivation levels, reduced interaction, decreased energy, expression of flat or blunted affect, anhedonia, and loss of interest. Scores range from 0 to 6 with higher scores indicating greater social withdrawal. This scale has been tested for reliability and validity, and has been found to have strong internal consistency (85). Categorized into 4 levels based on summed scores: no social withdrawal, score of 1 to 2, scores of 3 to 5, and score of 6.

c. *Cognitive Performance:* Measured with the Cognitive Performance Scale (CPS). Includes an assessment of daily decision making, short-term memory, ability to express oneself, and self-performance of eating. Scores range from 0 to 6 with higher scores indicating greater level of impairment. Validity of this scale has been assessed (78). Dichotomized as presence (score >2), or absence (scores ≤2).

d. *Depressive Symptoms:* Measured using the Depression Severity Index (DSI) and is based on the presence of sad/pained facial expressions, negative statements, self-

deprecation, guilt/shame and hopelessness. Scores range from 0 to 15 with higher scores indicating higher levels of depressive symptoms. Dichotomized as absence (score <3) and presence (score ≥3). This scale has been tested for reliability and validity (86).

e. *Mania:* Measured based on indicators including inflated self-worth, hyperarousal, irritability, increased sociability, pressured speech, labile effects, and sleep problems due to hypomania. Scores range from 0 to 20 with higher scores indicating more symptoms of mania. Categorized with 4 levels based on summed scores: no symptoms of mania, scores of 1 to 3, scores of 4 to 8, and scores greater than 8. No current literature has assessed the reliability and validity of this scale. However, internal consistency was assessed with the current data (Cronbach's alpha=0.69).

f. *Problem with addiction:* Assessed using the CAGE scale and indicates whether there may be a potential problem with substance addiction. Indicators include the need to cut down on substance use, angered by criticisms from others, expression of guilt about substance use, and drinking or use of other substances in the morning. Scores are summed and range from 0 to 4. This variable is dichotomized as scores less than 2 and 2 or more indicating a potential problem with substance addiction. There is limited research on the reliability of the CAGE as an embedded scale in the RAI-MH. Therefore, internal consistency was evaluated based on the current sample, with results supporting good internal consistency (Cronbach's alpha=0.89).

g. *Anxiety:* Used to assess levels of anxiety. Indicators of anxiety include presence of anxious complaints, fears/phobias, obsessive thoughts, compulsive behaviour, intrusive thoughts/flashbacks, and episodes of panic. Each indicator is measured as

indicator not exhibited in the last 3 days, indicator not exhibited in the last 3 days but is reported to be present, indicator exhibited on 1 to 2 of the last 3 days, indicator exhibited daily in the last 3 days. Dichotomized as indicator not exhibited in the last 3 days or indicator exhibited in the 3 days (not exhibited but reported to be present, 1 to 2 of the last 3 days, daily in the last 3 days). Score across all indicators are summed. Higher scores indicate greater levels of anxiety. No literature has assessed this scale. However, internal consistency was assessed with the current data (Cronbach's alpha=0.68).

4.6 ANALYSES

All analyses were conducted using Statistical Analysis Software (SAS) 9.4.

4.7 STATISTICAL METHODS

Research Question 1: Trends in cannabis use

Time-trend analyses were conducted to explore trends in the proportion of persons admitted to inpatient psychiatry reporting past 30-day cannabis in Ontario, Canada from 2006 to 2016. Prevalence was also calculated over time for age, sex, and DSM diagnosis. This was done to determine whether certain populations disproportionately represented past 30-day cannabis users and whether changes in rates of use were concentrated among individuals with particular demographic and clinical characteristics.

Research Question 2: Characteristics of cannabis use

Logistic regression was used to examine characteristics associated with past 30-day cannabis use among individuals in inpatient psychiatry. Bivariate analyses were first conducted to identify demographic and clinical factors significantly associated with past 30-day cannabis use ($p<0.0001$). Variables that were not significant at the bivariate level were removed. Variables

found to be statistically significant were removed if there was less than a 5% difference in the prevalence of past 30-day cannabis users between any two levels of that variable (e.g., if the difference in prevalence of cannabis use between males and non-males was less than 5%, sex would be removed from the model). The remaining variables were considered for the multivariate model. Due to the large number of variables being included in the analysis, block modelling was carried out with all of the variables that were significant at the bivariate level. Blocks are outlined in Appendix A. After each block was modelled independently, all significant variables from each block were included in a final model. Non-significant variables were manually removed and interactions between sex and age, and sex and diagnostic categories were examined. Year of admission was also evaluated in the final model, adjusting for all other variables found to be significant.

Research Question 3: 30-day readmissions by cannabis use status

For this analysis, individuals were not counted as being readmitted if they were transferred to another mental health facility, psychiatric hospital, long-term care, a rehabilitation unit, palliative care, or acute hospital. This was done to avoid miscounting a transfer as a readmission. Individuals who died in hospital at index admissions were excluded. Once the study sample was reduced, 30-day readmission rates were analyzed to determine whether rates differed among past 30-day cannabis users and non-recent users. First, a bivariate analysis was conducted to determine whether past 30-day cannabis use was significantly associated 30-day readmissions at the bivariate level. Bivariate modelling was then carried forward to identify other variables significantly associated with 30-day readmissions among the general inpatient psychiatric population. Non-significant variables ($p<0.0001$) were removed and block modelling was carried out similar to the previous question. Past 30-day cannabis was added into the final model to

determine whether it remained significantly associated with 30-day readmissions after controlling for all other significant variables. Potential interactions with past 30-day cannabis use were identified by examining readmission rates among past 30-day cannabis users relative to non-recent users for demographic and clinical characteristics. Cross tabulations that showed considerable difference in the prevalence of readmissions between each group were examined as interactions in the multivariate model.

Two separate models were then created to identify variables associated with readmissions among cannabis users and non-users. The same process was repeated, identifying variables associated with readmissions in past 30-day cannabis users, testing individual blocks, and adding blocks together to generate a final model. This process was again repeated among the cohort of non-cannabis users.

4.9 EXCLUSION CRITERIA

Short-stay patients (admissions <3 days) were excluded as they are not assessed with the full RAI-MH assessment.

CHAPTER 5: RESULTS

5. 1 PREVALENCE OF CANNABIS USE BY POPULATION CHARACTERISTICS

5.1.1 Prevalence of past 30-day cannabis use

Across all study years (2006 to 2006), 18.9% (n=30330) of individuals admitted to inpatient psychiatry reported past 30-day cannabis use, where 81.1% (n=130002) reported no past 30-day cannabis use. More specifically, 75.2% of all inpatients had no lifetime or past year cannabis use, 3.6% used within the past year, 2.3% used in the past 3 months, 5% used in the past month, 6.7% used in the past 7 days, and 7.2% used in the past 3 days.

Across the study period, the prevalence of males and non-males was approximately (50.8% versus 49.2%, respectively) (Table 3). However, cannabis use was higher among males at 24.4%, compared to 13.2% among non-males. The greatest prevalence of past 30-day cannabis use was among 18 to 24-year olds (42%), followed by those younger than 18-years of age (36.8%), 25 to 34-year olds (30.3%), 35 to 44-year olds (18.6%), 45 to 54-year olds (12.7%), 55 to 64-year olds (5.9%), and finally, 65 and older (0.8%). The prevalence of cannabis use was higher among those who were never married (28.2%), compared to those who were married or had a partner/significant other (10.4%), or who were widowed, separated or divorced (11.1%). Half of the study population had greater than a high school education, 24.4% had less than a high school education and 25% had a high school level education. Having a higher level of education was associated with lower prevalence of cannabis use; 23% of individuals with less than a high school education reported past 30-day cannabis use relative to 21.1% of individuals with a high school education, and 15.9% of individuals with greater than a high school education. The majority of the study population did not identify as being of Indigenous origin (97%). However, the prevalence of cannabis use was higher among those of Indigenous origin (36.3% relative to

18.4%). Nearly one quarter of the study population stated that their most recent residence was temporary with the prevalence of cannabis use being similar between those with and without residential instability (19.9% and 18.6%, respectively). The majority of the study population did not live alone at the time of admission (71.2%), and there was approximately equal reported past 30-day cannabis use among those who did and did not live alone (17.8% and 19.4%, respectively). There was greater prevalence of cannabis use among those who were at risk of unemployment or disrupted education (27.6%) relative to those who were not at risk (16%).

Table 3. Prevalence of past 30-day cannabis use among the inpatient psychiatric population by individual demographic characteristics

CHARACTERISTICS		**PROPORTION REPORTING PAST 30-DAY CANNABIS** *N (%)*	**TOTAL STUDY POPULATION** *N (%)*
Sex	Male	19916 (24.4)	81481 (50.8)
	Non-male	10414 (13.2)	76651 (49.2)
Age	<18	1269 (36.8)	3452 (2.5)
	18-24	10120 (42.0)	24073 (15.0)
	25-34	8163 (30.3)	26904 (16.8)
	35-44	5338 (18.6)	28637 (17.9)
	45-54	4034 (12.7)	31766 (19.8)
	55-64	1220 (5.9)	20636 (12.9)
	65+	186 (0.8)	24864 (15.5)
Marital status	Never married	21282 (28.2)	75506 (47.1)
	Married/Partner/Significant other	5352 (10.4)	51545 (32.2)
	Widowed/Separated/Divorced	3696 (11.1)	33281 (20.8)
Education level	< High school	8984 (23.0)	39132 (24.4)
	High school	8478 (21.2)	40070 (25.0)
	> High school	12868 (15.9)	81130 (50.6)
Indigenous origin	Yes	1762 (36.3)	4849 (3.0)
	No	28568 (18.4)	155483 (97.0)
Residential stability	Temporary residence	**7997 (19.9)** *	40130 (25.0)
	Non-temporary residence	**22333 (18.6)**	120202 (75.0)
Lived alone	Lived alone	**8201 (17.8)**	46151 (28.8)
	Did not live alone	**22129 (19.4)**	114181 (71.2)
Employment status	Employed	**9023 (21.0)**	43068 (26.9)
	Not employed	**21307 (18.2)**	117264 (73.0)

Risk of unemployment/ disrupted education	At risk	11160 (27.6)	40447 (25.2)
	Not at risk	19170 (16.0)	119885 (74.8)
*Bolded variables indicate less than a 5% difference in the prevalence of cannabis users among all levels of that variable. Regardless of their significance at the bivariate level, these variables were removed for the logistic regression modelling process for Research Question 2.			

5.1.2 Diagnostic characteristics of study population and prevalence of past 30-day cannabis use

Of the seven diagnostic groups, individuals with a primary, secondary, or tertiary diagnosis of a substance-related and addictive disorder had the highest prevalence of reported past 30-day cannabis users (38.3%). Individuals with personality disorders had the second highest prevalence of reported past 30-day cannabis users (24%), followed by schizophrenia and other psychotic disorders (20.3%), other disorders (17.4%), mood disorders (17.1%), anxiety disorders (16.5%), and neurocognitive disorders (1.9%) (Table 4).

Table 4. Prevalence of past 30-day cannabis use in the inpatient psychiatric population by mental health diagnosis

DIAGNOSTIC GROUP	**PROPORTION REPORTING PAST 30-DAY CANNABIS** *N (%)*	**TOTAL STUDY POPULATION** *N (%)*
Neurocognitive disorders	252 (1.9)	13578 (8.5)
Substance-related and addictive disorders	16840 (38.3)	44016 (27.5)
Schizophrenia and other psychotic disorders	8631 (20.3)	42622 (26.6)
Mood disorders	14488 (17.1)	84547 (52.7)
Anxiety disorders	3830 (16.5)	23299 (14.5)
Personality disorders	3210 (24.0)	13376 (8.3)
Other disorders*	3766 (17.4)	21615 (13.5)
*Diagnostic categories were only considered for the analysis if at least 5% of the inpatient population had a primary, secondary, or tertiary diagnosis under the category. Those that represented less than 5% of the inpatient population were amalgamated into the 'other' category.		

5.1.3 Substance use characteristics of study population and prevalence of past 30-day cannabis use

Among the inpatient population, 16.9% stated they had past year use of inhalants, hallucinogens, cocaine or crack, stimulants, or opiates, with 11.6% having used these substances in the prior 30-days. Among those using these substances in the prior year, 47.4% also reported past 30-day cannabis use, where 53.1% of individuals who used these substances in the past month reported past 30-day cannabis use. Those who used hallucinogens either in the past year or past month were most likely to also have recently used cannabis (65.5% and 79.4%, respectively). Within the study population, 38.7% reported tobacco use, of which 33.8% also reported past 30-day cannabis use. However, only 9.6% of non-smokers reported past 30-day cannabis use. A greater proportion of individuals with "problematic" drinking patterns reported past 30-day cannabis use (35.1%), relative to individuals who consumed less alcohol (15.9%). Finally, a greater proportion (26.9%) of individuals who stated that they had intentionally misused medication reported past 30-day cannabis use relative to those who did not report the intentional misuse of medication (17.7%) (Table 5).

Table 5. Prevalence of past 30-day cannabis use in the inpatient psychiatric population by other substance use behaviours

SUBSTANCE USE BEHAVIOURS		**PROPORTION REPORTING PAST 30-DAY CANNABIS USE** *N (%)*	**TOTAL STUDY POPULATION** *N (%)*
Past year substance use	Any substance use	12823 (47.4)	27032 (16.9)
	Inhalants	737 (45.1)	1634 (1)
	Hallucinogens	3394 (65.5)	5342 (3.3)
	Cocaine and crack	9107(53.4)	17054 (10.6)
	Stimulants	3699 (56.0)	6601 (4.1)
	Opiates	5061 (42.9)	11802 (7.4)
	Cannabis	30330 (76.3)	39760 (24.8)
	Any past 30-day substance use	9855 (53.1)	19570 (11.6)
	Inhalants	453 (58.0)	781 (0.5)

Past 30-day substance use	Hallucinogens	1687 (79.4)	2126 (1.3)
	Cocaine and crack	6345 (60.9)	10412 (6.5)
	Stimulants	2429 (65.5)	3710 (2.3)
	Opiates	3776 (46.1)	8190 (5.1)
Problematic alcohol use	Yes	8859 (35.1)	25232 (15.7)
	No	21471 (15.9)	135100 (84.3)
Smoking	Yes	20924 (33.8)	62000 (38.7)
	No	9406 (9.6)	98332 (61.3)
Misuse of medications	Yes	5720 (26.9)	21256 (13.3)
	No	24610 (17.7)	139076 (86.7)

5.1.4 Clinical characteristics of study population and prevalence of past 30-day cannabis use

The greatest prevalence of past 30-day cannabis use was reported in those who were admitted to inpatient psychiatry for problems with addiction (39%), involvement with the criminal justice system (23.6%), and for being a threat to others (15.8%). There was a relationship between past 30-day cannabis use and LOS (x^2=1598.9, p<0.0001) with shortest stays (3 to 14 days) having the greatest proportion of past 30-day cannabis users (22.1%) relative to those with the longest stays (>90 days; 6.5%). The prevalence of past 30-day cannabis use was similar among those who visited community mental health in the past 30 days and those who had not. There was a greater prevalence of past 30-day cannabis use among those experiencing financial hardship (25.9%) relative to those not experiencing hardship (18.8%). Medication adherence was also associated with past 30-day cannabis use, with a higher proportion of recent use among those who were less adherent; 14.2% of individuals who were always adherent to prescribed medication reported past 30-day cannabis use, compared to 17.3% of those who were adherent at least 80% of the time, 22.5% of those who were adherent less than 80% of the time and 33.3% of those with no medication history. There was little difference in prevalence of cannabis use when looking at recent psychiatric hospitalization history. However, increasing number of lifetime admissions was associated with lower prevalence of reported past 30-day

cannabis users (e.g., 18.6% among those with no lifetime admission versus 14.1% of those with 6 or more admissions). There was decreasing prevalence of reported past 30-day cannabis use as an individual's dependence level increased (Table 6).

Table 6. Prevalence of past 30-day cannabis use among the inpatient psychiatric population by clinical characteristics

CLINICAL CHARACTERISTICS			PROPORTION REPORTING PAST 30-DAY CANNABIS USE *N (%)*	TOTAL STUDY POPULATION *N (%)*
Reason for admission	Threat to self		15511 (20.6)	75410 (47.0)
	Threat to others		6202 (21.3)	29190 (18.2)
	Inability to care		9166 (15.8)	58105 (36.2)
	Problem with addiction		16648 (39.0)	42740 (27.4)
	Specific psychiatric symptoms		21447 (18.6)	115513 (72.1)
	Involvement criminal justice system		1959 (23.6)	8307 (5.2)
	Other		874 (14.4)	6052 (14.4)
	Forensic assessment		167 (15.3)	1093 (0.7)
Inpatient status at admission	Application for psychiatric assessment		10121 (23.2)	43610 (27.2)
	Voluntary		7255 (18.4)	39413 (24.6)
	Informal		70 (5.2)	1346 (0.8)
	Involuntary		3549 (20.0)	17718 (11.1)
	Forensic		1982 (23.5)	8452 (5.3)
LOS	3-14 days		14582 (22.1)	65848 (41.2)
	15-30 days		10449 (19.4)	54013 (33.8)
	31-60 days		4293 (15.3)	28074 (17.6)
	61-90 days		588 (10.3)	5730 (3.6)
	>90 days		403 (6.5)	6222 (3.9)
Past year contact with community MH	No contact		**17423 (19.8)**	87996 (54.9)
	Contact >30 days		**4495 (19.7)**	22843 (14.3)
	Contact <30 days		**8412 (17.0)**	49493 (30.9)
Safety	Harm to others	History of violence	9107 (27.8)	32709 (20.4)
		Aggressive Behaviour Scale (>2)	5220 (21.1)	24792 (15.5)
	Self-harm	Yes	**17177 (19.3)**	89182 (55.6)
		No	**13153 (18.5)**	71150 (44.4)
Social life	Social relationships	Social isolation	3631 (19.7)	18412 (11.5)
		Dysfunction	20289 (21.5)	94184 (58.7)
	Interpersonal conflict		19820 (20.8)	95167 (59.4)

	Traumatic life events	Current abuse	2909 (24.0)	12133 (7.6)
		Past traumatic event(s)	3573 (25.0)	14487 (9.0)
		No history	23848 (17.8)	133712 (83.4)
	Criminal activity		11745 (28.5)	41255 (25.7)
	No support systems for discharge		9258 (18.4)	50227 (31.3)
Financial hardship	Yes		6240 (25.9)	24125 (23.2)
	No		14989 (18.8)	79732 (76.8)
Autonomy	Medication management	Independent	23108 (21.9)	105526 (65.8)
		Needs assistance	7222 (13.2)	54806 (34.2)
	Medication adherence history	Always adherent	9571 (14.2)	67362 (42.0)
		Adherent >80% of time	5602 (17.3)	32347 (20.2)
		Adherent <80% of the time	6492 (22.5)	28912 (18.0)
		No medication	5438 (33.2)	16404 (10.0)
		Unknown	3227 (21.1)	15307 (9.6)
	Number of psychiatric hospitalizations in prior 2 years	0	**23286 (18.6)**	124931 (77.9)
		1-2 admissions	**5896 (20.3)**	29086 (18.1)
		3+ admissions	**1166 (18.5)**	6315 (3.9)
	Number of psychiatric hospitalizations in lifetime	0	17725 (20.0)	88539 (55.2)
		1-3 admissions	9535 (18.7)	51000 (31.8)
		4-5 admissions	1642 (15.4)	10652 (6.6)
		6+ admissions	1428 (14.1)	10141 (6.3)
	Independence	Lowest dependence	25279 (22.2)	113877 (71.0)
		Moderate dependence	1935 (17.9)	10820 (6.8)
		Greatest dependence	3116 (8.7)	35635 (22.2)

5.1.5 Symptoms severity of study population and prevalence of past 30-day cannabis use

Among those who with more severe positive symptoms on the PSS (scores >2), 20.6% were past 30-day cannabis users compared to 18.1% of those who did not trigger the PSS. An inverse relationship was found between past 30-day cannabis use status and social withdrawal severity; as withdrawal scores increased, the prevalence of past 30-day cannabis users decreased; 21.5% of individuals who scored lowest on the SWS reported past 30-day cannabis use, relative to 14.9% who scored highest. The prevalence of past 30-day cannabis use did not differ between those with scores above and below 3 on the Depressive Severity Index. Higher prevalence of cannabis use was found among those with greater symptoms of mania (28.7%) relative to those

with no mania symptoms (15.5%). Those who scored higher on CAGE scale had greater past 30-day cannabis use (31.7% relative to 14.1%). Finally, those who had higher anxiety scores, as measured by the Anxiety Scale, had roughly equal rates of past 30-day cannabis use to those who did not trigger the scale (Table 7).

Table 7. Prevalence of past 30-day cannabis use among the inpatient psychiatric population by symptom severity

SYMPTOM SCALE	SCORE	PROPORTION REPORTING PAST 30-DAY CANNABIS USE *N (%)*	TOTAL STUDY POPULATION *N (%)*
Positive Symptom Scale	0-2: No or mild symptoms	**19417 (18.1)**	107383 (67.0)
	3+: More severe symptoms	**10913 (20.6)**	52949 (33.0)
Social Withdrawal Scale	0: No withdrawal	8028 (21.5)	37402 (23.3)
	1,2	9831 (20.4)	48255 (30.1)
	3,4,5	9539 (17.4)	54982 (34.3)
	6: Most severe withdrawal	2932 (14.9)	19693 (12.3)
Cognitive Performance Scale	0-2: No or mild impairment	29056 (20.1)	144613 (90.2)
	3+: More severe impairment	1274 (8.1)	15719 (9.8)
Depressive Severity Index	0-2: No or mild depression	**12836 (19.0)**	67438 (42.1)
	3+: More severe depression	**17494 (18.8)**	92894 (57.9)
Mania Scale	0: No mania symptoms	11293 (15.5)	73046 (45.5)
	1	7726 (18.6)	41577 (25.9)
	2	7300 (23.0)	31708 (19.8)
	3: Most severe symptoms	4011 (28.7)	14001 (8.7)
CAGE	0-1: No potential problem with addiction	17374 (14.1)	123180 (78.8)
	2+: Potential problem with addiction	12476 (37.7)	33085 (21.1)
Anxiety Scale	0-2: No or mild anxiety	**25034 (18.9)**	132383 (82.6)
	3+: More severe anxiety	**5296 (19.0)**	27949 (17.4)

5.2 QUESTION 1: TRENDS IN CANNABIS USE

5.2.1 General trend in proportion of inpatients reporting past 30-day cannabis use

From 2006 to 2016, the number of individuals in inpatient psychiatry who reported past 30-day cannabis use increased by approximately 10% from 15.4% in 2006 to 25.3% in 2016. This represents a 64% increase in overall prevalence (Table 8, Figure 1).

Table 8. Prevalence of past 30-day cannabis use among the inpatient psychiatric population from 2006 to 2016

YEAR	PROPORTION REPORTING PAST 30-DAY CANNABIS USE *N (%)*	TOTAL STUDY POPULATION *N*
2006	3214 (15.4)	20827 (13.0)
2007	2727 (16.1)	16911 (10.6)
2008	2565 (16.8)	15303 (9.5)
2009	2493 (17.0)	14666 (9.2)
2010	2502 (18.0)	13915 (8.7)
2011	2607 (19.2)	13588 (8.5)
2012	2551 (19.1)	13387 (8.4)
2013	2723 (20.5)	13266 (8.3)
2014	2923 (22.1)	13204 (8.2)
2015	2810 (22.3)	12580 (7.9)
2016	3215 (25.3)	12685 (7.9)
Absolute change (%)	9.9	
Relative change (%)	64.3	

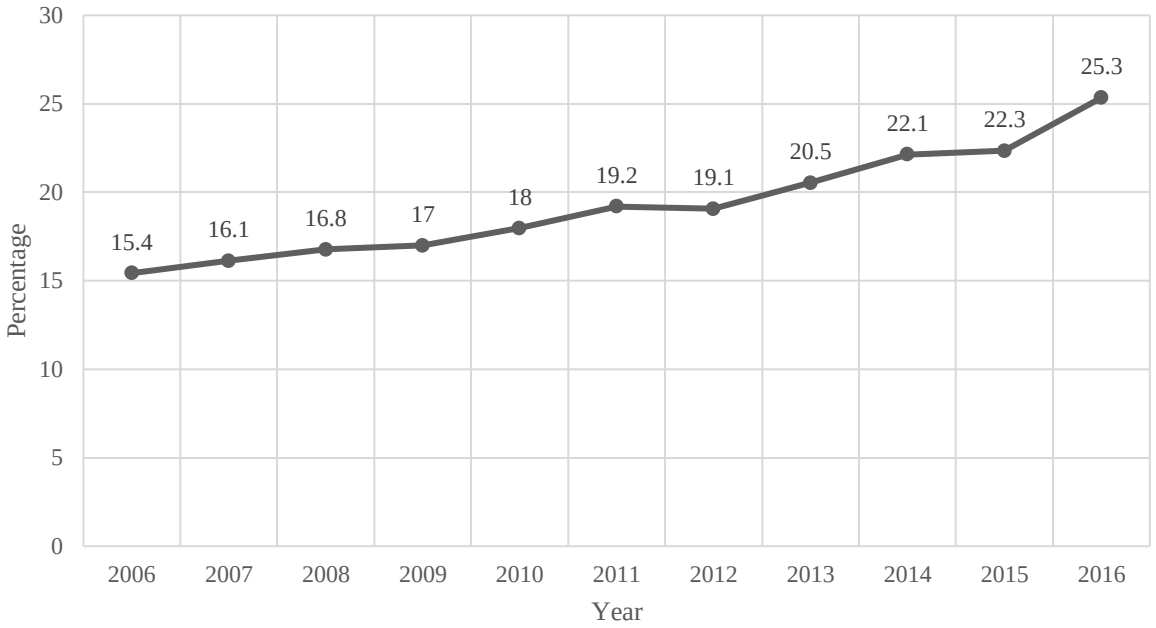

Figure 1. Reported past 30-day cannabis use from 2006 to 2016 among the inpatient psychiatric population

5.2.2 Trend in proportion of inpatients reporting past 30-day cannabis use by sex

The prevalence of reported past 30-day cannabis use increased for both males and non-males (Table 9). From 2006 to 2016 there was an 11.1% absolute change in reported cannabis among males (Figure 2), attributing to a 54.4% relative increase. In non-males, reported past 30-day cannabis use increased by 8.5%, which is a relative increase of 82.5%. This suggests that males are more likely to report past 30-day cannabis use, but that non-males had a greater increase in use during the study period.

Table 9. Prevalence of past 30-day cannabis use among the inpatient psychiatric population from 2006 to 2016 stratified by sex categories

	SEX	
YEAR	**MALE** *N (%)*	**NON-MALE** *N (%)*
2006	2162 (20.4)	1052 (10.3)
2007	1806 (21.3)	921 (10.9)
2008	1712 (22.6)	853 (11.1)
2009	1655 (22.2)	838 (11.6)
2010	1684 (23.5)	818 (12.1)
2011	1737 (24.8)	870 (13.2)
2012	1655 (24.4)	896 (13.5)
2013	1734 (26.2)	989 (14.9)
2014	1879 (27.7)	1044 (16.3)
2015	1833 (28.1)	977 (16.1)
2016	2059 (31.5)	1156 (18.8)
Absolute change (%)	11.1	8.5
Relative change (%)	54.4	82.5

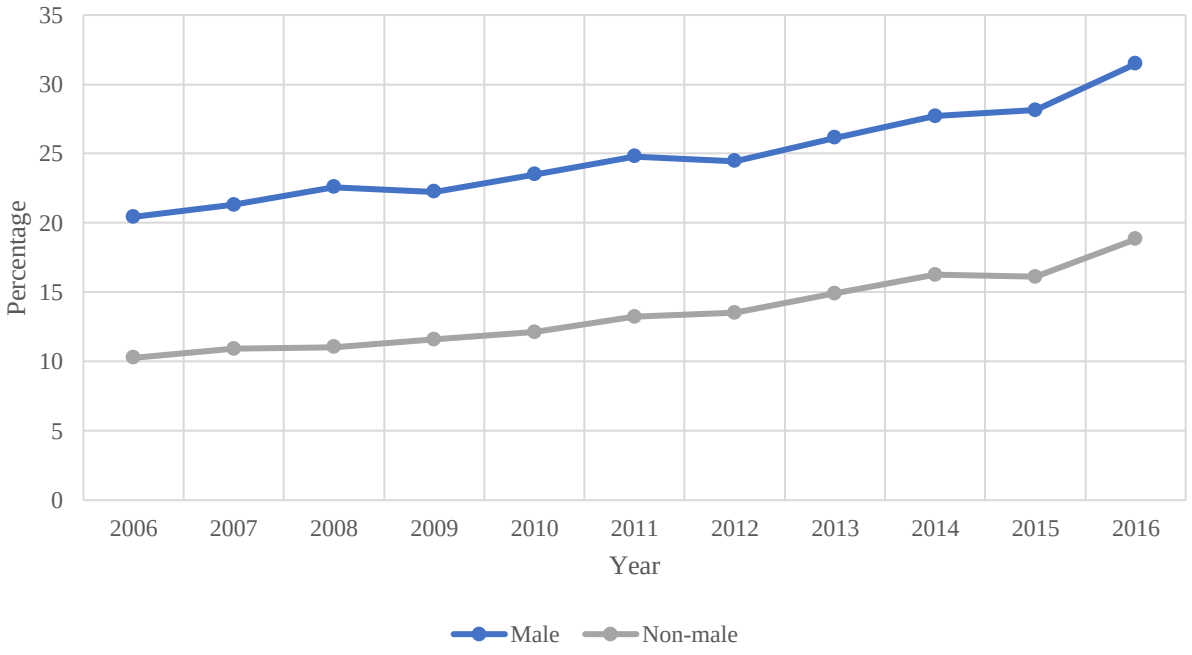

Figure 2. Reported past 30-day cannabis use from 2006 to 2016 stratified by sex categories

5.2.3 Trend in proportion of inpatients reporting past 30-day cannabis use by age

Nearly all age groups had increases in past 30-day cannabis use from 2006 to 2016 (Table 10, Figure 3). Inpatients less than 18 years, however, had a slight decrease in past 30-day cannabis use across the study period. Individuals age 65 and older had the largest percent increase at 467%, however, this was only an absolute increase of 1.5%. Individuals ages 18 to 24 remained the greatest users throughout the entire study period with nearly half (48%) reporting past 30-day cannabis use in 2016.

Table 10. Prevalence of reported past 30-day cannabis use among the inpatient psychiatric population from 2006 to 2016 stratified by age categories

	AGE						
YEAR	**<18** *N (%)*	**18-24** *N (%)*	**25-34** *N (%)*	**35-44** *N (%)*	**45-54** *N (%)*	**55-64** *N (%)*	**65+** *N (%)*
2006	103 (36.0)	865 (36.2)	980 (26.8)	772 (16.5)	419 (8.5)	71 (2.9)	**
2007	103 (34.6)	717 (36.8)	834 (27.8)	595 (16.4)	396 (11.0)	75 (3.7)	7 (0.3)
2008	123 (39.2)	727 (38.3)	726 (27.9)	539 (17.9)	363 (11.3)	75 (4.0)	12 (0.5)
2009	106 (40.2)	742 (40.0)	691 (28.5)	479 (17.6)	385 (12.1)	81 (4.2)	9 (0.4)
2010	100 (39.2)	825 (41.9)	655 (29.3)	446 (18.4)	378 (12.9)	82 (4.3)	16 (0.7)
2011	118 (39.9)	904 (43.6)	696 (31.3)	390 (17.0)	404 (14.3)	87 (5.0)	8 (0.4)
2012	134 (36.6)	896 (41.4)	645 (29.7)	404 (19.0)	331 (12.5)	118 (6.6)	23 (1.1)
2013	124 (36.4)	1038 (44.0)	640 (30.5)	399 (18.8)	356 (14.9)	139 (7.9)	27 (1.2)
2014	130 (35.9)	1131 (45.4)	746 (34.8)	431 (22.2)	327 (13.9)	142 (8.1)	16 (0.7)
2015	101 (32.3)	1021 (42.9)	750 (34.8)	453 (22.9)	321 (15.3)	161 (9.4)	31 (1.5)
2016	127 (35.6)	1254 (48.3)	800 (36.7)	458 (25.1)	354 (16.8)	189 (11.7)	33(1.7)
Absolute change (%)	-0.4	12.1	9.9	8.6	8.3	8.9	1.5
Relative change (%)	-1.1	33.4	36.9	52.1	97.6	303.4	466.7
**Results not reported due to a cell count of less than 5.							

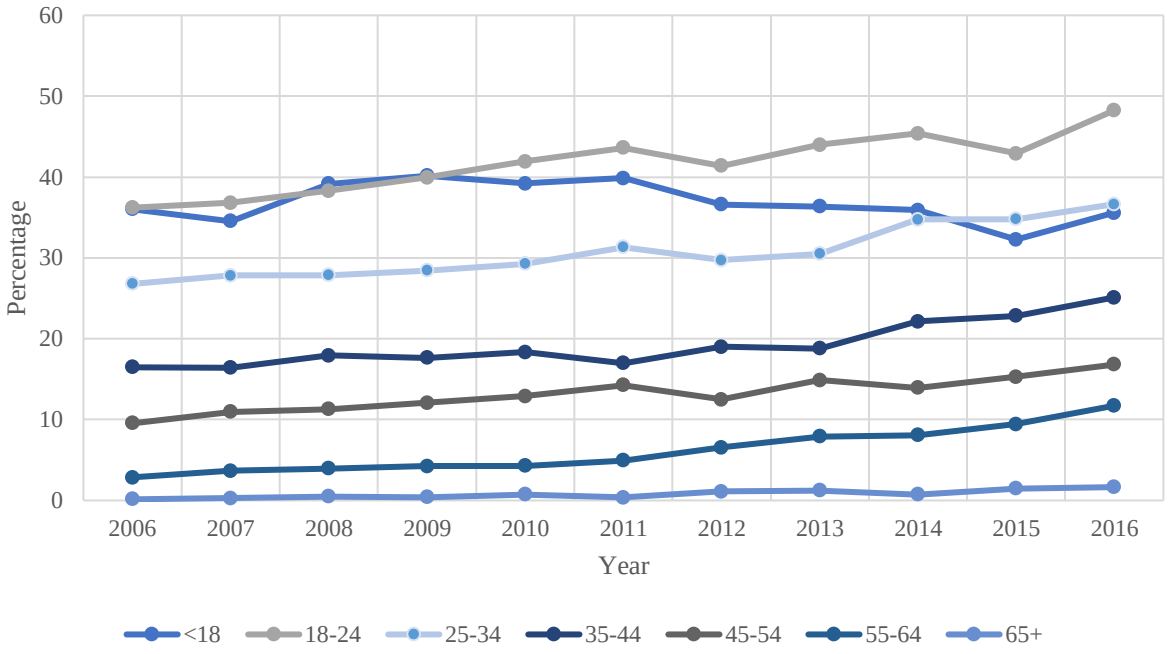

Figure 3. Reported past 30-day cannabis use from 2006 to 2016 stratified by age categories

5.2.4 Trend in proportion of inpatients reporting past 30-day cannabis use by diagnostic group

The prevalence of past 30-day cannabis use increased among all diagnostic categories with the prevalence almost doubling among those with schizophrenia and other psychotic disorders; in 2006 approximately 15.2% of individuals with a primary, secondary, or tertiary diagnosis of schizophrenia or other psychotic disorders reported past 30-day cannabis use, relative to 30.6% reporting use in 2016. Large increases were also seen among individuals with personality disorders and anxiety disorders, with a 97.1% relative increase for personality disorders, and an 87.8% increase for anxiety disorders. There was a 64.7% relative increase in use among those with neurocognitive disorders, however, this was only due to a 1.1% absolute increase in the number of past 30-day cannabis users.

Although the proportion of individuals reporting past 30-day cannabis use for all diagnostic groups from 2006 to 2016 increased, the absolute number of individuals reporting past 30-day cannabis use for some diagnostic categories decreased (Table 11, Figure 4). Among those with neurocognitive disorders, anxiety disorders, personality disorders and disorders in the 'other' category both the number and proportion of individuals reporting past 30-day cannabis use increased. However, for substance-related and addictive disorders, schizophrenia and other psychotic disorders, and mood disorders, the number of individuals reporting past 30-day cannabis use from 2006 to 2016 decreased while the actual proportion of individuals in each diagnostic group reporting past 30-day cannabis use increased.

Table 11. Prevalence of reported past 30-day cannabis use among the inpatient psychiatric population from 2006 to 2016 stratified by DSM diagnostic groups

	DIAGNOSTIC GROUP						
YEAR	**Neurocognitive disorders** *N (%)*	**Substance-related and addictive disorders** *N (%)*	**Schizophrenia and other psychotic disorders** *N (%)*	**Mood disorders** *N (%)*	**Anxiety disorders** *N (%)*	**Personality disorders** *N (%)*	**Other disorders** *N (%)*
2006	27 (1.7)	1857 (34.1)	1038 (15.2)	1443 (13.7)	277 (11.5)	355 (17.5)	347 (12.8)
2007	25 (1.8)	1537 (33.3)	732 (15.6)	1259 (14.3)	242 (12.5)	284 (19.8)	300 (14.4)
2008	22 (1.7)	1443 (35)	658 (16.5)	1260 (15.3)	265 (13.7)	303 (22.8)	266 (14.6)
2009	18 (1.5)	1371 (34.3)	660 (17.0)	1186 (15.4)	323 (15.8)	293 (23.5)	307 (16.7)
2010	23 (1.9)	1455 (37.3)	697 (19.7)	1234 (16.4)	299 (14.9)	264 (23.6)	322 (18.0)
2011	17 (1.4)	1467 (38.2)	721 (20.7)	1283 (17.6)	359 (17.1)	294 (25.9)	329 (18.3)
2012	17 (1.5)	1436 (39.4)	686 (20.1)	1288 (17.9)	370 (17.1)	236 (24.1)	313 (17.6)
2013	30 (2.5)	1483 (41.2)	804 (23.9)	1325 (18.6)	382 (17.3)	258 (25.2)	326 (18.0)
2014	27 (2.4)	1597 (43.2)	860 (26.3)	1434 (20.4)	447 (19.9)	269 (26.4)	388 (19.6)
2015	18 (1.6)	1561 (43.3)	811 (26.6)	1354 (20.0)	455 (20.2)	293 (28.8)	353 (20.3)
2016	28 (2.8)	1633 (46.0)	964 (30.6)	1422 (22.3)	411 (21.6)	361 (34.5)	515 (22.9)
Absolute change (%)	1.1	11.9	15.3	8.6	10.1	17.0	10.1
Relative change (%)	64.7	34.9	101.3	62.8	87.8	97.1	78.9

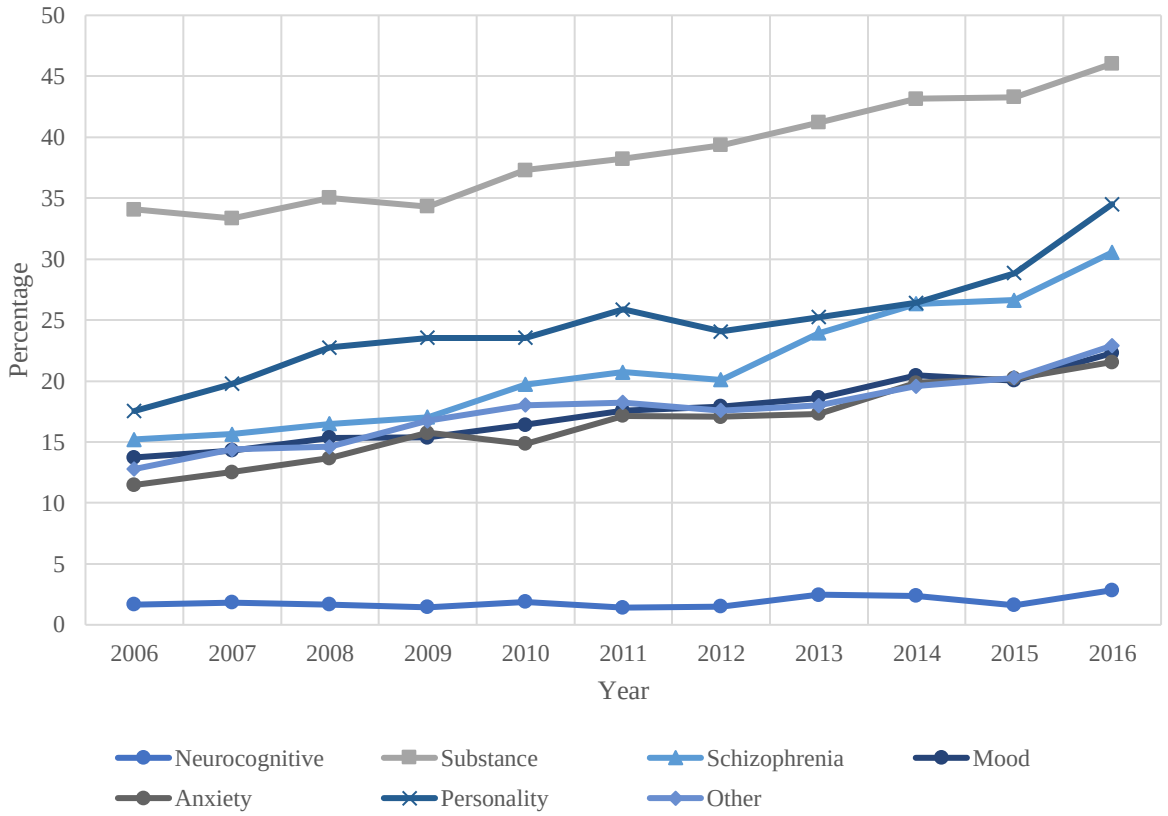

Figure 4. Reported past 30-day cannabis use from 2006 to 2016 stratified by DSM diagnosis

5.3 QUESTION 2: CHARACTERISTICS ASSOCIATED WITH CANNABIS USE

Table 12 illustrates the bivariate associations between candidate variables and past 30-day cannabis use. A number of variables were excluded from the block modelling process as they were not significantly associated with past 30-day cannabis use ($p<0.0001$) at the bivariate level including: forensic assessment (reason for admission), voluntary inpatient status, social isolation, pain, severity of depressive symptoms, and severity of anxiety symptoms. Additional variables were removed if there was not at least a 5% difference in the prevalence of past 30-day cannabis users between any two levels of the variable. Variables excluded include: residential stability, lived alone, employment status, and recent psychiatric hospitalization history.

Table 12. Bivariate analyses of independent variables considered for the logistic regression model describing demographic and clinical characteristics associated with past 30-day cannabis use

VARIABLE		x^2	p-value
BLOCK 1			
Non-male		3297.9	<0.0001
Age		19825.1	<0.0001
Marital status		8000.5	<0.0001
Education level		1041.8	<0.0001
Indigenous origin		989.3	<0.0001
Residential stability		35.7	<0.0001
Lived alone		55.6	<0.0001
Employment status		158.8	<0.0001
Risk of unemployment/disrupted education		2653.8	<0.0001
BLOCK 2			
Past year substance use		17241.1	<0.0001
Past 30-day substance use		15971.1	<0.0001
Problematic alcohol use		5119.2	<0.0001
Smoking		14497.7	<0.0001
Misuse of medications		1020.7	<0.0001
BLOCK 3			
Mental health diagnosis	Neurocognitive disorders	2815.1	<0.0001
	Substance-related and addictive disorders	14798.0	<0.0001
	Schizophrenia and other psychotic disorders	67.3	<0.0001
	Mood disorders	369.9	<0.0001
	Anxiety disorders	104.5	<0.0001
	Personality disorders	245.6	<0.0001
	Other disorders	36.4	<0.0001
Reason for admission	Threat to self	253.3	<0.0001
	Threat to others	126.3	<0.0001
	Inability to care	586.6	<0.0001
	Problem with addiction	15533.2	<0.0001
	Specific psychiatric symptoms	33.1	<0.0001
	Involvement criminal justice system	124.3	<0.0001
	Other	82.1	<0.0001
	Forensic assessment	9.5	0.0021
Inpatient status at admission	Application for psychiatric assessment	719.1	<0.0001
	Voluntary	8.8	0.0029
	Informal	166.5	<0.0001
	Involuntary	16.1	<0.0001
	Forensic	119.5	<0.0001
LOS		1598.9	<0.0001
BLOCK 4			

Safety	Harm to others	History of violence	2134.2	<0.0001
		Aggressive Behaviour Scale (<2)	87.4	<0.0001
	Self-harm		15.5	<0.0001
BLOCK 5				
Social life	Social relationships	Social isolation	8.8	0.0031
		Dysfunction	1025.5	<0.0001
	Interpersonal conflict		556.6	<0.0001
	Traumatic life events		616.3	<0.0001
	Criminal activity		3304.5	<0.0001
BLOCK 6				
Financial hardship			586.6	<0.0001
Autonomy	Medication adherence history		2725.0	<0.0001
	Number of psychiatric hospitalizations in prior 2 years		42.6	<0.0001
	Number of psychiatric hospitalizations in lifetime		311.5	<0.0001
BLOCK 7				
Health Promotion	Sleep disturbance		36.6	<0.0001
	Pain		5.1	0.0771
BLOCK 8				
Symptom Severity	Positive Symptom Scale		147.8	<0.0001
	Social Withdrawal Scale		521.3	<0.0001
	Cognitive Performance Scale		1328.3	<0.0001
	Depressive Severity Index		1.0	0.3090
	Mania Scale		1784.9	<0.0001
	CAGE		15533.2	<0.0001
	Anxiety Scale		0.02	0.8812

Each block was modelled separately. Within each block, several variables became insignificant including employment status, involvement with criminal justice system, other reason for admission, forensic inpatient status, aggression, and social isolation. Each insignificant variable was removed from the associated block, and the model was rerun. All blocks composed of the remaining variables were combined together one by one. Insignificant variables were again removed after each block was combined, and the model was rerun. Variables that became insignificant included: inability to care for oneself, admission due to threat to oneself, admission due to threat to others, harm to self, anxiety disorders, personality

disorders, other disorders, dysfunctional social relationships, interpersonal conflict, history of criminal activity, risk of unemployment or disrupted education, sleep disturbances, pain, and additional lifetime substance use (not including cannabis). A final model was generated with the remaining variables (C-statistic=0.868, Table 13).

5.3.1 Block 1

After controlling for other variables, sex, age, marital status, education level, and Indigenous origin all remained significantly associated with past 30-day cannabis use. After controlling for other variables, those who were married or had a partner/significant other were approximately 16% less likely to report being a past 30-day cannabis user relative to those who were never married (95% CI: 0.80-0.88). However, no significant difference was found between those who were widowed/separated/divorced, relative to those who were never married. Additionally, there was no significant difference in the odds of being a cannabis user for those who had less than a high school education relative to those with a high school education. However, those with more than a high school education were 12% less likely to be a past 30-day cannabis user relative to those with a high school education (95% CI: 0.85-0.91). Finally, individuals who identified as being of Indigenous origin had 1.3 times greater odds of being a past 30-day cannabis user relative to those who did not identify as being of Indigenous origin (95% CI: 1.25-1.45). There was no significant difference in cannabis use status for those who were residentially stable versus those who were not, for those who lived alone versus those who did not, and those who were employed versus unemployed. There was also no significant difference in the odds of past 30-day cannabis use between those at risk of unemployment or of experiencing disrupted education. There were differences in the odds of cannabis use by year.

Starting in 2012, year was significantly associated with being a past 30-day cannabis user with the odds of past 30-day cannabis use increasing between 2012 and 2016.

5.3.2 Block 2

Past 30-day cannabis use was significantly associated with recent use of additional substances, indicators of problematic alcohol use, and being a current smoker. Those who reported recent use of additional substances were approximately 2.3 times more likely to report past 30-day cannabis use relative to those who did not report past 30-day substance use (95% CI: 2.20-2.39). However, those who reported a lifetime use of additional substances were not more likely to be past 30-day cannabis users. Problematic alcohol users were 23% more likely to report past 30-day cannabis use (95% CI: 1.18-1.28) relative to those without problematic use. Finally, inpatients that reported being a smoker were 2.6 times more likely to be past 30-day cannabis users relative to non-smokers (95% CI: 2.54-2.72).

5.3.3 Block 3

After controlling for other variables, past 30-day cannabis was found to be significantly associated with a primary, secondary, or tertiary diagnosis of neurocognitive disorders, substance use disorders, schizophrenia, and mood disorders. Those with neurocognitive disorders were less likely to have past 30-day cannabis use (OR 0.67, 95% CI: 0.58-0.78) than those without. Those with mood disorders were more likely to report past 30-day cannabis use relative to those without (OR 1.34, 95% CI: 1.29-1.39). Past 30-day cannabis use was also significantly associated with LOS of the index admission; the odds of reported past 30-day cannabis use decreased as LOS increased. Those with the shortest LOS (3 to 14 days) were most likely to be past 30-day cannabis users. Individuals with a LOS from 15 to 30 days were 13% less likely to be past 30-day cannabis users relative to those who had a LOS 3 to 14 days (95% CI: 0.84-0.90).

Individuals with a LOS from 31 to 60 days were 30% (95% CI: 0.66-0.73), 61 to 90 days were 37% (95% CI: 0.57-0.70), and those with a LOS greater than 90 days were 59% less likely (95% CI: 0.36-0.46) to be a past 30-day cannabis user relative to those had an index LOS 3 to 14 days.

5.3.4 Block 4 and 5

Past 30-day cannabis was associated with having a history of violence and experiencing traumatic life events. Those who had a history of violence were more likely to be past 30-day cannabis users (OR 1.14, 95% CI: 1.10-1.19), as were those who experienced past (OR 1.20, 95% CI: 1.14-1.27) or current traumatic events (OR 1.18, 95% CI: 1.12-1.24).

5.3.5 Block 6

After controlling for other variables, experiences of financial hardship, medication adherence, and lifetime psychiatric hospitalization history were significantly associated with past 30-day cannabis use. Past 30-day cannabis users were approximately 20% more likely to report financial hardship, which includes having a history of major loss of income or experiencing serious economic hardship due to poverty (95% CI: 1.16-1.24). Additionally, past 30-day cannabis was positively associated with medication adherence levels; decreasing medication adherence was associated with greater odds of being a past 30-day cannabis user relative to those who were always adherent to prescribed medication. Those who had no prescribed medication had 34% greater odds (95% CI: 1.27-1.40) of being a past 30-day cannabis user relative to those who had medication and were always adherent. Finally, those with greater lifetime hospital admissions were less likely to be recent users of cannabis. Those with 1 to 3 hospitalizations were 11% less likely to be past 30-day cannabis users (relative to those with no history) (95% CI: 0.86-0.92), and individuals with 4 to 5 hospitalizations and 6 or more hospitalizations were

both 21% less likely to be past 30-day cannabis users (95% CI: 0.74-0.85, 0.73-0.85, respectively).

5.3.6 Block 8

Past 30-day cannabis use remained significantly associated with several measures of symptoms severity after controlling for other variables. Those with more severe positive symptoms were 23% more likely to be past 30-day cannabis users relative to those with a score of 0 to 2 on the Positive Symptom Scale (95% CI: 1.18-1.28). Greater levels of social withdrawal were associated with reduced odds of being a cannabis user. There was no significant difference in the odds of being a past 30-day cannabis user for those with the least severe withdrawal symptoms relative to those with no symptoms (OR 0.94, 95% CI: 0.90-0.98). Those with moderate severity of withdrawal symptoms were 13% less likely to be past 30-day cannabis users (95% CI: 0.84-0.91), and those with the most severe symptoms were 17% less likely to be past 30-day cannabis users relative to those with no symptoms (95% CI: 0.78-0.88). Individuals with lower cognitive performance were less likely to be past 30-day cannabis users relative to those with no cognitive performance decline (OR 0.77, 95% CI: 0.71-0.83). Increasing severity of mania symptoms was associated with greater odds of being a past 30-day cannabis user. Those with the most severe mania symptoms were two times more likely to report past 30-day cannabis use relative to those with no mania symptoms (OR 2.0, 95% CI: 1.89-2.12). Finally, those with indicators of addiction (as measured by the CAGE scale), had approximately 1.2 times greater odds of being a past 30-day cannabis user relative to those who did not have indicators of addiction (95% CI: 1.14-1.24).

5.3.7 Interaction terms

After controlling for other variables, significant interactions were found between sex and having a diagnosis of schizophrenia or other psychotic disorders, as well as, between age and substance-related and addictive disorders. Males with schizophrenia or other psychotic disorders had greater rates of cannabis use than males without this diagnosis. However, non-males with schizophrenia or other psychotic disorders had lower rates of cannabis use than those without this diagnosis (Table 14). Among males with schizophrenia and other psychotic disorders, 27.4% reported past 30-day cannabis use relative to 10% of non-males with this diagnosis. Comparatively, 23.1% of males without schizophrenia or other psychotic disorders reported past 30-day cannabis use, relative to 14.1% of non-males without this diagnosis (Figure 5). Past 30-day cannabis use was found to be significantly greater for individuals with a substance use disorder for all age categories except those 65 and older; 76.5% of those less than 18, 67.9% of 18-24 year olds, 49.3% of 25 to 34 year olds, 33.6% of 35 to 44 year old, 23.4% of 45 to 54 year olds, 12.9% of those 55 to 64, and 3.8% of those 65 and older with a substance use and addictive disorder reported past 30-day cannabis use. These figures compare to 25.6%, 29.4%, 19.6%, 11.2%, 8.1%, 3.9%, and 0.5% of individuals without a substance use disorder diagnosis (by age category) (Table 15, Figure 6).

Table 13. Demographic and clinical characteristics included in the final predictive logistic regression model for individuals most likely to be past 30-day cannabis users

VARIABLE	LEVEL	ODDS RATIO	95% CONFIDENCE INTERVAL		P-VALUE
Year (ref=2006)	2007	1.05	0.98	1.12	0.1888
	2008	1.09	1.02	1.17	0.0099
	2009	1.01	0.94	1.09	0.7669
	2010	1.01	0.94	1.09	0.7420
	2011	1.14	1.06	1.23	0.0006
	2012	1.15	1.07	1.24	0.0002
	2013	1.27	1.18	1.37	<0.0001

	2014	1.38	1.28	1.48	<0.0001
	2015	1.43	1.33	1.54	<0.0001
	2016	1.67	1.55	1.80	<0.0001
BLOCK 1					
Non-male		See Interaction Terms			
Age (ref=18-24)	<18				
	25-34				
	35-44				
	45-54				
	55-64				
	65+				
Marital (ref=never married)	Married/Partner/ Significant other	0.84	0.80	0.88	<0.0001
	Widowed/Separated/ Divorced	0.97	0.92	1.02	0.1866
Education (ref=high school)	< High school	1.05	1.01	1.10	0.0152
	> High school	0.88	0.85	0.91	<0.0001
Indigenous origin		1.34	1.25	1.45	<0.0001
BLOCK 2					
Past 30-day substance use		2.29	2.20	2.39	<0.0001
Problematic alcohol use		1.23	1.18	1.28	<0.0001
Smoking		2.63	2.54	2.72	<0.0001
BLOCK 3					
Mental health diagnosis	Neurocognitive disorders	0.67	0.58	0.78	<0.0001
	Substance-related and addictive disorders	See Interaction Terms			
	Schizophrenia and other psychotic disorders				
	Mood disorders	1.34	1.29	1.39	<0.0001
Reason for Admission	Problem with addiction	2.01	1.93	2.09	<0.0001
	Psychiatric symptoms	1.12	1.08	1.16	<0.0001
Inpatient status at admission	Application for psychiatric assessment	1.33	1.27	1.39	<0.0001
	Involuntary	1.22	1.16	1.30	<0.0001
LOS (ref=3-14)	15-30 days	0.87	0.84	0.90	<0.0001
	31-60 days	0.70	0.66	0.73	<0.0001
	61-90 days	0.63	0.57	0.70	<0.0001
	>90 days	0.41	0.36	0.46	<0.0001
BLOCK 4					
History of violence		1.14	1.10	1.19	<0.0001
BLOCK 5					
Traumatic life events	Past traumatic event	1.20	1.14	1.27	<0.0001
	Current abuse	1.18	1.12	1.24	<0.0001

(ref=no history)					
BLOCK 6					
Financial hardship		1.20	1.16	1.24	<0.0001
Medication adherence (ref=always adherent)	Adherent >80% of time	1.05	1.01	1.10	0.0255
	Adherent <80% of time	1.21	1.16	1.27	<0.0001
	No medication	1.34	1.27	1.40	<0.0001
	Unknown	1.13	1.07	1.19	<0.0001
Number of psychiatric hospitalizations in lifetime (ref=0)	1-3 admissions	0.89	0.86	0.92	<0.0001
	4-5 admissions	0.79	0.74	0.85	<0.0001
	6+ admissions	0.79	0.73	0.85	<0.0001
BLOCK 8					
Positive Symptom Scale		1.23	1.18	1.28	<0.0001
Social Withdrawal Scale (ref=none)	1,2	0.94	0.90	0.98	0.0032
	3,4,5	0.87	0.84	0.91	<0.0001
	6: More severe withdrawal	0.83	0.78	0.88	<0.0001
Cognitive Performance Scale		0.77	0.71	0.83	<0.0001
Mania Scale (ref=none)	1	1.25	1.20	1.30	<0.0001
	2	1.56	1.50	1.63	<0.0001
	3: Most severe symptoms	2.00	1.89	2.12	<0.0001
CAGE		1.19	1.14	1.24	<0.0001
INTERACTION TERMS					
Interaction term		**Maximum Likelihood Estimate (β)**	**Standard Error**	**Chi-Square**	**p-value**
Schizophrenia and other psychotic disorders*Sex		-0.30	0.04	61.04	<0.0001
Substance-related and addictive disorders*Age	<18	0.65	0.11	35.04	<0.0001
	25-34	-0.39	0.05	74.65	<0.0001
	35-44	-0.39	0.05	65.68	<0.0001
	45-54	-0.46	0.05	85.50	<0.0001
	55-64	-0.38	0.07	29.53	<0.0001
	65+	0.26	0.16	2.71	0.0997
C-statistic					**0.868**

Table 14. Proportion of sample reporting past 30-day cannabis use by sex and DSM diagnosis of schizophrenia or other psychotic disorders

	SEX	
DIAGNOSIS	**MALE** *N (%)*	**NON-MALE** *N (%)*
Schizophrenia or other psychotic disorder	6869 (27.4)	1762 (10.0)
No schizophrenia or other psychotic disorder	13047 (23.1)	8652 (14.1)

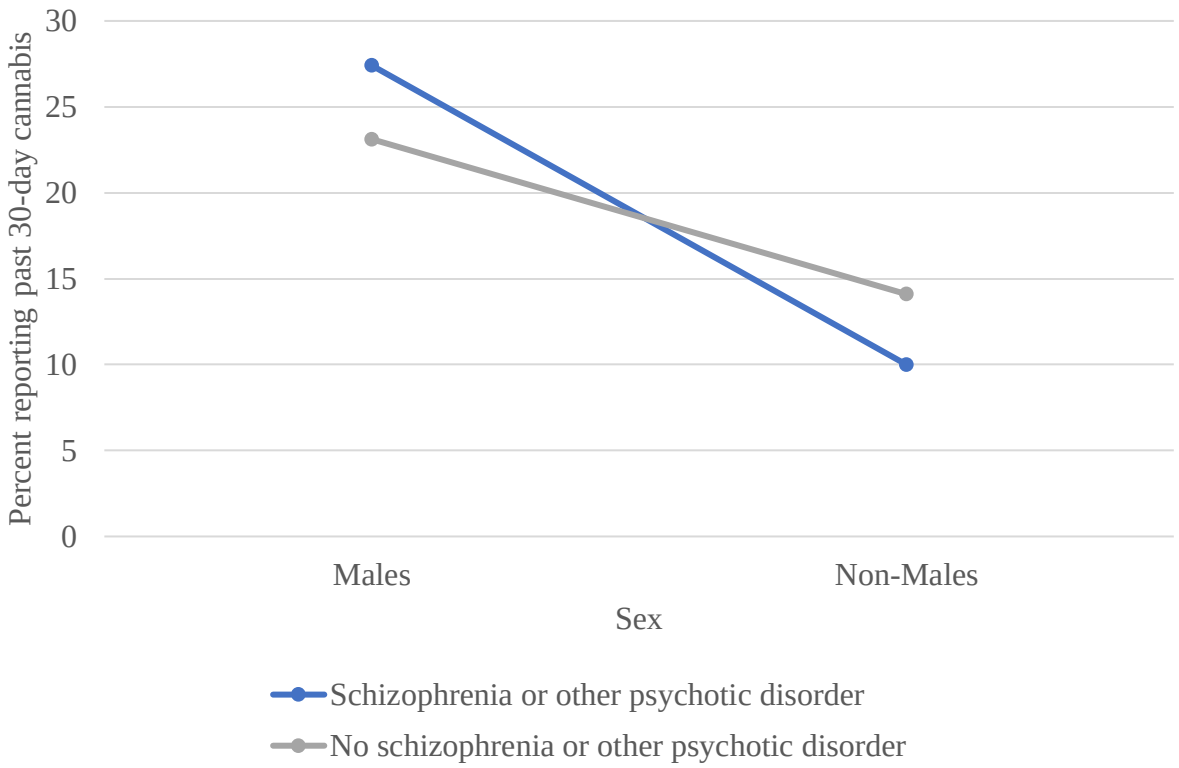

Figure 5. Proportion of sample reporting past 30-day cannabis use by sex and a schizophrenia or other psychotic disorder diagnosis

Table 15. Proportion of sample reporting past 30-day cannabis use by age and DSM diagnosis of a substance use disorder

	AGE						
DIAGNOSIS	**<18** *N (%)*	**18-24** *N (%)*	**25-34** *N (%)*	**35-44** *N (%)*	**45-54** *N (%)*	**55-64** *N (%)*	**65+** *N (%)*
Substance use disorder	579 (76.5)	5382 (67.9)	4787 (49.3)	3199 (33.6)	2226 (23.4)	591 (12.9)	76 (3.8)
No substance use disorder	690 (25.6)	4738 (29.4)	3376 (19.6)	2139 (11.2)	1808 (8.1)	629 (3.9)	110 (0.5)

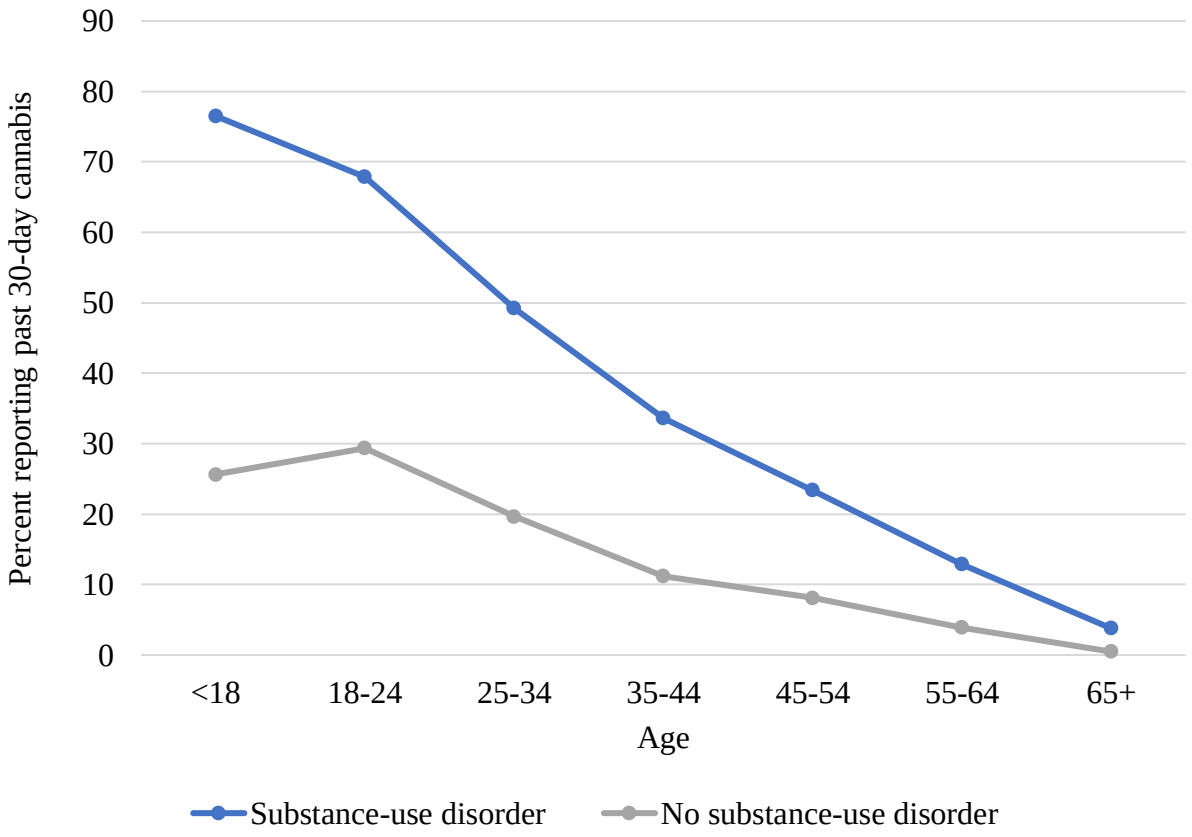

Figure 6. Proportion of sample reporting past 30-day cannabis use by age and a substance use diagnosis

5.4 QUESTION 3: 30-DAY READMISSIONS BY CANNABIS USE STATUS

At the bivariate level, past 30-day cannabis was significantly associated with 30-day readmissions ($p<0.0001$) (Table 16). Therefore, it was important to determine whether past 30-day cannabis use remained significantly associated with readmissions after controlling for other variables. The bivariate analyses to determine which variables to include in the block modelling process are outlined below in Table 16.

Table 16. Bivariate analysis for 30-day readmissions by cannabis use status

		ALL INPTIENTS		PAST 30-DAY CANNABIS USE		NO PAST 30-DAY CANNABIS USE	
VARIABLE		**x^2**	**p-value**	**x^2**	**p-value**	**x^2**	**p-value**
BLOCK 1							
Non-male		0.03	0.8676	1.0	0.3191	3.1	0.0773
Age		660.7	<0.0001	92.4	<0.0001	493.4	<0.0001
Marital status		335.2	<0.0001	75.4	<0.0001	213.6	<0.0001
Residential stability		4.0	0.0449	3.7	0.0551	1.2	0.2759
Lived alone		7.0	0.0083	1.2	0.2809	6.8	0.0089
Employment status		67.8	<0.0001	50.3	<0.0001	33.7	<0.0001
Risk of unemployment/disrupted education		0.3	0.5615	16.8	<0.0001	3.4	0.0661
BLOCK 2							
Past year substance use		1.1	0.2996	5.3	0.0213	0.4	0.5416
Past 30-day substance use		0.2	0.6937	4.4	0.0356	1.9	0.1643
Past 30-day cannabis use		79.0	<0.0001	Not Applicable			
Problematic alcohol use		0.1	0.7639	4.4	0.0354	0.003	0.9535
Smoking		67.0	<0.0001	1.9	0.1694	52.8	<0.0001
Misuse of medications		19.6	<0.0001	0.7	0.4052	15.0	0.0001
BLOCK 3							
Mental health diagnosis	Neurocognitive disorders	200.8	<0.0001	0.7	0.3953	178.8	<0.0001
	Substance-related and addictive disorders	47.2	<0.0001	39.6	<0.0001	60.9	<0.0001
	Schizophrenia and other psychotic disorders	117.9	<0.0001	80.5	<0.0001	53.0	<0.0001
	Mood disorders	56.3	<0.0001	0.1	0.7176	77.6	<0.0001
	Anxiety disorders	6.8	0.0090	24.5	<0.0001	0.05	0.8294
	Personality disorders	86.9	<0.0001	10.3	0.0013	72.5	<0.0001
	Other disorders	3.0	0.0838	5.1	0.0235	0.4	0.5229
Inpatient status at admission	Voluntary	273.4	<0.0001	144.7	<0.0001	151.2	<0.0001
	Involuntary	10.5	0.0012	23.4	<0.0001	0.9	0.3444
LOS		455.7	<0.0001	100.6	<0.0001	331.6	<0.0001

Contact with community mental health (past year)			19.5	<0.0001	0.9	0.6369	32.3	<0.0001
BLOCK 4								
Safety	Harm to others	History of violence	3.8	0.0512	4.9	0.0276	0.09	0.7612
		Aggressive Behaviour Scale (<2)	167.8	<0.0001	175.0	<0.0001	50.9	<0.0001
	Self-harm		86.7	<0.0001	2.6	0.1056	91.8	<0.0001
BLOCK 5								
Social life	Social relationships	Social isolation	22.9	<0.0001	4.9	0.0262	17.3	<0.0001
		Dysfunction	0.5	0.4785	2.9	0.0908	0.5	0.4601
	Interpersonal conflict		0.0005	0.9814	0.002	0.9606	0.3	0.5554
	Traumatic life events		24.5	<0.0001	8.2	0.0166	16.3	0.0003
	Criminal activity		57.2	<0.0001	15.6	<0.0001	24.9	<0.0001
	No support system for discharge		37.8	<0.0001	22.7	<0.0001	20.4	<0.0001
BLOCK 6								
Autonomy	Medication management		0.5	0.4641	47.6	<0.0001	1.9	0.1628
	Medication adherence history		164.0	<0.0001	59.3	<0.0001	100.2	<0.0001
	Number of psychiatric hospitalizations in prior 2 years		332.0	<0.0001	63.4	<0.0001	273.1	<0.0001
	Number of psychiatric hospitalizations in lifetime		318.2	<0.0001	49.1	<0.0001	287.0	<0.0001
BLOCK 7								
Health promotion	Sleep disturbance		8.6	0.0034	1.4	0.2442	6.4	0.0111
	Pain		14.5	0.0007	15.2	0.0005	6.1	0.0471
BLOCK 8								
Symptom severity	Positive Symptom Scale		293.7	<0.0001	226.8	<0.0001	121.0	<0.0001
	Social Withdrawal Scale		34.5	<0.0001	2.1	0.5497	54.4	<0.0001
	Cognitive Performance Scale		17.4	<0.0001	27.2	<0.0001	29.3	<0.0001
	Depressive Severity Index		15.4	<0.0001	0.002	0.9693	20.2	<0.0001
	Mania Scale		414.2	<0.0001	193.2	<0.0001	205.0	<0.0001
	CAGE		107.1	<0.0001	76.0	<0.0001	90.5	<0.0001
	Anxiety Scale		63.4	<0.0001	7.8	0.0051	56.6	<0.0001

Table 17. Readmission rates among inpatients by cannabis use status and demographic and clinical variables

VARIABLE	LEVEL	READMISSIONS		
		ALL INPATIENTS *N (%)*	**PAST 30-DAY CANNABIS USE** *N (%)*	**NO PAST 30-DAY CANNABIS USE** *N (%)*
BLOCK 1				
Sex	Male	5509 (6.9)	1604 (8.2)	3905 (6.5)
	Non-male	5336 (6.9)	807 (7.9)	4529 (6.8)
Age	<18	287 (8.4)	107 (8.6)	180 (8.3)
	18-24	2303 (9.8)	972 (9.8)	1331 (9.7)
	25-34	2121 (8.0)	670 (8.4)	1451 (7.9)
	35-44	1974 (7.0)	353 (6.7)	1621 (7.1)
	45-54	1921 (6.2)	232 (5.8)	1689 (6.2)
	55-64	1191 (5.9)	66 (5.5)	1125 (5.9)
	65+	1048 (4.4)	11 (6.1)	1037 (4.4)
Marital status	Never married	6022 (8.2)	1868 (9.0)	4154 (7.9)
	Married/Partner/Significant other	2921 (5.8)	291 (5.5)	2630 (5.8)
	Widowed/Separated/Divorced	1902 (5.9)	252 (6.9)	1650 (5.7)
Residential stability	Temporary residence	2795 (7.1)	674 (8.6)	2121 (6.8)
	Non-temporary residence	8050 (6.9)	1737 (7.9)	6313 (6.6)
Lived alone	Lived alone	3238 (7.2)	671 (8.4)	2567 (6.9)
	Did not live alone	7607 (6.8)	1740 (8.0)	5867 (6.5)
Employment	Employed	2571 (6.1)	569 (6.4)	2002 (6.0)
	Not employed	8274 (7.2)	1842 (8.8)	6432 (6.9)
Risk of unemployment/ disrupted education	At risk	2781 (7.0)	799 (7.3)	1982 (6.9)
	Not at risk	8064 (6.9)	1612 (8.6)	6453 (6.6)
BLOCK 2				
Past year substance use	Yes	1877 (7.1)	966 (7.7)	911 (6.5)
	No	8968 (6.9)	1445 (8.4)	7523 (6.7)

Past 30-day substance use		Yes	1275 (7.0)	736 (7.6)	539 (6.3)
		No	9570 (6.9)	1675 (8.3)	7895 (6.7)
Past 30-day cannabis use		Yes	2411 (8.1)	Not Applicable	
		No	8434 (6.6)		
Problematic alcohol use		Yes	1729 (7.0)	659 (7.6)	1070 (6.6)
		No	9116 (6.9)	1752 (8.3)	7364 (6.7)
Smoking		Yes	4604 (7.6)	1633 (8.0)	2971 (7.4)
		No	6241 (6.5)	778 (8.4)	5463 (6.3)
Misuse of medication		Yes	1594 (7.6)	470 (8.4)	1124 (7.4)
		No	9251 (6.8)	1941 (8.0)	7310 (6.5)
BLOCK 3					
Mental health diagnosis		Neurocognitive disorders	503 (3.9)	16 (6.6)	487 (3.8)
		Substance-related and addictive disorders	2694 (6.2)	1195 (7.2)	1499 (5.6)
		Schizophrenia and other psychotic disorders	3345 (8.1)	870 (10.4)	2475 (7.5)
		Mood disorders	6116 (7.4)	1163 (8.2)	4953 (7.2)
		Anxiety disorders	1493 (6.5)	229 (6.1)	1264 (6.6)
		Personality disorders	1164 (8.9)	302 (9.6)	862 (8.7)
		Other disorders	1408 (6.6)	265 (7.2)	1143 (6.5)
Inpatient status at admission		Voluntary	1975 (5.1)	340 (4.7)	1635 (5.2)
		Involuntary	1293 (7.5)	354 (10.2)	939 (6.8)
LOS		3-14 days	5222 (8.1)	1334 (9.3)	3888 (7.7)
		15-30 days	3797 (7.2)	819 (8.0)	2978 (7.0)
		31-60 days	1345 (4.9)	216 (5.1)	1129 (4.8)
		61-90 days	255 (4.5)	25 (4.3)	230 (4.6)
		90+ days	226 (3.8)	17 (4.2)	209 (3.8)
Contact with community mental health		No contact	5751 (6.7)	1400 (8.2)	4351 (6.3)
		0-30 days	3524 (7.3)	648 (7.9)	2876 (7.2)
		31+ days	1570 (7.1)	363 (8.2)	1207 (6.8)
BLOCK 4					
	History of violence	Yes	2283 (7.2)	770 (8.6)	1513 (6.6)

Harm to others		No	8562 (6.9)	1641 (7.9)	6921 (6.7)
	Aggressive Behaviour Scale	Score >2	2108 (8.9)	645 (12.7)	1463 (7.9)
		Score ≤2	8737 (6.6)	1766 (7.3)	6971 (6.4)
Harm to self		Yes	6485 (7.5)	1400 (8.3)	5085 (7.3)
		No	4360 (6.3)	1011 (7.8)	3349 (5.9)
BLOCK 5					
Social relationships	Social isolation	Yes	1396 (7.8)	322 (9.2)	1074 (7.5)
		No	9449 (6.8)	2089 (8.0)	7360 (6.5)
	Dysfunction	Yes	6348 (6.9)	1576 (7.9)	4772 (6.6)
		No	4497 (7.0)	835 (8.5)	3662 (6.7)
Interpersonal conflict		Yes	6441 (6.9)	1577 (8.1)	4864 (6.6)
		No	4404 (6.9)	834 (8.1)	3570 (6.7)
Traumatic life events		No history	9014 (6.9)	1899 (8.1)	7115 (6.6)
		Current abuse	896 (6.3)	251 (7.1)	645 (6.0)
		Past traumatic event(s)	935 (7.8)	261 (9.1)	674 (7.5)
Criminal activity		Yes	3120 (7.7)	1023 (8.9)	2097 (7.3)
		No	7725 (6.6)	1388 (7.6)	6337 (6.6)
No support system for discharge		Yes	3653 (7.5)	836 (9.2)	2817 (7.1)
		No	7194 (6.7)	1575 (7.6)	5617 (6.4)
BLOCK 6					
Medication management		Needs assistance	3705 (7.0)	710 (10.1)	2995 (6.5)
		Independent	7140 (6.9)	1701 (7.5)	5439 (6.7)
Medication adherence		Always adherent	4056 (6.1)	638 (6.8)	3418 (6.0)
		Adherent >80% of time	2220 (7.0)	428 (7.8)	1792 (6.9)
		Adherent <80% of time	2348 (8.4)	640 (10.1)	1708 (8.0)
		No medication	1098 (6.8)	437 (8.2)	661 (6.1)
		Unknown	1123 (7.6)	268 (8.5)	655 (7.3)
Number of psychiatric hospitalizations in prior 2 years		0	7775 (6.4)	1699 (7.4)	6076 (6.1)
		1-2 admissions	2400 (8.5)	588 (10.3)	1812 (8.1)
		3+ admissions	670 (11.0)	124 (11.1)	546 (11.0)
Number of psychiatric hospitalizations in lifetime		0	5251 (6.0)	1268 (7.3)	3983 (5.7)
		1-3 admissions	3717 (7.5)	830 (8.9)	2887 (7.1)

	4-5 admissions	922 (8.9)	162 (10.2)	760 (8.7)
	6+ admissions	955 (9.8)	151 (11.0)	804 (9.6)
BLOCK 7				
Sleep disturbance	Yes	5367 (7.1)	1227 (8.3)	4140 (6.8)
	No	5478 (6.7)	1184 (7.9)	4294 (6.5)
Pain	No	9479 (7.0)	2143 (8.3)	7336 (6.7)
	Medium priority	1108 (6.3)	226 (6.7)	882 (6.3)
	High priority	258 (6.6)	42 (6.1)	216 (6.8)
BLOCK 8				
Positive Symptoms Scale	0-2: No or mild symptoms	6483 (6.2)	1210 (6.3)	5273 (6.1)
	3+: More severe symptoms	4362 (8.5)	1201 (11.1)	3161 (7.8)
Social Withdrawal Scale	0: No withdrawal	2312 (6.3)	646 (8.2)	1666 (5.8)
	1,2	3240 (6.9)	790 (8.2)	2450 (6.5)
	3,4,5	3855 (7.2)	729 (7.8)	3115 (7.0)
	6+: More severe withdrawal	1449 (7.5)	246 (8.5)	1203 (7.3)
Cognitive Performance Scale	0-2: No or mild impairment	9935 (7.0)	2261 (7.9)	7674 (6.8)
	3+: More severe impairment	910 (6.1)	150 (12.1)	760 (5.6)
Depressive Severity Index	0-2: No or mild depression	4352 (6.6)	1018 (8.1)	3334 (6.3)
	3+: More severe depression	6493 (7.1)	1393 (8.1)	5100 (6.9)
Mania Scale	0: No mania symptoms	4386 (6.1)	694 (6.2)	3692 (6.1)
	1	2656 (6.6)	556 (7.3)	2100 (6.4)
	2	2344 (7.6)	655 (9.2)	1689 (7.1)
	3: Most severe symptoms	1459 (10.8)	506 (13.0)	953 (9.9)
CAGE	0-1: No potential problem with addiction	8988 (7.3)	1608 (9.3)	7380 (6.9)
	2+: Potential problem with addiction	1857 (5.6)	803 (6.5)	1054 (5.1)
Anxiety	0-2: No or mild anxiety	8650 (6.7)	1940 (7.9)	6710 (6.4)
	3+: More severe anxiety	2195 (8.0)	471 (9.1)	1724 (7.8)

5.4.1 Readmissions among all inpatients

After controlling for other variables, the main effect for past 30-day cannabis use did not remain significantly associated with 30-day readmissions for all inpatients. However, past 30-day cannabis did increase readmissions for those exhibiting positive symptoms; a significant interaction was found between past 30-day cannabis use and positive symptoms, suggesting that cannabis users exhibiting positive symptoms are at an increased risk of readmission relative to recent users without these symptoms or those with positive symptoms who have not had past 30-day cannabis use. Among past 30-day cannabis users, 11.3% of those with positive symptoms were readmitted within 30 days of discharge relative 6.3% without positive symptoms. Among non-past 30-day cannabis users, 7.8% of those with positive symptoms were readmitted within 30-days relative to 6.1% of those without positive symptoms (Figure 7). This relationship became more pronounced when readmissions within one year of discharge were considered (Figure 8). Additional variables that predicted 30-day readmissions included age, employment, mood disorders, personality disorders, having a voluntary inpatient status, length of stay, aggression, having no support system at discharge, recent and lifetime psychiatric hospitalization history, social withdrawal severity, mania symptom severity, and problem with addiction (Table 18).

Table 18. Results of the multi-variable logistic regression analysis for 30-day hospital readmissions among all individuals in inpatient psychiatry from 2006 to 2016

VARIABLE	LEVEL	ODDS RATIO	95% CONFIDENCE INTERVAL		P-VALUE
BLOCK 1					
Age (ref=18-24)	<18	0.81	0.72	0.93	0.0018
	25-34	0.84	0.88	0.89	<0.0001
	35-44	0.72	0.67	0.77	<0.0001
	45-54	0.62	0.58	0.66	<0.0001
	55-64	0.57	0.53	0.62	<0.0001
	65+	0.45	0.42	0.49	<0.0001

Employment status		0.85	0.82	0.91	<0.0001
BLOCK 3					
Mental health diagnosis	Mood disorders	1.24	1.18	1.29	<0.0001
	Personality disorders	1.15	1.08	1.23	<0.0001
Inpatient status at admission	Voluntary	0.83	0.78	0.87	<0.0001
LOS (ref=3-14 days)	15-30 days	0.91	0.87	0.95	<0.0001
	31-60 days	0.64	0.61	0.69	<0.0001
	61-90 days	0.56	0.49	0.64	<0.0001
	90+ days	0.46	0.40	0.53	<0.0001
BLOCK 4					
Aggressive Behaviour Scale (>2)		1.17	1.10	1.24	<0.0001
BLOCK 5					
No support system for discharge		1.10	1.05	1.15	<0.0001
BLOCK 6					
Number of psychiatric hospitalizations in prior 2 years (ref=0)	1 to 2	1.12	1.06	1.19	0.0002
	3+	1.30	1.18	1.43	<0.0001
Number of psychiatric hospitalizations in lifetime (ref=0)	1 to 3	1.17	1.11	1.24	<0.0001
	4 to 5	1.35	1.24	1.47	<0.0001
	6+	1.53	1.40	1.67	<0.0001
BLOCK 8					
Social Withdrawal Scale (ref=none)	1,2	1.06	1.0	1.12	0.0349
	3,4,5	1.12	1.06	1.18	0.0001
	6+: More severe withdrawal	1.20	1.12	1.29	<0.0001
Mania Scale (ref=none)	1	1.01	0.96	1.06	0.7192
	2	1.07	1.01	1.13	0.0180
	3: Most severe symptoms	1.35	1.25	1.45	<0.0001
CAGE		0.83	0.78	0.87	<0.0001
INTERACTION TERMS					
		Maximum Likelihood Estimate	**Standard Error**	**Chi-Square**	**p-value**
Positive Symptom Severity*Past 30-day cannabis		0.31	0.05	39.45	<0.0001
C-statistic					**0.631**

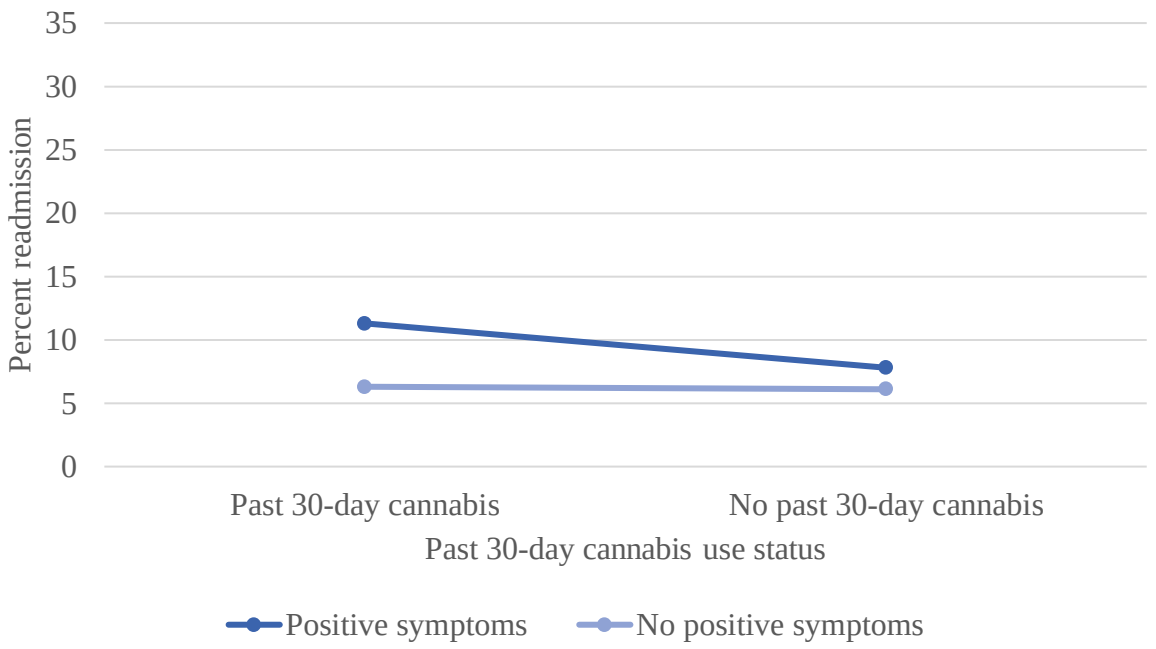

Figure 7. Readmissions within 30 days of discharge by past 30-day cannabis use status and presence of positive symptoms[6]

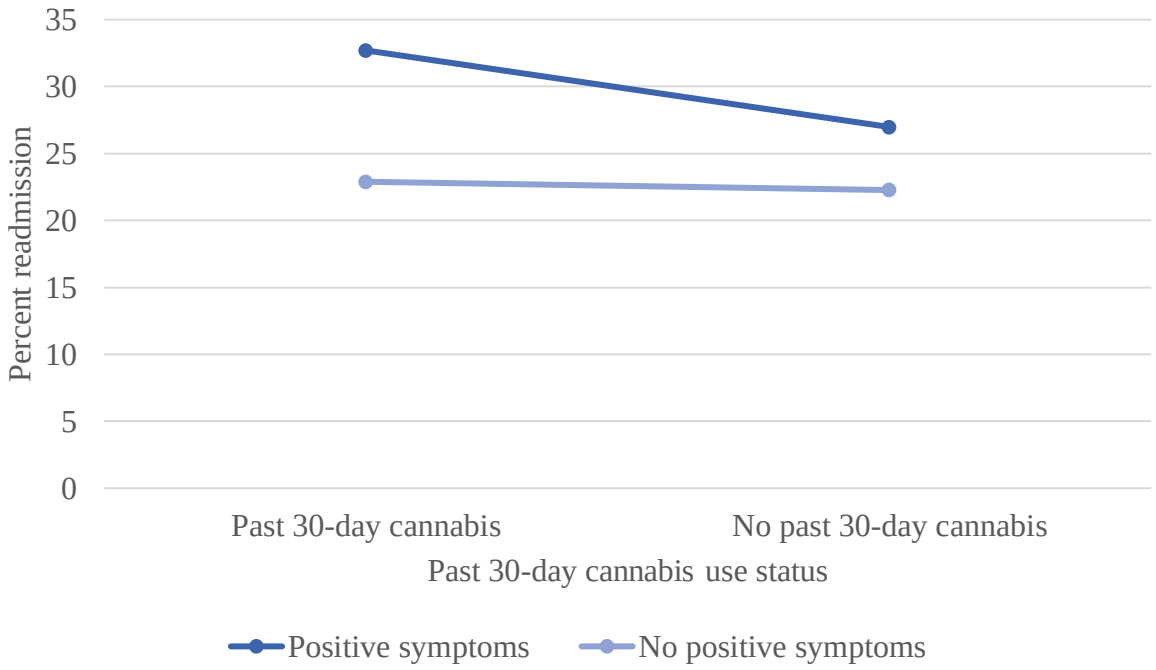

Figure 8. Readmissions within 1 year of discharge by past 30-day cannabis use status and presence of positive symptoms

[6] Positive symptoms are measured with the Positive Symptom Scale.

5.4.2 Readmissions among past 30-day cannabis users

As cannabis use was associated with higher rates of readmissions at the bivariate level, a separate model was developed to examine predictors of readmissions specifically among past 30-day cannabis users (Table 19). For past 30-day cannabis users, age was significantly associated with 30-day readmissions. There was no significant difference in 30-day readmission rates for individuals less than 18 years old (p=0.1148), 25 to 34 years old (p=0.1481), and older than 65 (p=0.1598) relative to those 18 to 24 years old after controlling for other factors. However, individuals aged 35 to 64 who reported past 30-day cannabis had lower odds of being readmitted within 30-days relative to cannabis users 18 to 24. Additionally, those with a voluntary inpatient status at admission were less likely to be readmitted within 30-days relative to those that had any other inpatient status (OR 0.70, 95% CI: 0.61-0.79). For past 30-day cannabis users, length of stay was significantly associated with readmission rates; decreasing length of stay was associated with greater odds of being readmitted. However, there was no significant difference in odds of being readmitted for past 30-day cannabis users with a LOS 3 to 14 days relative to those with a LOS from 15 to 30 days (OR 0.84, 95% CI: 0.77-0.92, p=0.0003). Past 30-day cannabis users with a length of stay from 31 to 60 days had approximately half the odds of being readmitted within 30-days relative to those with a LOS from 3 to 14 days (OR 0.56, 95% CI: 0.48-0.65). Past 30-day cannabis users with a LOS from 61 to 90 days were 60% less likely to be readmitted within 30-days (OR 0.41, 95% CI: 0.27-0.62), and those with LOS 90 or more days had approximately 73% decreased odds (OR 0.37, 95% CI: 0.23-0.61) of being readmitted within 30-days relative to those who had a length of stay 3 to 14 days. Past 30-day cannabis users who were admitted with aggressive behaviour were 1.5 times more likely to be readmitted within 30 days relative to those without indicators of aggression (95% CI: 1.32-1.62). Recent psychiatric

hospitalization history was also found to be associated with 30-day readmissions for past 30-day cannabis users; a greater number of hospitalizations in the past two years was associated with greater odds of being readmitted within 30-days. Those with 3 or more admissions in the past two years were approximately 50% more likely to be readmitted within 30 days relative to those who had no recent admissions (95% CI: 1.24-1.83). Positive symptom severity was a predictor of 30-day readmissions for past 30-day cannabis users. Those with more severe positive symptoms had increased odds of being readmitted within 30 days (OR 1.49, 95% CI: 1.36-1.64). Finally, past 30-day cannabis users who had a potential problem with addiction were less likely to be readmitted within 30-days of discharge (OR 0.82, 95% CI: 0.75-0.90).

Table 19. Results of the multi-variable logistic regression analysis for 30-day hospital readmissions among individuals reporting past 30-day cannabis use

VARIABLE	LEVEL	ODDS RATIO	95% CONFIDENCE INTERVAL		P-VALUE
BLOCK 1					
Age (ref=18-24)	<18	0.84	0.68	1.04	0.1148
	25-34	0.93	0.83	1.03	0.1481
	35-44	0.76	0.67	0.86	<0.0001
	45-54	0.66	0.57	0.77	<0.0001
	55-64	0.59	0.46	0.77	<0.0001
	65+	0.64	0.35	1.19	0.1598
BLOCK 3					
Inpatient status at admission	Voluntary	0.70	0.61	0.79	<0.0001
LOS (ref=3-14)	15-30 days	0.84	0.77	0.92	0.0003
	31-60 days	0.55	0.48	0.65	<0.0001
	61-90 days	0.41	0.27	0.62	<0.0001
	90+ days	0.37	0.23	0.61	<0.0001
BLOCK 4					
Aggressive Behaviour Scale (>2)		1.46	1.32	1.62	<0.0001
BLOCK 6					
Number of psychiatric hospitalizations in prior 2 years (ref=0)	1 to 2	1.38	1.25	1.53	<0.0001
	3+	1.50	1.24	1.83	<0.0001
BLOCK 8					
Positive Symptom Scale		1.49	1.36	1.64	<0.0001
CAGE		0.82	0.75	0.90	<0.0001

C-statistic	**0.641**

5.4.3 Readmissions among non-past 30-day cannabis users

Variables associated with 30-day readmissions for non-past 30-day cannabis users were identified (Table 20). After controlling for all other variables, age remained significantly associated with 30-day readmissions. Similar to past 30-day cannabis users, increasing age was generally associated with a reduced likelihood of being readmitted. Non-cannabis users less than 18 years did not have significantly different readmission rates relative to 18 to 24-year olds (p=0.0043). However, non-cannabis users 25 and older were less likely to be readmitted relative to 18 to 24-year olds. The odds of being readmitted for those age 25 and older decreased for each older age category. Being employed was protective against readmissions for non-cannabis users (OR 0.86, 95% CI: 0.81-0.90). Mood disorders was the only diagnostic category significantly associated with readmissions for non-past 30-day cannabis users. Those diagnosed with a mood disorder were approximately 1.3 times more likely to be readmitted within 30 days of discharge relative to those without a mood disorder diagnosis (95% CI: 1.20-1.32). Inpatients with a voluntary inpatient status were less likely to be readmitted, similar to past 30-day cannabis users. However, non-recent users were only 17% less likely to be readmitted, relative to a 31% less likely for those who were past 30-day cannabis users. Similar to past 30-day cannabis users, those who did not use cannabis use in the past 30 days who had longer LOS had decreased odds of being readmitted within 30 days. However, this relationship only became significant for LOS greater than 30 days. Additionally, recent psychiatric hospitalization history was positively associated with 30-day readmissions. There was no significant difference in readmissions among those with 0 versus 1 to 2 recent lifetime admissions (p=0.0029). This relationship became significant when recent admissions increased to 3 or more in the last two years; those with 3 or more recent hospitalizations had 36% increased odds of being readmitted within 30-days relative

to those with no recent hospitalization history. 30-day readmissions were also significantly associated with lifetime psychiatric hospitalization history for non-past 30-day cannabis users; the odds of readmission increased as the number of lifetime hospitalizations increased. Those with the most lifetime admissions (6 or more) were 1.6 times more likely to be readmitted relative to those without any lifetime admissions (95% CI: 1.42-1.72). Positive symptom severity was also a significant predictor of 30-day readmissions for non-past 30-day cannabis users. Those with more severe positive symptoms were 15% more likely to be readmitted within 30-days of discharge relative to those with less severe and no positive symptoms (95% CI: 1.09-1.21). Severity of mania symptoms and social withdrawal were also significantly associated with readmissions with increasing severity being more strongly associated with readmissions. Non-cannabis users with the greatest social withdrawal were 23% more likely to be readmitted within 30-days (95% CI: 1.13-1.33), and those with the more severe mania symptoms were 43% more likely to be readmitted (95% CI: 1.32-1.55). Finally, non-past 30-day cannabis users who had a potential problem with addiction were less likely to be readmitted within 30-days of discharge (OR 0.82, 95% 0.77-0.88).

Table 20. Results of the multi-variable logistic regression analysis for 30-day hospital readmissions among individuals reporting no past 30-day cannabis use

VARIABLE	LEVEL	ODDS RATIO	95% CONFIDENCE INTERVAL		P-VALUE
BLOCK 1					
Age (ref=18-24)	<18	0.79	0.67	0.93	0.0043
	25-34	0.81	0.75	0.87	<0.0001
	35-44	0.71	0.66	0.77	<0.0001
	45-54	0.61	0.56	0.65	<0.0001
	55-64	0.56	0.52	0.61	<0.0001
	65+	0.44	0.41	0.48	<0.0001
Employment status		0.86	0.81	0.90	<0.0001
BLOCK 3					
Mental health diagnosis	Mood disorder	1.26	1.20	1.32	<0.0001
Inpatient status at admission	Voluntary	0.83	0.79	0.88	<0.0001
LOS (ref=3-14)	15-30 days	0.93	0.88	0.98	0.0037
	31-60 days	0.67	0.62	0.72	<0.0001
	61-90 days	0.60	0.52	0.68	<0.0001
	90+ days	0.49	0.43	0.57	<0.0001
BLOCK 6					
Number of psychiatric hospitalizations in prior 2 years (ref=0)	1 to 2	1.11	1.04	1.18	0.0029
	3+	1.36	1.22	1.51	<0.0001
Number of psychiatric hospitalizations in lifetime (ref=0)	1 to 3	1.18	1.12	1.26	<0.0001
	4 to 5	1.38	1.26	1.52	<0.0001
	6+	1.57	1.42	1.72	<0.0001
BLOCK 8					
Positive Symptom Scale		1.15	1.09	1.21	<0.0001
Social Withdrawal Scale (ref=none)	1,2	1.09	1.03	1.17	0.0067
	3,4,5	1.17	1.10	1.25	<0.0001
	6: More severe withdrawal	1.23	1.13	1.33	<0.0001
Mania Scale (ref=none)	1	1.02	0.96	1.07	0.6009
	2	1.09	1.02	1.16	0.0092
	3: Most severe symptoms	1.43	1.32	1.55	<0.0001
CAGE		0.82	0.77	0.88	<0.0001
C-statistic					**0.623**

5.4.4 Summary: Readmissions among past 30-day cannabis users versus non-users

After controlling for other factors found to be significantly associated with readmissions, no significant association was found between 30-day readmissions and cannabis use status among all inpatients (p=0.1941). However, those exhibiting positive symptoms who used cannabis had increased risk of 30-day readmission. Different factors were found to be associated with 30-day readmissions depending on past 30-day cannabis use status (Table 21). Additionally, some factors were more strongly associated with readmissions for each cannabis status group. For both groups, it was found that those who stayed longer in hospital had lower risk of being readmitted within 30 days of discharge. Recent hospitalization history was a stronger predictor of readmissions for past 30-day cannabis users compared to non-recent users. Individuals with 1 to 2 recent admissions who were cannabis users were 38% more likely to be readmitted (95% CI: 1.25-1.53), relative to only a 10% increase in odds of being readmitted for non-recent users (95% CI: 1.04-1.18). Both groups had greater odds of being readmitted with increasing number of recent psychiatric hospital admissions. Finally, higher aggressive behaviour scale scores were a predictor of readmissions for past 30-day cannabis users but not for non-past 30-day cannabis users.

Table 21. Variables significantly associated with 30-day readmissions for all inpatients, past 30-day cannabis users, and non-past 30-day cannabis users

ALL INPATIENTS (Model 1)		PAST 30 DAY CANNABIS USE (Model 2)		NO PAST 30-DAY CANNABIS USE (Model 3)	
Increase Odds	**Decrease Odds**	**Increase Odds**	**Decrease Odds**	**Increase Odds**	**Decrease Odds**
Younger age	Employed	Younger age	Voluntary inpatient status	Younger age	Employed
Mood disorder	Voluntary inpatient status	Shorter LOS	Problem with addiction	Mood disorder	Voluntary inpatient status
Personality disorder	Problem with addiction	More aggressive behaviour		Shorter LOS	Problem with addiction
Shorter LOS		> Recent admissions		> Lifetime admissions	
More aggressive behaviour		More severe positive symptoms		> Recent admissions	
No support system for discharge				More severe positive symptoms	
> Lifetime admissions				Higher level of social withdrawal	
> Recent admissions				More severe mania symptoms	
More severe positive symptoms					
Higher level of social withdrawal					
More severe mania symptoms					

CHAPTER 6: DISCUSSION

Due to large gaps in current cannabis literature, many of the public health impacts of non-medical cannabis legalization remain largely unknown. This study explored the patterns of past 30-day cannabis use among individuals in inpatient psychiatry in Ontario, Canada. The present study established trends in past 30-day cannabis use among those in inpatient psychiatry across a 10-year period (2006 to 2016), identified characteristics associated with those most likely to report being a past 30-day cannabis user, and determined whether past 30-day cannabis use was associated with increased risk of 30-day readmissions. The importance and relevance of this study's findings will be presented and can be used to guide future research and public health and education campaigns that aim to reduce the negative impacts of cannabis use in those living with and who are at risk of mental health conditions.

6.1 PREVALENCE AND TRENDS IN CANNABIS USE

To our knowledge, this was the first study to establish prevalence rates and trends in cannabis use for an entire inpatient psychiatric population. The findings will, therefore, be primarily compared to previous literature that has evaluated cannabis use in the general population and to subsets of other mental health populations.

Cannabis use is commonly understood to be more prevalent among persons with mental health conditions than the general population. In two studies that assessed cannabis use in individuals with mental health conditions, 19.5% and 9.9% of participants reported cannabis use, relative to 10.3% and 1.3% of individuals without mental illnesses, respectively (1,2). Although cannabis has been commonly measured in the broader mental health population, studies assessing the prevalence of substance use specifically in the inpatient population are limited. A small-scale study evaluating cannabis use in adolescent psychiatric inpatients found 13% to

report lifetime cannabis use (87). In the present study, from 2006 to 2016, 18.9% of inpatients reported past 30-day cannabis use. This compares to studies of the general Canadian population that have found cannabis use to range from 12.3% for use within the past year (23) to 14% based on medical and non-medical use within the past three months (88). Together, these findings confirm that those in inpatient psychiatry use cannabis more than the general population and in similar amounts to other mental health populations. A challenge to note while comparing prevalence estimates is the scale for reporting; the current study used past month use while others report prior 90 days, 12 months, and lifetime measures. Having a broader definition of past 30-day cannabis use may have increased the prevalence found in the current study.

Throughout the study period, increases in reported rates of past 30-day cannabis were observed. In 2006, 15.4% of the inpatient population reported past 30-day cannabis use compared to 25.3% in 2016, attributing to a relative change of 64.3%. While the cause of this trend cannot be identified using the existing data, it does raise questions about the potential impact of changing culture, perception, legal status, and social acceptability of a cannabis on the availability, risk perception, and usage of cannabis. Research from the United States has found that cannabis use has increased, and risk perception has decreased during the time where significant changes in the legal environment of cannabis (both medical and non-medical) have occurred (89,90). Thus, the question of whether cannabis use will increase following legalization arises. Increasing cannabis use among psychiatric inpatients is cause for further investigation, with a particular need to tease out whether the cannabis use is associated with the person's need for inpatient psychiatric care or whether an increasing trend is representative of a changing attitude about disclosing cannabis use. If increased rates of use are seen in the general

population post-legalization, rates of use in the inpatient psychiatric population should be established and should be stratified by demographic and clinical characteristics.

For some diagnostic groups, there were both increases in the number of individuals being admitted into psychiatric hospitals and in the proportion of individuals reporting cannabis over time (e.g., substance-related and addictive disorders, and anxiety disorders). For other diagnostic categories, there were decreases in admissions over time while the proportion of individuals reporting past 30-day cannabis use increased (e.g., schizophrenia and other psychotic disorders, and personality disorders). These patterns raise the question of how cannabis relates to an admission into inpatient psychiatry for each mental health condition. Although admissions into inpatient psychiatry for some diagnostic groups decreased despite cannabis use increasing, this may be related to the availability of community resources for certain mental health conditions. For instance, it may be that community resources for schizophrenia and other psychotic disorders have increased in the community during the time where admissions have decreased which has reduced the need of inpatient psychiatric care for this population. Regardless of the actual number of individuals being admitted into inpatient psychiatry, the proportion of cannabis users increased across nearly all diagnostic groups. Continual monitoring is needed to determine how rates of admission change for all diagnostic groups following legalization, and how this relates to changes in rates of cannabis use.

Starting at the beginning of 2018, a new survey is being administered quarterly by the Canadian government which captures information on cannabis use (88). This survey will be an important tool for monitoring how prevalence and patterns of cannabis use in the general population compare to trends in use in the inpatient population, which has been captured on the RAI-MH since 2005. It is also important to monitor the characteristics of individuals in inpatient

psychiatry who are recent users of cannabis. This can give insight into whether certain populations begin to use cannabis more, whether cannabis adversely affects their mental health, or whether users experience improved mental health and clinical outcomes.

6.1.1 Age

As per the general population, younger individuals in inpatient psychiatry report greater cannabis use. Among most age groups, use has increased over time with a slight decrease seen in those less than 18.[7] Higher and increasing use among younger age groups is of particular concern for several reasons. First, this trend indicates a possible association between increased use of cannabis and an increased need for mental health services among younger age groups. This is evidenced by the increase seen in both reported cannabis use among younger groups and among admission rates (Table 10, Table 28). Second, there is reason to anticipate that use within younger cohorts will continue to increase following legalization. This hypothesis is rooted in the idea that following legalization the perceived risk associated with cannabis will decrease. As the perceived risk of a substance decreases, use of that substance tends to increase, particularly among younger individuals (91). Increased rates of cannabis use among youth and adolescents raises concern as earlier initiation of use has been associated with long-term adverse psychosocial outcomes that may persist for an individual's lifespan (26,27,30,92). This knowledge depicts why it is important for use among youth to be discouraged. Youth need to be informed on the potential harms associated with cannabis use and how to adopt safer, age-appropriate consumption habits through public health efforts, including integration of necessary information into school curriculums. Particular emphasis should be placed on abstinence among

[7] This decrease is likely a sample size issue as very few persons under 18 are admitted to adult beds per year.

youth and warning labels that describe the risk of adverse mental health outcomes (e.g., risk of psychosis). The government has already alluded to measures that aim to reduce use among youth, such as the proposed use of plain packaging (comparable to tobacco products), use of warnings on packages, and careful consideration for storefront locations and legal age of purchase (93).

Despite rates of use historically being higher in younger age categories, increases in reported cannabis use were seen in older age groups. Use among older age groups pose their own unique considerations. For instance, a concern for older adults in inpatient psychiatry, and healthcare more generally, is the problematic use of substances. Older adults have typically not been thoroughly assessed for their substance use behaviours (94). With easier access to cannabis following legalization, it is imperative that all individuals presenting to inpatient psychiatry are adequately screened for substance use behaviours as identifying problematic substance use patterns is critical from a treatment perspective. Monitoring older age groups, where cannabis use has historically been low, can also help to understand whether there are any unique and unanticipated experiences in this population. Exploring use in this population is important as current research on the efficacy and safety of cannabis (for both medical and non-medical cannabis) has failed to uniquely consider the impact of cannabis use on this population (95).

Although increases in use among all populations may be due to increased non-medical use, more doctors may also be prescribing medical cannabis for the alleviation and management of health conditions. The current study does not differentiate between medical and non-medical use indicating that these figures may capture medical cannabis use. The increase seen among older adults, therefore, may be attributable to increases in physician prescriptions for medical cannabis and not non-medical use. Although cannabis may be beneficial for physical health

conditions, it is important to consider whether this has any negative cognitive impacts over time. Futuristic studies that differentiate between medical and non-medical cannabis can give insight into reasons for and type of use among different age cohorts, and measure whether medical cannabis has any adverse mental health effects.

6.1.2 Sex

The patterns of cannabis use by sex among the inpatient psychiatric population were consistent with trends in the general population, with a higher prevalence among males than non-males. However, our findings show that there has been a greater increase in the prevalence of cannabis use among non-males over time. From 2006 to 2016 there was a 54.4% relative increase in past 30-day cannabis use among males, and an 82.5% relative increase among non-males. Some researchers suggest that the gap between male and female users may narrow with legalization and as social acceptability increases. It may be that women who currently feel social pressure to abstain from cannabis become more accepting once the legal status of the drug changes (96), or that females may be more willing to openly discuss their cannabis use behaviours.

To date, little research has focused on sex-specific effects of cannabis with animal studies primarily using males, and studies failing to conduct sex-stratified analyses (97). Sex-stratified analyses may reveal how the brain is affected by cannabis and the different motivations behind cannabis use (98). For instance, some researchers propose that women are more likely to use cannabis for suppression of anxiety than men (29), and that cannabis may actually be able to decrease anxiety levels for females but not for males (99). Variations in effects may be due, in part, to differences in muscle mass and fatty tissue distribution in males and females (98). With

increased use among females, it is important to monitor and evaluate sex-specific differences of cannabis use on mental health disorders for those in inpatient psychiatry.

6.1.3 Mental Health Diagnosis

The prevalence of cannabis use was highly variable between diagnostic groups. However, rates of use increased for all diagnostic group over time. Among those with schizophrenia and other psychotic disorders, 23% reported past 30-day cannabis use. Within this population, the percentage of individuals reporting past 30-day cannabis nearly doubled, despite the absolute number of persons in this diagnostic group decreasing over time (see Appendix C). Rates of use in this population were consistent with prior literature that has established a strong relationship between cannabis use and psychosis. Green, Young, and Kavanagh (100) found that, of 14 studies that looked at current cannabis use (n=1695), 23% of individuals with psychosis and those exhibiting positive symptoms reported current cannabis use. The current study confirms this high rate of use on a more acute level and with a larger study population. Another study by Myles, Myles and Large (101) found higher rates of cannabis use among individuals experiencing first episode psychosis than rates found in this study. Thus, it may be important to consider whether individuals being admitted for their first time have higher rates of use than individuals with a known history of psychosis. Higher rates of use may be expected among individuals with first-episode psychosis as cannabis has been associated with the onset of psychotic symptoms in those with a genetic predisposition (34). Research suggests that after an initial diagnosis, the odds of being a continued cannabis user decrease by half (101). The inclusion of individuals with first-episode psychosis and those with a prior known history of psychosis may account for lower prevalence observed in this general diagnostic category compared to first episode samples. This particular diagnostic group is important to monitor over

time to determine whether increased use of cannabis in the general population (a possible outcome of cannabis legalization), is accompanied by a change in the prevalence and incidence of hospitalizations for first-episode schizophrenia and other psychotic disorders, and/or for those presenting with psychotic symptoms.

The prevalence of past 30-day cannabis use may be anticipated to increase in certain diagnostic groups following legalization. For instance, use among those with mood and anxiety disorders may increase as there is a common notion that cannabis can help with anxiety and depressive symptoms. However, it is important to assess whether those who turn to cannabis actually receive symptom relief. Research that evaluates the effects of cannabis on anxiety and depression has been bidirectional and suggests that the effects of cannabis are dependent on several factors such as the dose (102), strain (48), and specific diagnosis (47,48). If the general public is not informed about these differences and this complex relationship, individuals may not receive the intended effects. Increased admissions for anxiety and depressive disorders, and increased rates of use within these diagnostic categories could suggest that an increasing number of people are turning to cannabis with the aim to reduce their depressive or anxiety symptoms. Analysis is needed to determine whether people are receiving the intended benefits from cannabis or whether they experience adverse events following cannabis initiation.

Among individuals with a primary, secondary, or tertiary diagnosis of a substance-related and addictive disorder, 38% reported cannabis use. Thus, cannabis is not the problematic substance for over two thirds of individuals with a SUD diagnosis. Although cannabis may not be driving a SUD diagnosis for the majority of individuals in inpatient psychiatry, it may serve as the primary substance driving this diagnosis for certain subgroups. For instance, youth tend to be primarily cannabis users and thus, a substance-related diagnosis among this cohort may be an

indication that cannabis is the problematic substance (see Section 6.2). This suggests that although addressing and discouraging use may not improve treatment outcomes and mental health status for all persons, it may improve treatment outcomes for certain subgroups (e.g., youth).

Summary

If an increase in cannabis use is seen following legalization, is important to consider the demographic characteristics that describe these individuals. For instance, if a greater number of younger individuals begin to use cannabis, longitudinal changes in the prevalence of particular diagnoses should be assessed. This is important as cannabis use in youth has been associated with long-term mental health outcomes, including the development of psychotic disorders for those with a genetic predisposition (34). Overall, the characteristics describing cannabis users in inpatient psychiatry should be monitored, and long-term impacts should be explored.

6.2 CHARACTERISTICS ASSOCIATED WITH CANNABIS USE

Demographic characteristics of cannabis users in inpatient psychiatry generally align with those of the general population. As per the general population, sex was found to be significantly associated with being a cannabis user with males being greater users than non-males. Additionally, higher rates of use were found among younger individuals, those who were never married (relative to those who were married or who had a partner/significant other), individuals identifying as being of Indigenous origin, and those with a high school or lower level of education (relative to those with higher than a high school education). Living alone, living in a temporary residence, or being at risk of unemployment/experiencing disrupted education were not significantly associated with past 30-day cannabis use.

The strength of the relationship between both sex and age and cannabis use interacted with the presence of specific mental health diagnoses. Having a primary, secondary, or tertiary diagnosis of schizophrenia or another psychotic disorder increased the odds of being a past 30-day cannabis user for males. However, there was no difference in the prevalence of past 30-day cannabis use for females based on this diagnosis. This finding may be related to the idea that males in general are more likely to report cannabis use than non-males. However, it may also relate to the idea that males and females have been suggested to metabolize and experience cannabis differently (98). Although this is among the first studies to report a differential pattern of cannabis use among those with psychosis by sex, the impact of cannabis has been noted to differ by sex for other diagnosis groups (e.g., anxiety) (99). This warrants further investigation to better understand why males with schizophrenia or another psychotic disorder are more likely to be past 30-day cannabis users than non-males. Age was also significantly associated with past 30-day cannabis use, with the strength of the relationship being dependent on the presence of a SUD. Not surprisingly, among all age groups, cannabis use was higher in those with SUDs than in those without. However, considerably higher rates of cannabis use were found in younger cohorts with a SUD relative to older cohorts. As cannabis is the most commonly used substance among younger cohorts, the question arises of whether cannabis is the problematic substance for younger age groups, with others driving this diagnosis for older individuals with SUDs. Future studies should evaluate whether younger cohorts with SUDs also report the use of additional substances, or whether cannabis is the primary problematic substance being used that is leading to this diagnosis. In summary, there is a need to further evaluate to what extent cannabis is the problematic substance, particularly for younger age categories.

High rates of polysubstance use were found among those reporting past 30-day cannabis use. Nearly half of individuals with either a lifetime or recent history of other substance use (including inhalants, hallucinogens, cocaine and crack, stimulants and opiates) also reported use of cannabis. After controlling for other variables, recent, but not lifetime, use of other substances increased the odds of being a past 30-day cannabis user. Problematic alcohol use was also associated with past 30-day cannabis use. The distinction between someone who is an exclusive cannabis user versus someone who problematically uses other substance is essential as polysubstance use has been understood to differentially affect a person's mental health compared to cannabis use alone. Research indicates that cannabis alone may not influence more adverse mental health states and more complex symptomology, but that cannabis use in addition to other substances may (103). Thus, polysubstance use should be uniquely considered and evaluated when trying to understand mental health states and to improve clinical outcomes. All research that aims to identify the public health implications of cannabis use needs to consider polysubstance use specifically to evaluate whether cannabis itself is problematic to mental health states, or whether other substances may be the source of the problem.

Prevalence of past 30-day cannabis was variable among mental health diagnoses, with some groups having higher odds of reporting recent use where others had decreased odds. Individuals with neurocognitive disorders were less likely to be past 30-day cannabis users, a finding not surprising considering that this group is largely made up of older persons, persons with lower levels of cognitive performance and greater levels of dependence. Persons with other diagnoses had increased odds of being a past 30-day cannabis user including those with substance-related and addictive disorders, schizophrenia and other psychotic disorders, and mood disorders. Concerns arise as cannabis use has been identified as problematic for some diagnostic

categories by contributing to more adverse social and clinical outcomes (see Section 2.4 and 2.5). Use among certain diagnostic groups may also contribute to an index admission by inducing undesirable psychiatric symptoms, such as acute cannabis-induced psychosis, that may subside after use is ceased (104), and that may not have occurred had cannabis not been used. Differentiating between cannabis-induced mental health states and those with a biological source is important from a treatment perspective, as one may be treated with abstinence of cannabis use, while the one may require additional medication and treatment. The strength of these relationships should be monitored to determine whether the odds of being a past 30-day cannabis user increase for some diagnostic groups following legalization.

Cannabis has been understood to be widely used among persons with PTSD with symptom management being a commonly cited reason for use (105-108). In the inpatient population, individuals with both a past history and those experiencing current trauma had increased odds of being a past 30-day cannabis user. There is an extensive body of literature that has identified a strong relationship between experiences of trauma and cannabis use. In a study that evaluated the relationship between cannabis use and having PTSD, cannabis use remained significantly associated with this diagnosis after controlling for sociodemographic factors and a co-diagnosis of an anxiety or mood disorders (109). Although the present study has not explicitly studied those with PTSD, the relationship between trauma and cannabis use has been confirmed on a large scale, and in a representative sample including those in inpatient psychiatry (109). Once cannabis is legalized, some individuals may seek to self-medicate their PTSD symptoms rather than consult a physician. It is imperative that the public is adequately informed about risks associated with self-medication, including the importance of strain differentiation (110).

Additional characteristics were found to be differentially associated with cannabis use status. Higher rates of cannabis use were found in those with shorter lengths of stay; the odds of being a past 30-day cannabis user decreased as LOS increased. This finding is consistent with other literature that has found cannabis users to have shorter lengths of stay in inpatient psychiatry (62,63). The shorter lengths of stay seen among cannabis users raise an important question of whether cannabis use contributed to the admission into inpatient psychiatry; it may be that once an individual is admitted and stops using cannabis, their symptoms subside leading to a quick discharge. This notion is consistent with other researchers' proposition that that a shorter length of stay commonly seen in cannabis users may be due to substance-induced cognitive distortion and symptom exacerbation, rather than there being an underlying etiological worsening or relapse of a mental illness (62,63). Findings from this study also found that those with a shorter length of stay had increased risk of readmission. Together, these findings point to the importance of substance use behaviours being adequately assessed and addressed among all individuals so that positive clinical outcomes can be supported. Failure to address substance use behaviours during an admission may lead to individuals re-using once they are discharged which may then contribute to an increased risk of readmission if their substance use contributed for the need for an admission in the first place. Overall, differentiating between cannabis-induced psychosis versus mental health conditions with an etiological basis is relevant from a treatment perspective as one may be treatable with cannabis abstinence, while the other may require more complex care.

Lifetime hospitalization history, but not recent hospitalization history, was significantly associated with past 30-day cannabis use. Those with a greater number of lifetime psychiatric hospitalizations had reduced odds of being a current cannabis user. It may be that these

individuals have abstained from cannabis as they have previously found cannabis to worsen their clinical symptoms and to contribute to their need to be admitted. This finding may also be related to greater use being present among those with no previous hospitalizations; individuals experiencing a first episode may have higher rates of cannabis use. Those with reduced levels of medication adherence were also found to have greater odds of being a past 30-day cannabis use. These findings raise the question of whether individuals not adherent to their medication are substituting prescriptions with cannabis, and whether those with no medication are receiving cognitive benefits (including symptom management) from cannabis. Motivators for use among those who are not adherent to their medications and among those with no psychotropic medication should be evaluated to determine whether they are aiming to control their psychiatric symptoms with cannabis, rather than with prescribed medications. Additionally, those with no medication had increased rates of cannabis use. Having no current medications may signify a first admission to a mental health hospital. The degree to which cannabis may have contributed to this first admission must be considered.

Overall, individuals with more complex and severe clinical symptoms had increased odds of reporting past 30-day cannabis use. For instance, those exhibiting positive symptoms had significantly increased odds of reporting past 30-day cannabis use relative to those who did not trigger this scale. Additionally, those presenting with the most severe mania symptoms were two times more likely to be a past 30-day cannabis user relative to those with no mania symptoms. As symptoms severity has been linked to more costly care (111,112), it is important for futuristic studies to determine if, or to what extent, cannabis is contributing to adverse clinical symptoms. Understanding the impact of cannabis use on clinical symptoms can help to determine whether interventions that aim to reduce cannabis use is a means to improve clinical outcomes and

decrease healthcare expenditures. It may also be of interest to track symptom severity for cannabis users following legalization. CBD has been proposed to aid in symptom management for some conditions (48). More research is being produced to further explore this relationship. Thus, being able to choose a cannabis strain in legal storefronts that has reduced THC concentration and elevated CBD levels, including pure concentrated CBD, may help to reduce the severity of undesirable symptoms lead to benefits to, rather than worsening of, mental health symptoms (20,21). Thus, if cannabis users are informed about different cannabis components and choose strains with higher CBD levels, there may be suppression, rather than exacerbation, of psychiatric symptoms.

Summary

Identifying factors associated with cannabis use can be used to understand a myriad of challenges and/or vulnerabilities that a person may face. Although this study cannot determine the degree to which cannabis use itself is a primary reason for a person's mental health condition, understanding these factors may guide future research in teasing out problematic cannabis use from non-problematic use. It may be important to target interventions towards subpopulations that are most likely to be past 30-day cannabis users only if cannabis is seen to contribute to adverse mental health outcomes and higher healthcare costs. For instance, among persons experiencing a first psychotic episode and reporting cannabis users, interventions should include education or counselling to prevent further cannabis use. The current study has identified characteristics of those most likely to be a past 30-day cannabis user among those in inpatient psychiatry. This information can be used to follow individuals longitudinally to explore mental health and clinical outcomes.

Identifying the current characteristics associated with people who report using past 30-day cannabis can also be used to monitor whether these identifiers change over time. As discussed, with impending legislation more people may be inclined to try or use cannabis when it becomes legalized. Results from the first quarter National Cannabis Survey suggest that there may be an increase in the number of people using cannabis following legalization; 6% of respondents who did not use cannabis in the past three months indicated that they would try cannabis or increase their consumption levels once non-medical cannabis is legalized (88). A change in the demographic and clinical characteristics of users can help to depict whether cannabis may be problematic for new users. Following individuals with characteristics outlined in Table 13 through time, can be used to determine whether those most likely to past 30-day cannabis users have more adverse clinical outcomes or need costlier mental health care.

6.3 QUESTION 3: 30-DAY READMISSIONS BY CANNABIS USE STATUS

The risk of being readmitted within 30-days of discharge for individuals in inpatient psychiatry reporting past 30-day cannabis use was evaluated. After controlling for other factors known to increase the risk of readmission within the psychiatric population, past 30-day cannabis users presenting with positive symptoms had increased rates of readmission relative to cannabis users without these symptoms. As those exhibiting positive symptoms were also found to have increased rates of cannabis use, it is imperative that rates of use within this population are reduced so that risk of readmission can be also lessened, and positive clinical outcomes can be supported. Literature suggests that cannabis use may be related directly to the readmission as those experiencing psychotic symptoms who use cannabis at baseline but who stop using after an admission have shown to have improved patient outcomes (113).

The relationship between psychosis and readmissions has been well documented (66,67). To our knowledge, this is the first study to link past 30-day cannabis use among those with positive symptoms specifically to increased risk of readmission in such a large representative sample. Previous studies have typically been conducted in small samples and have been criticized for failing to adjust for confounders (e.g., other substance use) (55). In this study's population, 11.3% of those presenting with positive symptoms who used cannabis were readmitted within 30-days of discharge relative to 7.8% of those with no positive symptoms. Among those with no positive symptoms, nearly equal rates of readmission were found in both the cannabis and non-cannabis use groups (Figure 7). This finding suggests that the risk of readmission among cannabis users is dependent on the presence of positive symptoms. This relationship became even more pronounced when readmissions within one year of discharge were considered (Figure 8). This finding points to the importance of education and intervention programs that aim to reduce cannabis use among those with positive symptoms as continued cannabis use may contribute to exacerbation of positive symptoms thus increasing the need for psychiatric intervention.

Regardless of cannabis use status, similar demographic and clinical factors were found to be associated with readmissions. However, there were fewer predictors of readmissions for past 30-day cannabis users. Some of the key factors associated with readmissions will be discussed to understand how cannabis use may relate to readmissions among the inpatient population. Overall, the factors associated with readmissions for this population were highly associated with psychosis and indicate mental health conditions that are more difficult to effectively treat. The inability for patients to receive the care that they need due to more complex clinical profiles may be a reason for readmission, rather than cannabis itself influencing the readmission.

The literature generally suggests that younger individuals have increased odds of being readmitted (66). However, among past 30-day cannabis users, those 65 years and older did not have significantly different rates of readmission than those 18 to 24 ($p=0.1598$). For non-cannabis users, the risk of readmission significantly decreased with increasing age. This indicates that cannabis may negatively affect cognitive states and treatment progression for older individuals. It is important to monitor patient outcomes for this population, as they may begin to use more once access to cannabis is made easier and social acceptability increases. It is important to assess readmission rates among older populations if they begin to use cannabis more following legalization.

Aggressive behaviour was identified as a risk factor for 30-day readmissions for past 30-day cannabis users only. However, aggressive behaviour was not associated with cannabis use status indicating that past 30-day cannabis users are not more likely to be aggressive than non-cannabis users. This indicates that there is something about aggression that increases the risk of readmissions for past 30-day cannabis users. It may be that those scoring high on the ABS are more difficult to treat due to the refusal of treatment. Thus, these individuals may not be receiving the amount of care that they need before being discharged. If substance use behaviours are not discussed and managed during their stay, they may return to substance use following discharge leading to an earlier readmission. Focusing treatment efforts on reducing aggressive behaviour (for instance, by providing anger management strategies) and substance use behaviours may help to reduce readmission rates among past 30-day cannabis users specifically. This relationship may also be related to the idea that there tends to be two distinct populations of aggressive individuals in inpatient psychiatry; those with dementia and other neurocognitive disorders, and those with psychosis or other conditions. Older individuals are less likely to be

past 30-day cannabis users and are also less likely to be readmitted into inpatient psychiatry as those who need continuing care may be admitted to other facilities (e.g., nursing and long-term care homes). Thus, age as well as diagnosis may be confounding this relationship. This population should be studied longitudinally to determine whether cannabis may be a source of agitation, and if ceasing use helps to decrease aggression levels, and thus readmission risk.

Surprisingly, scoring higher on the CAGE scale, which measures problem with addiction, was protective against a 30-day readmission for both past 30-day cannabis users and non-recent users. Both subgroups had 18% reduced odds of being readmitted within 30-days relative to those who did not score high on this measure. As they both are at equal risk of being readmitted, it may be that cannabis does not differentially affect the risk of readmission for those with problematic substance use. There may be other substances more highly related to a readmission. Problem with addiction not being associated with readmissions may be explained by the idea that those being admitted with SUDs only, with no other secondary or tertiary diagnosis, tend to be higher functioning and thus are less likely to be readmitted (64). Those with concurrent mental health and SUDs, rather than a mental health or SUD alone, however, are at increased risk for future readmissions (64). Despite individuals typically spending a shorter time in hospital, those with concurrent disorders usually have higher health care use due to more frequent readmissions (64). This information suggests that in order to limit the risk of readmission it is imperative that both the mental health and SUD be considered in care planning. Another important consideration is that SUDs did not significantly predict readmissions for either past 30-day cannabis users or non-users. However, this may be explained by the idea that SUDs are often underdiagnosed in the inpatient setting (64). The CAGE scale embedded into the RAI-MH may be a useful tool that captures substance use issues that may not have been diagnosed as an actual mental health

disorder. Individuals who trigger the CAGE scale should be further screened for SUDs and aspects of care planning should consider addressing substance use issues in order to decrease an individual's readmission risk.

Summary

Cannabis use was found to be related to 30-day readmissions for those exhibiting positive symptoms. Reducing cannabis use in this population is crucial to improve patient outcomes and decrease health care costs. Factors associated with increased risk for readmissions in each subgroup can also be used to identify individuals who may be at increased risk of readmissions and can be used to inform care planning so that risk of readmission can be reduced.

6.4 POLICY IMPLICATIONS AND PRACTICE

This research points to the importance of ongoing monitoring and evaluation of cannabis use in the inpatient setting following legalization of non-medical cannabis. Baseline trends and relationships of cannabis use in the inpatient psychiatric population have been identified and need to be continually evaluated to determine whether changes in the legal status of the drug affects those living with and who are at risk of mental health conditions. Following this population longitudinally will help to evaluate whether they have been adequately protected and can be used to identify gaps in policy that need to be addressed. It is important to evaluate whether changes in the patterns and prevalence of cannabis use in the entire Canadian population has any implications for inpatient psychiatry.

Some policy recommendations can be made from this work to date. As previously discussed, cannabis use at younger ages has been associated with adverse psychosocial outcomes. However, as evidenced by high rates of use among youth in this population, youth continue to be significant users of cannabis. This indicates that this population is either not aware

of the risk of cannabis use, or that they do not see these risks as a concern. It is crucial for warning labels that inform about the adverse mental health and social outcomes for youth are included on all cannabis products. Additionally, school curriculums need to reflect changes in the legal status and accessibility of cannabis so that if youth do choose to use, they are informed on cannabis constituents (including the differentiation between THC and CBD), the physiological effects of cannabis, and the known risks of use. This can help to ensure that they adopt safer consumptions habits and can identify adverse physical and psychological reactions that would indicate that use should be ceased.

Literature is beginning to emerge on potential drug interactions between cannabis and prescription medications (17,114). If individuals have the perception that cannabis helps with mental health conditions, and they begin to use cannabis while on other medications, there is need to clarify whether cannabis has either an additive or diminishing effect on the prescribed medications. In order to ensure that individuals are adequately protected and do not experience adverse effects, an open dialogue between patients and physicians must be encouraged. Those taking medications to aid in symptom management, for instance, should be informed about potential interactions and should be encouraged to report adverse effects to their physicians. A central reporting system that tracks these interactions can help clinicians stay informed so that they can warn their patients of safe consumptions patterns, and about whether specific strains have contributed to adverse experiences.

Following legalization, problematic substance use behaviours must be screened for in all populations, not just populations that have been historically known to be greater users of cannabis. For instance, although older populations have tended to have lower rates of cannabis use, they may be inclined to use following legalization. SUDs are commonly underdiagnosed in

older populations (94) which is problematic from a treatment perspective. Substance use behaviours need to be evaluated in all populations and should be integrated into care planning to maximize positive clinical outcomes.

Finally, cannabis use was found to be associated with increased risk of readmission for those with positive symptoms. Labels on cannabis products should include information on the risk of psychosis and should encourage abstinence for those with a known history/heightened risk of psychosis. It is important that those with psychotic disorders and those expressing positive symptoms are informed about the increased risk for adverse psychological experiences so that they use can be ceased and undesirable symptoms can be avoided.

6.5 FUTURE RESEARCH

A number of future areas for research were mentioned throughout the discussion. In general, this study opens the conversation about cannabis use in inpatient psychiatry and has identified avenues where follow-up studies are needed. As this study broadly describes the relationship between cannabis use and mental health outcomes, further analysis should be considered to determine whether mental health outcomes vary by patterns of cannabis use and not just cannabis use in the general sense. For instance, additional consumption behaviours such as the dose of cannabis used, the typical route of administration, the frequency of use, and strain of use are important as the effects of cannabis have been noted to vary by these factors (12). Thus, it may be useful to conduct qualitative research to obtain more information about individual patterns of cannabis use.

A key change from the DSM-IV to DSM-V definition of mental health disorder diagnoses was the separation of bipolar and depressive disorders. Prior to the DSM-V, bipolar and depressive disorders were both captured under the umbrella diagnostic category of mood

disorders. Once more data is collected with this diagnostic distinction, the analyses can be separated to determine whether readmissions are different for bipolar and depressive disorders. Given the findings related to mania symptoms in this study, it may be that cannabis use is more common among individuals with bipolar disorder. There is a need to determine whether such use is detrimental to ongoing recovery.

6.6 LIMITATIONS

Some limitations arise due to the retrospective design of the study and the data collection methods. One key limitation is that information obtained from inpatients on their cannabis use history can sometimes be primarily collected using self-report, although other information sources can be used. As cannabis is currently an illicit substance, individuals may be apprehensive to accurately report on cannabis use (115). This may lead to underreporting of use among individuals in inpatient psychiatry. However, for many patients, data is also collected from the other key informants including family, first responders, and other clinical staff who may be more willing to accurately state the individual's cannabis use status. Use of multiple key informants can help to mitigate the potential of obtaining inaccurate information from patients themselves. Additionally, underreporting suggests that our results will be modest in nature and thus some relationships may not be as strong as they actually are, and other relationships may appear to be non-significant when there is a true relationship.

There are also several limitations that exist due to the retrospective nature of the study. As follow-up questions cannot be asked and the RAI-MH is a pre-constructed assessment tool, we are unable to decipher whether reported cannabis is being used for medical or non-medical purposes. Although this can provide grounds for a future study, individuals using medically prescribed cannabis may not be receiving the intended benefits if it has not been helpful in

disease and symptom management. Another potential limitation is that findings can only be generalized as far as the inpatient psychiatric population and cannot be assumed to reflect the general mental health population. Those with mental health disorders capture a larger population than that of the specific inpatient population. Had information on community mental health clients been available, for instance, the prevalence of past 30-day cannabis use may be expected to increase. With the increasing use of compatible assessment tools, such as the interRAI Community Mental Health, more information about the patterns of cannabis use in the community can be ascertained in future studies.

Finally, a key gap in the literature is understanding the temporal relationship between cannabis use and mental health. Although we were able to establish relationships between cannabis use and aspects of mental health, this study did not allow us to establish a temporal relationship. As data use is collected retrospectively, we are limited in being able to understand whether cannabis use or mental illness came first.

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APPENDIX

APPENDIX A: OPERATIONALIZATION OF VARIABLES

Table 22. Operationalization of dependent variables for logistic regression models

VARIABLE	OPERATIONALIZATION
Past 30-day cannabis use	Binary: • Past 30-day cannabis use • No past 30-day cannabis use
Readmissions	Binary: • 30-day readmission • No 30-day readmission

Table 23. Operationalization of independent variables used in logistic regression models

VARIABLE	OPERATIONALIZATION
Year	Ordinal: • 2006 (ref) • 2007 • 2008 • 2009 • 2010 • 2011 • 2012 • 2013 • 2014 • 2015 • 2016
BLOCK 1: DEMOGRAPHIC FACTORS	
Sex	Nominal: • Male (ref) • Non-male
Age	Ordinal: • <18 • 18-24 (ref) • 25-34 • 35-44 • 45-54 • 55-64 • 65+
Marital status	Nominal: • Never Married (ref) • Married/Partner/Significant Other

	• Widowed/Separated/Divorced
Education level	Ordinal: • Less than high school • High school (ref) • Greater than high school
Indigenous origin	Nominal: Yes/no answered to, "Person's origin is Inuit, Métis or First Nations" • Not Inuit, Métis, or First Nations (ref) • Inuit, Métis, or First Nations
Residential stability	Nominal: Yes/no answered to, "Prior to admission, most recent residence was temporary" • No temporary residence (ref) • Temporary residence
Lived alone	Nominal: • Did not live alone (ref) • Lived alone
Employment status	Nominal: • Employed • Unemployed (ref)
Risk of unemployment/ disrupted education	Yes/no answered to any of the following items: Increase in lateness or absenteeism over the last 6 months Poor productivity or disruptiveness at work/school Expresses intent to quit work/school Persistent unemployment or fluctuating work history over the last 2 years Nominal: • Answered yes to at least one of the above • Did not answer yes to any of the above (ref)
BLOCK 2: SUBSTANCE USE	
Past year substance use	Answered yes to past year use of any of the following substances: Inhalants Hallucinogens Cocaine and Crack Stimulants Opiates Nominal: • Use of any of the above in the past year • No use of any of the above in the past year (ref)
Past 30-day substance use	Answered yes to past 30-day use of any of the following substances: Inhalants

	Hallucinogens Cocaine and Crack Stimulants Opiates <u>Nominal:</u> • Use of any of the above in the past 30-days • No use of any of the above in the past 30-days (ref)
Problematic alcohol use	<u>Nominal:</u> • Consumed 5+ drinks in a single sitting in the past two weeks • Consumed <5 drinks in a single sitting in the past two weeks (ref)
Smoking	<u>Nominal:</u> • Daily smoker or usually a daily smoker of cigarettes or chewing tobacco • Not a daily smoker or user of chewing tobacco (ref)
Misuse of medications	<u>Nominal:</u> Answered yes/no to "Use of medication for a purpose other than intended in the past 3 months" • Did not use medication for purpose other than intended (ref) • Used medication for purpose other than intended
BLOCK 3: CLINICAL VARIABLES	
Mental health diagnosis[8]	<u>Nominal:</u> • Neurocognitive disorders • Substance-related and addictive disorders • Schizophrenia and other psychotic disorders • Mood disorders (including depression) • Anxiety disorders • Personality disorders • Other[9]
Reason for admission	<u>Nominal:</u> Answered yes/no to the following items (each item assessed separately and multiple can be selected): • Threat or danger to self • Threat or danger to others

[8] Considered primary, secondary, and tertiary diagnosis

[9]Includes: neurodevelopmental disorders; mental disorders due to general medical conditions; somatoform disorders; factitious disorders; dissociative disorders; sexual and gender identity disorders; eating disorders; sleep-wake disorders; disruptive, impulse-control and conduct disorders; adjustment disorders; obsessive-compulsive and related disorders; trauma- and stressor-related disorders; elimination disorders; sexual dysfunction; paraphilic disorders; other mental disorders; and medication-induced movement disorders and other adverse effects of medication

	• Inability to care for self due to mental illness • Problem with addiction/dependency • Specific psychiatric symptoms • Involvement with criminal justice system • Other • Forensic assessment
Inpatient status at admission	Nominal: • Application for psychiatric assessment • Voluntary • Informal • Involuntary • Forensic
Past year contact with community mental health	Ordinal: • No contact in the last year (ref) • 31 days or more • 30 days or less
LOS	Ordinal: • 3 to 14 days (ref) • 15 to 30 days • 31 to 60 days • 61 to 90 days • > 90 days
CLINICAL INDICATORS	
BLOCK 4: SAFETY	

Variable		Measures	Operationalization
Harm to others	History of violence	• Violence towards others • Intimidation of others or threatened violence • Violent ideation • History of sexual violence or assault as perpetrator	Answered yes to any of the measures Binary: • No history of violence (ref) • History of violence
	Aggressive Behaviour Scale	• Verbal abuse • Physical abuse • Socially inappropriate/disruptive • Resists care Scores range from 0 to 12 Higher scores related to greater frequency and diversity of aggressive behaviour.	Binary: • Score ≤2 (ref) • Score >2
Self-harm	History of suicide attempt	Categorical: • No suicide attempt history (ref)	

		• History of hurting oneself but not with intent to kill self • Intent of self-injury was to kill oneself	
	History of self-injury/behaviour	<u>Binary:</u> • No suicide attempt or self-injury history (ref) • Some history	
BLOCK 5: SOCIAL LIFE			
Social relationships	Social isolation	• Reports of having no confidant • Participation in social activities of long-standing interest • Withdrawal from activities of interest or long-standing relations • Reduced social interaction • Presence/absence of telephone or email contact with long-standing social relation/family member	<u>Binary:</u> • Having a confidant (ref) • Having no confidant and any of the above
	Relationship dysfunction	• Belief that relationship(s) with immediate family members is disturbed or dysfunctional • Family/close friends report feeling overwhelmed by person's illness • Conflict-laden or severed relationship, including divorce	<u>Binary:</u> • Did not answer yes to any of the measures (ref) • Answered yes to any of the measures
Support person for discharge		• Presence of support person post-discharge • Homeless status • Presence of individual who feels positive about discharge	<u>Binary:</u> • Has support system for discharge (ref) • The individual does not have someone to provide support
Interpersonal conflict		• Belief that relationship(s) with immediate family members is disturbed or dysfunctional • Reports having no confidant • Family/close friends report feeling overwhelmed by person's illness • Is persistently hostile towards or critical of family/friends • Is persistently hostile of others or staff	<u>Binary:</u> • Did not answer yes to any of the 8 items (ref) • Answered yes to at least one of the 8 measures

	• Family/friends are persistently hostile towards or critical of person • Staff reports persistent frustration in dealing with person • Family/friends require unusual amounts of facility staff time	
Traumatic life events	Assesses immediate safety concerns: • Experience traumatic event in the past 7 days including sexual abuse, physical abuse, emotional abuse, criminal victimization; OR • Are fearful of others or currently have concerns for personal safety Reduce the impact of prior traumatic events: • Have experienced: serious accident or physical impairment, death of a close family member or friend, lived in a war zone or area of violent conflict, witness severe accident/disaster/act of terrorism or violence/abuse, victim of crime, victim of sexual assault or abuse, victim of physical assault or abuse, victim of emotional assault or abuse; AND • Describe the event(s) as having evoked an intense sense of horror or fear	<u>Nominal:</u> • No traumatic life events (ref) • Facing immediate safety concerns (i.e., any type of abuse or fear for personal safety) • History of traumatic life events
Criminal activity	• Past year police intervention • Admission from correctional facility	<u>Binary:</u> • No criminal history (ref) • Past year history of violent or nonviolent criminal behaviour in which there was police intervention
BLOCK 6: FINANCIAL HARDSHIP AND AUTONOMY		

Financial hardship	Major loss of income or serious economic hardship due to poverty	Binary: • Never (ref) • Lifetime history
Medication management	Measure of IADLs Assesses ability to manage medication (e.g. remembering to take medications, open bottles, take correct drug dosages, give injections, apply ointments)	Binary: • Manage medication independently (ref) • Some degree of assistance (Supervision, limited assistance, extensive assistance, maximal assistance, total dependence)
Medication adherence	Adherence to prescribed medications 1 month prior to admission	Ordinal: • Always adherent (ref) • Adherent 80% or more of time • Adherent less than 80% of time, including failure to purchase prescribed medication • No medication prescribed • Unknown
Recent psychiatric admissions	Number of recent (last 2 years) psychiatric admissions	Ordinal: • None (ref) • 1 to 2 • 3 or more
Lifetime psychiatric admissions	Number of lifetime psychiatric admissions	Ordinal: • None (ref) • 1 to 3 • 4 to 5 • 6+
Independence (IADL)	• Meal preparation • Ordinary housework • Managing finances • Managing medications • Phone use • Shopping • Transportation	Scores range from 0 to 42 Higher scores indicate lower capacity Ordinal: • 0 to 2 (ref)

		• 3 to5 • 6+
BLOCK 7: HEALTH PROMOTION		
Sleep disturbance	Sleep problems present in the past 3 days including: difficulty falling asleep, restless or non-restful sleep, interrupted sleep (including awakening earlier than desired), or too much sleep	<u>Dichotomized:</u> • No sleep disturbances (ref) • Sleep disturbance
Pain	Frequency and intensity of pain	<u>Ordinal:</u> • No pain or less than daily mild to moderate pain (ref) • Daily mild to moderate pain • Severe, horrible or excruciating pain (regardless of frequency)
BLOCK 9: SYMPTOM SEVERITY**		
Cognitive Performance Scale	• Daily decision making • Short-term memory • Expression (i.e., making self understood) • Self-performance in eating	Scores summed and range from 0 to 6 with higher scores indicating greater impairment <u>Ordinal:</u> • Score 0 to 2 (ref) • Score 3+
Depression Severity Index (DSI)	• Sad, pained facial expression • Negative statements • Self-deprecation • Guilt/shame • Hopelessness	Scores range from 0 to 15 Higher scores indicate more depressive symptoms <u>Ordinal:</u> • Score of 0 to 2 (ref) • Score 3+

Positive Symptom Scale	**PSS Short:** • Hallucinations • Command hallucinations • Delusions • Abnormal thought process	PSS short scores range from 0 to 12 Higher scores indicate higher levels of positive symptoms <u>Ordinal:</u> • Score of 0 to 2 (ref) • Score 3+
Social Withdrawal Scale	• Decreased energy • Flat or blunted affect • Anhedonia • Loss of interest • Lack of motivation • Reduced social interaction	Scores range from 0 to 6 Higher scores indicate greater social withdrawal <u>Ordinal:</u> • No social withdrawal (ref) • Scores of 1 or 2 • Scores of 3 to 5 • Score of 6
Mania Scale	• Inflated self-worth • Hyperarousal • Irritability • Increased sociability/hypersexuality • Pressured speech • Labile affects • Sleep problems due to hypomania	Scores range from 0 to 20 Higher scores indicate more mania symptoms <u>Ordinal:</u> • No symptoms of mania (ref) • Scores of 1 to 3 • Scores of 4 to 8 • Score of 9+
Problem with addiction (CAGE)	• Need to cut down on substance use • Angered by criticisms from others • Guilt about substance use • Drinking/using substances in the morning	Scores range from 0 to 4 Scores of 2+ indicates that there may be a potential problem with substance addiction <u>Ordinal:</u>

		• Scores <2 (ref) • Scores 2+
Anxiety Scale	• Anxious complaints • Fears/phobias • Obsessive thoughts • Compulsive behaviours • Intrusive thoughts/flashbacks • Episodes of panic	Scores range from 0 to 6 Higher scores indicate greater levels of anxiety <u>Ordinal:</u> • Scores ≤2 (ref) • Score >2
** Adapted from (116)		

APPENDIX B: CROSSWALKED DSM-IV AND DSM-V CODES

Table 24. Breakdown of DSM diagnoses from 2014 RAI-MH assessment with DSM-IV codes and 2016 RAI-MH assessment with DSM-V codes

OLD RAI-MH ASSESSMENT	NEW RAI-MH ASSESSMENT
Disorders of childhood/adolescence	Neurodevelopmental disorders
Delirium, dementia and amnestic and other cognitive disorders	Neurocognitive disorders
Mental disorders due to general medical conditions	Not Applicable
Substance-related disorders	Substance-related and addictive disorders
Schizophrenia and other psychotic disorders	Schizophrenia and spectrum and other psychotic disorders
Mood disorders	Bipolar and related disorders
	Depressive disorders
Anxiety disorders	Anxiety disorders
Somatoform disorders	Somatic symptoms and related disorders
Factitious disorders	Not Applicable
Dissociative disorders	Dissociative disorders
Sexual and gender identity disorders	Gender dysphoria
Eating disorders	Feeding and eating disorders
Sleep disorders	Sleep-wake disorders
Impulse-control disorders not classified elsewhere	Disruptive, impulse-control and conduct disorders
Adjustment disorders	Not Applicable
Personality disorders	Personality disorders
New Categories	Obsessive-compulsive and related disorders
	Trauma- and stressor-related disorders
	Sexual dysfunctions
	Paraphilic disorders
	Medication-induced movement disorders and other adverse effects of medication

APPENDIX C: FREQUENCY TABLES FOR POPULATION SAMPLES

Table 25. Number and percentage of inpatients by year

YEAR	FREQUENCY *N (%)*
2006	20827 (13.0)
2007	16911 (10.6)
2008	15303 (9.5)
2009	14666 (9.2)
2010	13915 (8.7)
2011	13588 (8.5)
2012	13387 (8.4)
2013	13266 (8.3)
2014	13204 (8.2)
2015	12580 (7.9)
2016	12685 (7.9)
TOTAL	160322 (100.0)

Table 26. Number and percentage of inpatient in each sex category by year

	SEX	
YEAR	Male *N (%)*	Non-male *N (%)*
2006	10579 (50.8)	10248 (49.2)
2007	8471 (50.1)	8440 (49.9)
2008	7583 (49.6)	7720 (50.5)
2009	7441 (50.7)	7225 (49.3)
2010	7165 (51.5)	6750 (48.5)
2011	7006 (51.6)	6582 (48.4)
2012	6763 (50.5)	6624 (49.5)
2013	6632 (50.0)	6634 (50.0)
2014	6781 (51.4)	6423 (48.6)
2015	6517 (51.8)	6063 (48.2)
2016	6543 (51.6)	6142 (48.4)
TOTAL	81481 (50.8)	76651 (49.2)

Table 27. Number and percentage of inpatients in each diagnostic category by year

	DIAGNOSTIC GROUP						
YEAR	Neurocognitive disorders *N (%)*	Substance-related and addictive disorders *N (%)*	Schizophrenia and other psychotic disorders *N (%)*	Mood disorders *N (%)*	Anxiety disorders *N (%)*	Personality disorders *N (%)*	Other disorders *N (%)*
2006	1631 (7.8)	5451 (26.2)	6823 (32.8)	10510 (50.5)	2414 (11.6)	2024 (9.7)	2716 (13.0)
2007	1368 (8.1)	4610 (27.3)	4683 (27.7)	8812 (52.1)	1931 (11.4)	1436 (8.5)	2085 (12.3)
2008	1307 (8.5)	4121 (26.9)	3991 (26.1)	8212 (53.7)	1939 (12.7)	1331 (8.7)	1822 (11.9)
2009	1245 (8.5)	3994 (27.2)	3875 (26.4)	7723 (52.7)	2050 (14.0)	1245 (8.5)	1835 (12.5)
2010	1217 (8.8)	3902 (28.0)	3536 (25.4)	7525 (54.1)	2014 (14.5)	1121 (8.1)	1786 (12.8)
2011	1208 (8.9)	3838 (28.2)	3477 (25.6)	7303 (53.8)	2095 (15.4)	1136 (8.4)	1803 (13.3)
2012	1140 (8.5)	3648 (27.3)	3412 (25.5)	7192 (53.7)	2169 (16.2)	981 (7.3)	1781 (13.3)
2013	1216 (9.2)	3598 (27.1)	3361 (25.3)	7114 (53.6)	2208 (16.6)	1022 (7.7)	1813 (13.7)
2014	1139 (8.6)	3701 (28.0)	3265 (24.7)	7017 (53.1)	2251 (17.1)	1018 (7.7)	1983 (15.0)
2015	1120 (8.9)	3605 (28.7)	3044 (24.2)	6759 (53.7)	2252 (17.9)	1016 (8.1)	1742 (13.9)
2016	987 (7.8)	3548 (28.0)	3155 (24.9)	6380 (50.3)	1906 (15.0)	1046 (8.3)	2249 (17.7)
TOTAL	13578 (8.5)	44016 (27.5)	42622 (26.6)	84547 (52.7)	23299 (14.5)	13376 (8.3)	21615 (13.5)

Table 28. Number and percentage of inpatients in each age category by year

	AGE						
YEAR	< 18 *N (%)*	18-24 *N (%)*	25-34 *N (%)*	35-44 *N (%)*	45-54 *N (%)*	55-64 *N (%)*	65+ *N (%)*
2006	286 (1.4)	2389 (11.5)	3660 (17.6)	4681 (22.5)	4391 (21.1)	2485 (11.9)	2935 (14.1)
2007	298 (1.8)	1948 (11.5)	2997 (17.7)	3625 (21.4)	3612 (21.4)	2050 (12.1)	2381 (14.1)
2008	314 (2.1)	1899 (12.4)	2606 (17.0)	3008 (16.7)	3210 (21.0)	1893 (12.4)	2373 (15.5)
2009	264 (1.8)	1857 (12.7)	2428 (16.6)	2715 (18.5)	3190 (21.8)	1915 (13.1)	2297 (15.7)
2010	255 (1.8)	1967 (14.1)	2237 (16.1)	2430 (17.5)	2928 (21.0)	1908 (13.7)	2190 (15.7)
2011	296 (2.2)	2072 (15.3)	2223 (16.4)	2299 (16.9)	2832 (20.8)	1758 (12.9)	2108 (15.5)
2012	366 (2.7)	2165 (16.2)	2172 (16.2)	2124 (15.9)	2650 (19.8)	1795 (13.4)	2115 (15.8)
2013	341 (2.6)	2360 (17.8)	2097 (15.8)	2125 (16.)	2395 (18.1)	1758 (13.3)	2190 (16.5)
2014	362 (2.7)	2493 (18.9)	2146 (16.3)	1946 (14.7)	2351 (17.8)	1756 (13.3)	2150 (16.3)
2015	313 (2.5)	2324 (18.5)	2155 (17.1)	1860 (14.8)	2100 (16.7)	1706 (13.6)	2122 (16.9)
2016	357 (2.8)	2599 (20.5)	2183 (17.2)	1824 (14.4)	2107 (16.6)	1612 (12.7)	2003 (15.8)
TOTAL	3452 (2.5)	24073 (15.0)	26904 (16.8)	28637 (17.9)	31766 (19.8)	20636 (12.9)	24864 (15.5)