# *CANreduce*: Findings from a Randomized Controlled Trial Testing a Novel Online Evidence-Based Intervention for Individuals with Heavy Cannabis Use

by

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**Abstract**

As cannabis use increases, so does the need for treatment. There is a current lack of evidence-based treatment programs for heavy cannabis use, and challenges around recruitment and retention for extant programs are common. The goals of this dissertation were to develop an online treatment program for adults with heavy cannabis use and examine the efficacy of a therapist-guided introduction. Study 1 ($N$ = 152) was a 3-arm RCT examining the efficacy of *CANreduce*, a 6-week, self-guided program using principles of cognitive behaviour therapy and motivational interviewing. Participants were randomized into a motivational enhancement therapist guided (MET) introduction, a nontherapist (non-MET) research assistant guided introduction, or waitlist control. Assessment data were collected at baseline, end of treatment (6 weeks) and follow up (10 weeks). All participants reduced their cannabis consumption frequency, quantity, and cannabis-related problems at 6 and 10 weeks. Participants in the MET-therapist condition showed significantly greater reductions in cannabis quantity compared to the control. Participants in the non-MET research assistant condition showed significantly greater reductions in cannabis problems compared to control. There was no significant effect of condition on cannabis frequency, anxiety, depression or quality of life. Study 2 examined the challenges in recruiting and engaging individuals in the *CANreduce* program. Despite following the core elements of published treatment retention protocols, significant recruitment challenges were experienced. Of the 801 people that completed screeners, 31.3% ($n$ = 251) were eligible for the program. Of those eligible, 54.3% ($n$ = 51) assigned to the MET therapist condition and 45.7% ($n$ = 43) assigned to the non-MET research assistant condition initiated treatment. Treatment initiation predictors included higher cannabis use problems score, lower family history density, increased alcohol use frequency, and more positive attitudes towards treatment. Treatment engagement (i.e., percentage of program completed) predictors included increased social motives for cannabis use and a more positive attitude towards treatment. Overall, this dissertation provided initial evidence for the Canadian *CANreduce* program, benefits of the MET therapist guided introduction, as well as provided insight into the difficulties recruiting and engaging individuals with heavy cannabis use in online treatment.

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## CONTRIBUTIONS OF AUTHORS

### Study 1

In collaboration with my supervisor, Dr. Keough, I designed the research question, translated, adapted and created treatment content, obtained ethics approval from the University of Manitoba and York University, recruited participants, conducted data cleaning and statistical analyses and submitted the manuscript for publication. In collaboration with coauthor Drs. Wegner and Schaub, I programmed the *CANreduce* website, including questionnaire batteries, treatment content, and diaries. With additional help from my secondary supervisor, Dr. Harold Wallbridge, Dr. Keough and I created content, trained, and supervised a team of 10 therapists and 6 research assistants for the guided introductions. I secured funding from the University of Manitoba (University of Manitoba Graduate Fellowship, James Gordon Fletcher Graduate Research Award in Arts), the government of Manitoba **(**Liquor, Gaming, and Cannabis Authority of Manitoba Scholarship, and a Vanier Canada Graduate Scholarship (Social Science and Humanities [SSHRC]). Coauthor Mr. Carusone managed all study-related processes for participants and study personnel. Coauthors Mr. Carusone and Drs. Wardell, Schaub, Wenger, Wallbridge, Edgerton, Kruk, Mackenzie, and Keough consulted on program and study conceptualization and provided extensive feedback on the manuscript. The final manuscript represents a substantial combined effort from all authors.

### Study 2

In collaboration with my supervisor, Dr. Keough, and coauthor Dr. Mackenzie, I designed the research question. In collaboration with my supervisor, Dr. Keough, I conducted data cleaning and statistical analyses, wrote and submitted the manuscript for publication. I secured funding from the University of Manitoba (University of Manitoba Graduate Fellowship, James Gordon Fletcher Graduate Research Award in Arts), the government of Manitoba **(**Liquor, Gaming, and Cannabis Authority of Manitoba Scholarship, and a Vanier Canada Graduate Scholarship (Social Science and Humanities [SSHRC]). Coauthors Mr. Carusone and Drs. Schaub, Wenger, Wallbridge, Edgerton, Kruk, Mackenzie, and Keough provided extensive feedback on the manuscript. The final manuscript represents a substantial combined effort from all authors.

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# CHAPTER 1
# GENERAL INTRODUCTION

## Scope

Previous to legalization of cannabis in October of 2018, cannabis was listed as the most commonly used illicit substance in Canada (Government of Canada, 2017), with over half of all Canadians having used cannabis at least once in their lifetime (Health Canada, 2017). In the time since legalization, cannabis has continued to be a highly used psychoactive substance among Canadians, with approximately 5.2 million or 17% of Canadians over age 15 reporting using cannabis in the previous 3 months (Statistics Canada, 2019). While many individuals can use cannabis recreationally and without major risks and consequences (Degenhardt & Hall, 2001), some people use cannabis in a manner that puts them at higher risk of cannabis related risks and harms (Windle et al., 2019). Cannabis use is best conceptualized as a spectrum of use (Health Officers Council of British Columbia, 2005), ranging from abstinence and low-risk use, to risky and problematic use, to Cannabis Use Disorder (CUD). Heavy cannabis use, broadly defined as the use of cannabis in frequent, chronic, or high quantity proportions, is characteristic of individuals who use cannabis towards the risky, problematic, and CUD-level severity side of the spectrum. Heavy cannabis use can substantially increase risk for associated harms compared to casual cannabis users (Calabria et al., 2010). These cannabis-related risks and harms include, but are not limited to, negative physical effects of cannabis (Baggio et al., 2014; Tetrault et al., 2007), alterations to cognition and perception (Hartman & Huestis, 2013; National Academics of Sciences, Engineering, and Medicine, 2017), worsened psychiatric comorbidities (e.g., depression, anxiety, etc.; Arendt & Munk- Jørgensen, 2004; Campeny et al., 2020; Fergusson et al., 2003; Khan et al., 2013; McLaren et al., 2010; Moore et al., 2007; Stefanis et al., 2004), interpersonal or social problems (American Psychiatric Association [APA], 2022; Campeny et al., 2020; Copeland et al., 2001; Leos-Toro et al., 2017), and financial difficulties (Copeland et al., 2001).

There are a variety of treatment programs aimed at reducing cannabis consumption and mitigating the above-mentioned risks and harms associated with heavy cannabis use. While there is limited research on the efficacy of pharmacotherapies, psychosocial approaches have been studied extensively (Gates et al., 2016; Jutras-Aswad et al., 2019). Indeed, literature consistently suggests that cognitive behavioural therapy (CBT) and motivational enhancement therapy (MET) are among the most efficacious online and in-person treatments for cannabis use, particularly when

they are combined (Connor et al., 2024; Gates et al., 2016; Hoch et al., 2014; Rooke et al., 2013; Sabioni & Le Foll, 2018). Effect sizes of combined CBT and MET programs range from small-to-large, with most falling in the moderate range (Gates et al., 2016; Hoch et al., 2014). McHugh et al. (2010) found that treatment for cannabis use disorder had larger treatment effect sizes compared to other substance use treatments (e.g., cocaine, opioids). While these treatment programs have some associated problems, such as lack of sustained change at longterm follow up (Gates et al., 2016; Hoch et al., 2014) and significant treatment noncompletion or dropout rates (Rooke et al., 2013; Tossman et al., 2011; Vendetti et al., 2002), they provide promising evidence of effectively reducing cannabis use and related risks and harms using psychotherapeutic approaches.

Despite the recognized benefits of CBT and MET treatment programs, only a small subset of cannabis users seek treatment (Degenhardt et al., 2001; Fischer et al., 2016; Khan et al., 2013; Wu et al., 2017). Research from the United States suggests that 7.2% of individuals with 12-month CUD prevalence and 13.7% of individuals with lifetime CUD prevalence received any type of service for cannabis problems (Hasin et al., 2016). As a Canadian comparison, an estimated 20-25% of the general adult population in Ontario meeting criteria for CUD was registered in Ontario's publicly funded treatment system (Fischer et al., 2016). Further, cannabis treatment accounted for 35.2% of substance-related treatment services sought in Ontario (Canadian Centre on Substance Use and Addiction, 2018).

While some studies demonstrate trends of stable (Drug and Alcohol Treatment Information System, 2013, 2016) or decreased (Imtiaz et al., 2018) rates of individuals seeking treatment for cannabis use over recent years, Jutras-Aswad et al. (2019) suggest this may be due to programs reaching treatment capacity rather than a stagnant demand for treatment. Indeed, researchers suggest that individuals with higher levels of cannabis use problems are seeking treatment, as the proportion of daily cannabis use of individuals presenting for treatment has increased (Imtiaz et al., 2018). This is to say that while some individuals with a greater magnitude of risks and harms of heavy cannabis use may be trying to access treatment, many of the individuals with lower-intensity cannabis use are not using treatment resources despite potentially benefiting from treatment (Foster et al., 2018). Indeed, Hasin et al. (2016) found service utilization rates for cannabis use problems in the United States varied according to severity of CUD. Differences were found for service utilization for both 12-month (4.1% mild, 6.0% moderate, 15.7% severe) and lifetime (7.3% mild, 11.7% moderate, 24.3% severe) prevalence of CUD. Given that non-CUD

regular cannabis users also experience psychosocial impairment and may still benefit from treatment (Foster et al., 2018), but are not often reported in treatment-seeking statistics, cannabis use treatment usage may be particularly low in the broader scope of the cannabis-using population.

In addition to the reduced access to cannabis use treatment, research also lists a significant number of barriers to treatment access for individuals who use cannabis. Research on perceived barriers to cannabis treatment include perceptions that treatment for cannabis is not necessary, minimization of cannabis use risks, negative beliefs about treatment, wanting to make changes on their own, worries of stigmatization or labelling as a drug user, and monetary costs of treatment, among other reasons (Ellingstad et al., 2006; Gates et al., 2012; Mian et al., 2024). Indeed, 40.8% of individuals who reported using cannabis within the past year believed there was a large chance of fixing their cannabis addiction on their own without treatment, compared to 19.3% of individuals who had used cannabis but not in the past year (Cunningham, 2020). Further, only 14.2% of individuals who had never used cannabis reported believing individuals with cannabis addiction could fix their addiction on their own without treatment (Cunningham, 2020). Given that individuals experiencing heavy cannabis use without reaching CUD threshold may not experience the same magnitude of cannabis-related risks and harms (e.g., psychiatric comorbidities, cannabis dependence and withdrawal), they may more likely to believe formal cannabis treatment is not necessary and want to work on reducing their cannabis use independently. Hence, the availability of free, online, self-guided treatment programs for heavy cannabis use may fill a significant gap that currently exists in the realm of cannabis use treatments in Canada.

The goal of the current RCT was to examine the efficacy of an evidence-based online treatment program for heavy cannabis use using a Canadian adaptation of the Swiss self-help treatment program, *CANreduce*. While there are some pre-existing heavy cannabis use treatment programs available, there is still a great need to find cost-effective, easily accessible treatment options in Canada, particularly for individuals with lower-intensity cannabis use than what would normally be captured by extant CUD treatment programs. Additionally, given individuals living in Canadian rural settings may consume cannabis at similar (Pirie & Simmons, 2014) or increased (Cooke et al., 2020) rates compared to urbal settings, but face significantly more barriers to treatment (e.g., lack of available treatment, geographic barriers, stigma; Oser et al., 2011; Pullen & Oser, 2014), development of evidence-based online treatments is crucial. Therefore, Study 1 of this dissertation aimed to demonstrate the efficacy of *CANreduce,* an

online heavy cannabis use treatment program using components of both CBT and MET among individuals with heavy cannabis use. Study 1 compared the efficacy of the self-guided CBT treatment program with therapist-guided MET introduction (hereinafter referred to as MET-therapist condition), the self-guided CBT treatment program with research assistant non-MET introduction (hereinafter referred to non-MET research assistant condition), and a waitlist control. Study 2 examined the practicality of a randomized controlled trial for online heavy cannabis use treatment and the predictors of treatment initiation and engagement in the Canadian *CANreduce* program.

## Literature Review

### *Brief Cannabis Overview*

Cannabis is a substance commonly used for medicinal, traditional, and recreational purposes. Cannabis is the generic term which encompasses three subspecies of plants (cannabis sativa, cannabis indica and cannabis ruderalis plants), each which have their own array of properties (World Health Organization [WHO], 2010). An important feature of cannabis is the wide variety cannabinoids, or chemical compounds, which act on cannabinoid receptors in the brain (WHO, 2010). Two well distinguished cannabinoids are (1) delta-9-tetrahydrocannabinol (THC), which is responsible for the psychoactive features of cannabis (Gaoni & Mechoulam, 1971) and (2) cannabidiol (CBD), which is responsible for nonpsychoactive features of cannabis (Mechoulam & Hanuš, 2002). Different strains of cannabis contain different combinations of cannabinoids. As an example, cannabis sativa plants generally have a higher concentration of THC and lower concentration of CBD compared to Cannabis indica and ruderalis plants (McPartland, 2017; WHO, 2010).

Cannabis can be prepared in a variety of ways, with the most common preparations being marijuana, hashish and hash oil (WHO, 2016). Depending on the preparation of cannabis, the product can be smoked, vaporized, and consumed through food or drink (WHO, 2016). Short term effects of cannabis can include positive effects like feelings of euphoria or relaxation (WHO, n.d.; WHO, 2016) as well as negative effects like anxiety (Crippa et al., 2009), impaired cognition (Broyd et al., 2016) and acute psychosis (D'Souza et al., 2016). However, short term effects will vary depending on dose, administration route, setting and mindset of the user (Brands et al, 1998).

### *Risks and Benefits of Cannabis Use*

To date, there has been a significant amount of research on the risks and benefits of cannabis, both in terms of short-term and longterm effects (WHO, n.d; WHO, 2016). On one hand, cannabis is postulated to be beneficial for a multitude of reasons (Borgelt et al., 2013). Some individuals who use cannabis postulate that cannabis helps provide relief from symptoms of some neurological disorders (e.g., muscle spasms), nausea, chronic pain, stress/anxiety, and insomnia (Borgelt et al., 2013; Koppel et al., 2014; Vickery & Finch, 2020; Webb & Webb, 2014). To illustrate, cannabis products are often prescribed to cancer patients as an antiemetic that also helps stimulate appetite and reduce neuropathic pain, while at the same time carrying a lower risk than other available drugs, such as opiates (Abrams & Guzman, 2015). Further, individuals may also use cannabis for non-medical related benefits. Some individuals report that cannabis use increases in concentration on a task and improves clarity (Sexton et al., 2019). Individuals may also use cannabis for social reasons, such as to fit in with peers, feel more socially accepted, or to better enjoy activities (Lee et al., 2007).

Despite the above-mentioned perceived benefits, cannabis use also has a considerable number of associated risks and harms (Windle et al., 2019). These include short-term deficits in learning, memory, attention, motor skills, and reaction time (Hartman & Huestis, 2013; Kroon et al., 2021; National Academics of Sciences, Engineering, and Medicine, 2017), increase apathy/lack of motivation (Pacheco-Colón et al., 2018; Petrucci et al., 2020), negative emotional reactions (Ashton, 2001), depressive symptoms (Campeny et al., 2020; Fergusson et al, 2005; Rey et al., 2002), respiratory problems (National Academics of Sciences, Engineering, and Medicine, 2017; Tetrault et al., 2007), as well as development and exacerbation of psychotic symptoms (Campeny et al., 2020; Fergusson et al., 2003; McLaren et al., 2010; Moore et al., 2007; Stefanis et al., 2004). Further, acute cannabis consumption is associated with increased risk of motor vehicle collisions, as well as fatal motor vehicle collisions (Asbridge et al., 2012; Campeny et al., 2020). Cannabis use during pregnancy can also carry significant risks, such as low birth weight, preterm labour, small for gestational age, and admission to neonatal intensive care units (Gesterling & Bradford, 2021; Hayatbakhsh et al., 2011). Cannabis users may also develop dependence and withdrawal symptoms with regular cannabis use, or develop disordered-level use consistent with Cannabis Use Disorder (APA, 2022).

Research suggests that the risks and perceived benefits of cannabis use vary depending on cannabis specifics, such as method of consumption and both quantity and frequency of

consumption. First, method of consumption affects associated risks and benefits. A study by Monte et al. (2019) examined cannabis-related emergency room visits in the United States. Researchers found that emergency room visits related to inhaled cannabis were more likely to be for cannabinoid hyperemesis syndrome, visits related to edible cannabis were more likely due to acute psychiatric symptoms, intoxication and cardiovascular symptoms (Monte et al., 2019). Second, quantity and frequency of cannabis consumption significantly impacts risks and benefits of cannabis use. Not only are chronic cannabis users exposed to the regular potential risks and benefits more frequently and over a longer period of time, but daily heavy cannabis users are at greater risk for adverse health outcomes, like fatal motor vehicle accidents, respiratory problems, and brain cancer (Calabria et al., 2010). Further, Zeisser and colleagues (2011) found that individuals who consumed cannabis daily and consumed more than one joint per day were at the greatest risk for problems.

In summary, there are myriad associated risks to cannabis use that are largely dependent on factors related to cannabis consumption. Based on this available literature, a set of low-risk guidelines for cannabis use has been developed (Fischer et al., 2017). These low-risk guidelines include a series of 10 harm reduction suggestions including safe practices for using cannabis (e.g., method of consumption, choosing cannabis with lower-risk properties), avoidance of risky use (e.g., avoiding operating vehicles, not using cannabis while pregnant), and avoidance of harms (e.g., not using cannabis to avoid related harms, not using cannabis earlier in life; Fischer et al., 2017).

### *Cannabis Use Statistics*

Cannabis is the most widely used illicit psychoactive substance worldwide (United Nations Office on Drugs and Crime [UNODC], 2015; WHO, 2010). Dried cannabis (flower/leaf) is the most commonly used cannabis product (Goodman et al., 2020), with approximately 84.2% of cannabis users reporting having used it (Rotermann, 2019). Estimated annual cannabis use rates range from approximately 2.5% - 3.9% of the world population, equating to approximately 147 million to 192 million individuals (UNODC, 2015; UNODC, 2018; WHO, n.d.). When examining prevalence of cannabis use across the world, North America shows some of the highest rates alongside Western Central Africa and Oceania (UNODC, 2015).

In Canada, approximately half of all Canadians over the age of 15 report having tried it in their lifetime (Health Canada, 2017). Recent survey of Canadians suggests cannabis is the

second most commonly used substance in the past year (21%), second only to alcohol (74%; Statistics Canada, 2019). Further, 17% of Canadians aged 15 or older reported cannabis use in the past 3 months, 40% of whom report daily cannabis use (Statistics Canada, 2019). Young adults tend to have the highest rates of cannabis use (Callaghan et al., 2019; Sandhu et al., 2019). Statistics Canada (2018) estimates that individuals aged 25-34 years had the highest cannabis use (26%), closely followed by those aged 15-24 (23%), with lower rates of use for those aged 35-44 (16%) and 45 years and older (7%). Further, males tend to have significantly higher rates of cannabis use than females (Callaghan et al., 2019), with Canadian estimates of 29% of males and 21% of females reporting past 12-month use (Government of Canada, 2019). Together, young males tend to be disproportionately represented in the heaviest using subgroups of cannabis users (Callaghan et al., 2019; Rotermann, 2019).

In October of 2018, Canada became the second country to federally legalize nonmedical cannabis use for adults (Cox, 2018). Previous to October 2018, only prescribed cannabis for medical purposes was legal, due to legislation passed in 2001 (Fischer et al., 2015). In data collected before the October 2018 legalization, approximately one in five Canadians sampled by Sandhu et al. (2019) reported that they intended to try or would increase their cannabis use following legalization. Some research studies report that actual cannabis consumption has significantly increased after legalization (Government of Canada, 2019; Rotermann, 2019; Rotermann, 2020), whereas others do not (Leyton, 2019; Statistics Canada, 2019). Some reports suggest that only certain subgroups of the population, such as young males, have increased their cannabis use since legalization (Statistics Canada, 2019). Evidence from research studies in the United States demonstrate that recreational cannabis legalization is associated with higher perceived rates of cannabis use by peers (Koval et al., 2019), and decreased perceived risk of harmfulness (Budney & Borodovsky, 2017; Johnston et al., 2017), which may contribute to higher rates of cannabis use. Unsurprisingly, since legalization, more cannabis users have reported obtaining cannabis from legal sources (53%) compared to before legalization (23%), and have reported sourcing cannabis from illegal sources at a reduced rate (42%, down from 52% before legalization; Statistics Canada, 2019).

### *Cannabis Use Disorder*

Similar to other addictive behaviours (e.g., alcohol misuse, illicit drug use, gambling), cannabis use is best conceptualized as a spectrum of use (Health Officers Council of British

Columbia, 2005). Cannabis use has been conceptualized as ranging from abstinence and low-risk use, to risky and problematic use, to cannabis addiction. Some individuals can use cannabis recreationally, without experiencing cannabis dependency, withdrawal, or presence of other cannabis-related problems. Indeed, research demonstrates that two-thirds of adults who reported using cannabis five or more times in the past year did not report adverse effects of their use (Degenhardt & Hall, 2001).

Despite the vast use of cannabis among Canadians, a small subset of the population tends to use cannabis frequency and in larger quantities (Callaghan et al., 2019; Statistics Canada, 2018). It is estimated that the top 10% of cannabis consumers (i.e., quantity of cannabis consumed) accounted for approximately two-thirds of all cannabis use across Canada (Callaghan et al., 2019). These heavy cannabis users may be more at risk for more risky cannabis use and more cannabis related harms (Calabria et al., 2010; Zeisser et al., 2011). Hall and Pacula (2003) estimate that one in ten individuals who have ever used cannabis will become dependent[1], but that the risk of dependency sharply increases with frequency, with one in two daily cannabis users likely to become dependent.

On the more severe end of the cannabis use spectrum falls the cannabis disorders and dependence. The Diagnostic and Statistical Manual – Fifth edition, text revision (DSM-5tr), a common diagnostic tool for clinicians, lists Cannabis Use Disorder (CUD) as a diagnostic condition (APA, 2022). To be diagnosed with CUD, the cannabis user must show problematic cannabis use leading to experiencing clinically significant impairment or distress while experiencing at least two of the nine listed symptoms in the past 12-month period, which include symptoms such as unsuccessful efforts to reduce use, craving for cannabis, impairment in roles, tolerance or withdrawal (APA, 2022).

Endorsing 2-3 of the listed symptoms characterized as mild, 4-5 symptoms as moderate, and 6 or more as severe (APA, 2022; Patel & Marwaha, 2019). Other diagnostic tools also recognize disordered levels of cannabis use as a diagnosable disorder, such as harmful use of cannabis and cannabis dependence in the International Classification of Diseases – 11$^{th}$ edition (ICD-11; WHO, 2020). However, some literature lists marked divergence in classifications of CUD

[1] Older literature based on the DSM-IV uses the terms cannabis "abuse" and "dependence". Changes in the DSM-5 included combining abuse and dependence into one more encompassing CUD. To properly represent literature, the original terms used in publication were used in this section.

between the ICD-11 and DSM-5 (Degenhardt et al., 2019; Lago et al., 2016). Research by Lago et al. (2016) found that while the ICD-10 (WHO, 1993), ICD-11, and DSM-IV (APA, 2000) showed high agreeableness for CUD diagnoses, the DSM-5 did not. Indeed, the DSM-5 identified more cases of lower severity, and even when the diagnosis was restricted to only individuals meeting criteria for moderate to severe use disorders, the DSM-5 still defined twice as many individuals as having a CUD (Lago et al., 2016). This may be due in part to the shift in the DSM-5 to include both cannabis dependence and cannabis abuse under the same general category of CUD (Lago et al., 2016). Other researchers purport that the lower correspondence between the DSM-IV and DSM-5 for CUD may reflect a difference in criteria, where withdrawal was not listed in the DSM-IV cannabis abuse criteria, but is listed in the DSM-5 CUD criteria (Compton et al., 2013). Regardless of reason, CUD as diagnosed by the DSM-5 seems to include a broader range of cannabis users. However, this may beneficial, as a broader definition of CUD may be better able to capture individuals with moderate risk for CUD.

As previously mentioned, the majority of individuals who use cannabis do not develop cannabis use problems or CUD. Indeed, recent studies suggest that only 27% of individuals who use cannabis in their lifetime transition to CUD (Feingold et al., 2020). Global estimates of CUD prevalence suggest approximately 0.2% of the general population was diagnosed with CUD in 2010 (Degenhardt et al., 2017). Given that North America has a significantly higher proportion of the population which uses cannabis (UNODC, 2015), prevalence rates of CUD are also higher. Using the DSM-5 as the diagnostic reference, American studies report that CUD 12-month prevalence and lifetime CUD prevalence are 2.5% and 6.3%, respectively (Hasin et al., 2016). In comparison, assessment of CUD rates in Canada have been less routine (Jutras-Aswad et al., 2019). Older estimates regarding 12-month prevalence of CUD (previously referred to as cannabis use and dependence in the DSM-IV) was 1.3%, and the lifetime prevalence was 6.8% (Pearson et al., 2013).

Some individuals who use cannabis may be at higher risk of developing CUD based on personal, environmental, biological, and social factors. Rates of CUD are said to be higher among men, Native American individuals, Black individuals, unmarried individuals, individuals with low incomes, and young adults aged 18-24 years of age (Hasin et al., 2016; Kerridge et al., 2018; Redonnet et al., 2012). Further, individuals who experience three or more childhood adverse events have a higher probability of progressing from cannabis use to CUD (Feingold et

al., 2020). Age of onset also increases risk of CUD, where younger age of first cannabis consumption increases risk of developing CUD (Feingold et al., 2020; Winters & Lee, 2008). Gender differences have also been found for an individual's experience with CUD. Research by Khan et al (2013) demonstrated that men with CUD met more criteria for cannabis abuse, had longer episodes of CUD, used higher quantities of cannabis, and were older at time of remission, and women experienced accelerated progression from first cannabis use to CUD.

CUD also commonly occurs with a host of other mental health issues, such as other addictive behaviours and psychopathologies. Indeed, research suggests that CUD is highly comorbid with other substance use disorders (Degenhardt et al., 2001; Hasin & Walsh, 2020). To illustrate, 50-70% of individuals who use cannabis report regular tobacco use, in comparison to 20% of noncannabis using individuals (Degenhardt et al., 2001). Beyond additional substance use problems, research by Agosti et al. (2002) found that 90% of study respondents with cannabis dependence also had a lifetime mental disorder. Common additional psychopathologies to CUD are posttraumatic stress disorder, antisocial personality disorder, borderline personality disorder, and schizotypal personality disorder (Kerridge et al., 2018). Research also demonstrated that individuals who use cannabis have significantly higher levels of depression compared with users of other drugs (Arendt & Munk- Jørgensen, 2004). There may be gender differences associated with CUD comorbidities. Khan et al. (2013) demonstrated a gender difference in CUD comorbidities, where men were more likely to be diagnosed with any psychiatric disorder, any substance use disorder and antisocial personality disorder, and women were more likely to be diagnosed with mood and anxiety disorders. Some research suggests depression is associated with a sixfold increase in rate of CUD (Grant, 1995). Further, research suggests that cannabis use disorder, daily cannabis use, and nondaily cannabis use is associated with higher prevalence of past-year suicidal ideation, plan, and attempt, with or without depression, in both sexes, but significantly more in women (Han et al., 2021).

In summary, many Canadians are dealing with heavy cannabis use, ranging from problematic and risky use to patterns of use meeting CUD criteria. Given the common co-occurrence of other substance and mental health issues, their treatment needs may be complex, and may require multiple facets of their current functioning to be examined and addressed (Hayley et al., 2017).

**Treatment Modalities**

**Cognitive behavioural therapy (CBT).** Cognitive behavioural therapy (CBT) is a treatment approach that aims to target maladaptive behavioural patterns leading to heavy cannabis use, while addressing both motivational and cognitive barriers to change (McHugh et al., 2010). CBT also focuses on teaching the individual skills relevant to reducing or quitting cannabis use, as well as skills in managing or avoiding other problems that may interfere with good outcomes (Budney et al., 2007). As part of CBT, individuals are asked to reflect on the thoughts, feelings, behaviours or situations that precipitate cannabis use, and then are encouraged to identify and practice alternative actions. Techniques used in CBT include self-monitoring, cost-benefit analyses, role-playing, modelling, and cognitive restructuring (Sherman & McRae-Clark, 2016). As an example, if an individual uses cannabis to cope with negative feelings, CBT could be instrumental in helping the individual acknowledge that negative feelings are a precipitant to cannabis use, and helping them to replace coping with cannabis with other more adaptive coping skills.

CBT is one of the most widely used forms of psychosocial treatment for substance use broadly (McHugh et al., 2010), and has been shown to be particularly efficacious in the treatment of heavy cannabis use (Copeland et al., 2001; Halicka et al., 2024; Sabioni & Le Foll, 2018). Indeed, McHugh and colleagues (2010) conducted a meta-analysis on the efficacy of CBT for drug use and dependence, finding large treatment effect sizes for cannabis. Halicka and colleagues (2024) also found through a systematic review that CBT increased abstinence from cannabis. CBT has also been shown to be effective in in-person (Copeland et al., 2001), telephone (Gates et al., 2012) and online (Rooke et al., 2013) intervention formats for heavy cannabis use. However, CBT frameworks are rarely used as the sole intervention. While CBT can aid the individual to develop skills to reduce cannabis use and manage problems that may interfere with efforts to reduce cannabis use (Budney et al., 2007), it can be difficult for the individual with heavy cannabis use to be engaged in treatment (e.g., lack of motivation, ambivalent about change). Additionally, sole CBT treatment for cannabis use can reduce treatment completion rates (Halicka et al., 2024). CBT is most commonly combined with other frameworks, such as motivation interviewing/motivational enhancement therapy (MI/MET) and contingency management (CM) to help increase initiation and engagement in treatment (Guydish et al., 2010).

**Motivational Enhancement Therapy (MET).** The goal of both motivational interviewing (MI) and motivational enhancement therapy (MET) is to decrease ambivalence and increase motivation for individual change (Miller & Rollnick, 2023). Guydish et al. (2010) delineates MI from MET by describing MI as a broader therapeutic approach, whereas MET is a more specific focus on personalized version of individualized feedback, change plans, and progress. Miller and Rollnick (2012) discussed the five main principles of MI as: (1) considering the client's problems and interests; (2) identifying ambivalence in the client and help motivate them to change; (3) emphasizing that MI is not a specific technique, but instead a way of communicating with the client; (4) ensuring that the client is internally motivated and genuinely wants to make change; and (5) acknowledging the importance of the client's values as a main reason why MI is successful. Given that individuals who have heavy cannabis use may be more likely to hold views that treatment is unnecessary (Gates et al., 2012), MI may be particularly useful in discussing ambivalence to change.

Broadly, research supports that MI/MET is an effective intervention in the treatment of individuals with substance use (Carroll et al., 2001; Jensen et al., 2011). MI/MET has also been demonstrated to be a significant factor in treatments for heavy cannabis use (Calomarde-Gómez et al., 2021; McCambridge et al., 2011; Walker, 2011). A recent systematic review found that MI treatment for cannabis use demonstrated efficacy in achieving abstinence, reducing frequency and quantity of use, and fewer joints per day compared to control group (Calomarde-Gómez et al., 2021). Other research suggests that integration of MI/MET, particularly at the beginning stages of cannabis use treatment is of high importance. Research by Vendetti et al. (2002) demonstrated that individuals who did not perceive themselves as cannabis dependent, despite having similar patterns of use and cannabis-related problems, were nearly four times as likely to be pretreatment dropouts. By using the tenets of MI/MET at the beginning stages of treatment, participants may be more likely to be more committed to completing treatment. Indeed, efforts to engage with individuals during the initial sessions may help individuals engage in treatment (Weisner et al., 2001).

**Multi-Modality.** A large majority of the literature on cannabis use treatments purports that the best outcomes of treatment come from using multi-modality treatments, such as CBT and MI/MET (Budney et al., 2006; Budney et al., 2007; Connor et al., 2024; Gates et al., 2016; Kadden et al., 2007; Sabioni & Le Foll, 2018; Walther et al., 2016). Indeed, Walther et al.,

(2016) suggests that CBT combined with other techniques has been found to have a moderate-to-large effect (Cohen's d = 0.53 - 0.90) on treatment outcomes such as quantity of cannabis consumed, severity of CUD, and level of psychosocial functioning. CBT and MET have been posited to be complimentary of each other, where MET helps the participant to conceptualize reasons for change, and CBT helps the individual to make and maintain the changes needed. A recent study examining findings from across studies in Europe suggested that CBT and/or MET improved short-term outcomes of frequency of cannabis use and dependency severity (Connor et al., 2024). Beginning a treatment program with MET has been shown to be efficacious in both reducing participant attrition (Philips & Wennberg, 2014) and amplifying cannabis treatment outcomes (Gates et al., 2016). Carroll et al. (2001) demonstrated that participants in a substance use treatment program who received enhanced initial evaluation (i.e., MET) were significantly more likely to attend at least one additional treatment session. Indeed, Carroll et al. (2001) reported that 59% of participants receiving the enhanced initial evaluation continued the program, whereas only 29% of participants who did not receive the enhanced initial evaluation continued the program. Theoretically, if participants continue to attend treatment sessions, they show better treatment outcomes. A meta-analysis by Gates and colleagues (2016) found that interventions of more than four sessions delivered over longer than one month produced consistently improved outcomes (i.e., reduced cannabis use frequency and lower severity of dependence). Indeed, combined CBT and MET sessions to treat cannabis use that extended beyond four sessions were shown to have better treatment outcomes than less sessions over a shorter duration of time (Connor et al., 2024).

While some studies suggest that the addition of contingency management (CM), in which individuals are paid to attend sessions or remain abstinent, may be helpful in attaining abstinent outcomes (Budney et al., 2007; Connor et al., 2024; Kadden et al., 2007; Kirby et al., 2006; Sabioni & Le Foll, 2018), CBT/MET programs continue to have greater results at follow up (Carroll et al., 2006). Common objections to using CM strategies are that they cost too much, do not address underlying problems of addiction, and do not address multiple behaviours (Kirby et al., 2006).

Indeed, some research suggests that using the principle of CM to pay individuals to complete treatment may not be beneficial to the individual or treatment program. Research by Gul and Ali (2010) found that participants in a treatment program who cited financial

compensation as their major reason for participation showed poor attendance and dropped out. Finally, CBT/MET combined treatment programs have been demonstrated to be the most cost-effective intervention over a very wide range of treatment costs, compared to CBT/MET plus CM, CM, or drug counselling (DC; Olmstead et al., 2007). In theory, if initial MET in a treatment program can help individuals address ambivalence to change and increase motivation to attend treatment, they may require less CBT sessions to achieve similar treatment outcomes. Additionally, individuals who achieve better outcomes during treatment may be less likely to need additional treatment programs in the future. Together, MET and CBT may be more cost-effective than other multi-modality treatments.

**Online interventions.** Across mental health and substance use approaches to treatment, there is growing interest in shifting evidence-based treatments online (Bucci et al., 2019; Chan et al., 2014). Online interventions have been adapted in many ways, including solely self-guided modules, solely therapist delivered therapy, and a combination of therapist support while completing online self-guided modules. Looking to wider literature beyond substance use, self-directed online interventions for depression are less effective than therapist-supported online interventions (Lam et al., 2024). This trend has also been demonstrated in online cannabis use programs, where therapist support while completing self-guided module content was superior to only completing self-guided modules (Schaub et al., 2015). However, more research is needed with higher quality research studies to be confident in the demonstrated superiority of therapist-guided treatments (Pelucio et al., 2024).

Across formats for online interventions, there are several benefits to the shifting towards online modalities, such as cost-effectiveness, mitigating stigma, and better access to treatment. First, online interventions may help to provide cost-effective treatment to a wide variety of individuals. Research suggests self-guided with therapist support online-delivered CBT/MET treatment for CUD was equally effective to therapist-delivered CBT/MET but self-guided with therapist support online-delivered are significantly more cost-effective (Budney et al., 2015). Previous research findings suggest that almost 30% of individuals who use cannabis reported monetary costs as a significant barrier to treatment (Ellingstad et al., 2006), so free or low-cost treatment may be a deciding factor in seeking and receiving treatment. Second, online interventions may help mitigate the perceived barrier of stigma when debating accessing treatment. Given that many individuals who use cannabis may delay treatment seeking due to

stigma (Ellingstad et al., 2006; Gates et al., 2012; van der Pol et al., 2013), offering an online treatment may afford a greater level of privacy and sense of anonymity (Richards & Viganó, 2013). Third, online treatments can provide greater access to treatment among individuals who may be at a disadvantaged likelihood of receiving treatment, such as rural or remote areas (Richards & Viganó, 2013). In Canada, rural areas are estimated to consume cannabis at similar (Pirie & Simmons, 2014) or increased (Cooke et al., 2020) rates compared to urban areas. Given that rural areas face significantly more treatment barriers (e.g., lack of available treatment, geographic barriers, stigma; Oser et al., 2011; Pullen & Oser, 2014), the development of evidence-based online treatments is needed to mitigate rural disadvantages in access to treatment (Sibley & Weiner, 2011). Fourth, online treatment may decrease the time in between being ready to receive treatment and actually receiving treatment. Given that potential substance use treatment patients can be lost if treatment is not available or readily accessible (National Institute on Drug Abuse, 2018), timely access to treatment is of great importance.

Existing literature on the efficacy of online interventions for substance use have been promising thus far (Elison et al., 2014; Tait et al., 2013; Sanchez & Bartel, 2015; Trudeau et al., 2017). Indeed, online heavy cannabis use interventions have been shown to decrease past month quantity and frequency of cannabis use and lower severity of CUD scores (Copeland et al., 2017). Boumparis and colleagues (2019) demonstrated that online prevention and treatment interventions showed small, significant, posttreatment reductions in cannabis use, but these results were maintained for only prevention, not treatment groups at 12-month follow-up.

Further, Rooke and colleagues (2013) found that individuals who participated in an online, six-module treatment MI and CBT program reported fewer days of cannabis use, lower quantity of cannabis misuse and fewer symptoms of cannabis abuse compared to controls (i.e., receiving web based educational information on cannabis) at a 6-week follow up, and reported fewer and less severe cannabis dependence than control at a 3-month follow up. The treatment program in the Rooke and colleagues (2013) study consisted of six modules of information addressing building motivation for change, managing urges and withdrawal, changing thinking, expanding coping strategies and skills, building on interpersonal skills, relapse prevention work, and automated feedback on the participant's cannabis use, However, the study by Rooke and colleagues (2013) reported issues with treatment adherence and retention of participants, where the average module completion was three-and-a-half out of six modules, and their retention rate

at follow up was 53%. Given that number of treatment modules completed was correlated with reduced frequency of use (Rooke et al., 2013), it may be important to find ways to reduce attrition and increase treatment adherence in online delivery settings.

## Current Studies

In response to the limitations of extant cannabis use treatments (e.g., lack of online formats, addressing only higher-risk CUD, significant dropout rates), I created a CBT/MET treatment program, based on the Swiss self-help program, *CANreduce* (Amann et al., 2018; Schaub et al., 2013, 2015), that is cost-effective, evidence-based, and accessible to individuals across Canada. Using a three-arm RCT, I tested the efficacy of this online, evidence-based treatment program for heavy cannabis use. Additionally, given the large amount of attrition and treatment noncompletion rates among cannabis use treatment programs, the current study placed a significant emphasis on the MET during the recruitment and initial sessions of treatment.

### *Rationale for Study 1*

Schaub and colleagues (2013, 2015) created a Swiss cannabis use self-guided treatment program by the name of *CANreduce*, which uses CBT and MI to motivate, educate, and make change in the heavy cannabis use habits of individuals. The Swiss version of *CANreduce* contains 8 modules to be completed within a 6-week timeframe, and address issues including ambivalence to change, functional strategies to reduce cannabis consumption, as well as harm-reduction techniques. Using the tenets of CBT and MI, as well as self-control practices, Schaub and colleagues use aim to reduce quantity of cannabis consumption, reduce cannabis-related risks and harms, and increase mental wellbeing. Exercises used in *CANreduce* include weighing pros and cons, goal setting, examining personal risk situations for using cannabis, and navigating brief returns to cannabis use (i.e., slips).

To test the efficacy of *CANreduce*, Schaub and colleagues (2015) randomly assigned 436 regular cannabis users to one of three conditions: self-help with chat, self-help without chat, or waitlist control. The self-help with chat condition offered for participants to connect with a counsellor to discuss progress and principles related to the *CANreduce* treatment program. Findings from this study supported that self-help with chat compared to self-help without chat, as well as self-help with chat compared to waitlist control had significantly improved cannabis reduction treatment outcomes in terms of mean number of cannabis use days per week at 3-month follow up. Schaub and colleagues (2015) reported small but significant effect sizes for the

self-help with chat compared to the self-help without chat ($d$ = 0.34) and self-help with chat compared to waitlist control ($d$ = 0.20) with reference to frequency of cannabis use. Further, self-reported abstinence from cannabis was significantly different between self-help with chat and self-help without chat conditions. From this, it can be understood that individuals with the opportunity to chat with a therapist demonstrated significantly greater cannabis reduction from those who did not. Interestingly, in the self-help with chat condition, only approximately 23% of participants actually received one or more chat sessions. Despite this low chat rate, the individuals in this condition who did not actually receive chat sessions still showed evidence of cannabis frequency reduction, indicating that even the possibility of having a chat session improved their outcome.

Given the demonstrated efficacy of the *CANreduce* treatment program with additional chat support offered, the current study aimed to replicate the efficacy of the *CANreduce* treatment program among an English-speaking, Canadian population. However, a few additional changes were made to the treatment program and experimental design. First, given that in the Schaub et al., (2015) study, participants receiving access to chat sessions (even if not used optimally) had significantly better outcomes than those who did not, all participants in the current study were offered contact with non-MET trained program facilitators on an as-needed basis for troubleshooting purposes. The program facilitator was able to give the participant feedback about their progress through the treatment program and address any questions they may have, but at no time provided MET or counselling.

Second, participants in the Swiss version of *CANreduce* only completed on average 3.2 out of 8 treatment modules and had a 62% attrition rate by the 3-month follow-up (Schaub et al., 2015). Hence, the current study aimed to put greater emphasis on participant retention and module completion via enhanced introductory modules. To our knowledge, we are the first to implement recommendations from a standardized protocol for treatment retention (see Study 1 Method section; Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013) to an online CBT/MET treatment program. All participants in the current study completed the first introductory module with a MET therapist over video chat, though only participants in the MET-therapist treatment condition received MET content during this enhanced introduction. The purpose of this therapist-guided MET introduction to *CANreduce* is to enhance motivation and increase willingness to change. For participants randomly assigned into the MET-therapist treatment condition, they

completed a standardized MET session with a therapist, which included personalized discussion of goals, addressing ambivalence to change, and formation of change plans. Participants in the non-MET research assistant condition did not have this added component of therapist-guided discussion. Given that a participant's perceived control to complete the treatment program predicted the number of treatment modules completed (Wojtowics et al., 2013), and increased number of treatment sessions attended predicts better treatment outcomes (Copeland et al., 2001), this therapist-guided MET introduction model aimed to increase feelings of self-efficacy and self-belief in change.

For Study 1, I hypothesized that participants who received either treatment program condition would have significant improvement in primary outcomes (i.e., reduced cannabis consumption days in the past week and quantity of cannabis) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in primary outcomes of interest. I also hypothesized that participants who received either treatment program condition would have significantly improved secondary outcomes of interest (i.e., lower cannabis-related problems, lower anxiety, lower depression, higher quality of life) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in secondary outcomes of interest.

***Rationale for Study 2***

While there has been much effort to systematically evaluate whether or not cannabis treatment programs are efficacious (Rooke et al., 2013; Schaub et al., 2015), less effort has been dedicated to examining for whom and under what conditions the treatment program works. Differential response to treatment based on individual factors has been well documents in cannabis use treatments (Sherman et al., 2016; Ullrich et al., 2021; Wetherill et al., 2015). To examine these individual differences, Kraemer et al. (2002) recommend that RCTs routinely include analysis of both moderators and mediators of treatment outcomes. Given the broad spectrum of cannabis use, problems, and reasons for using cannabis, it can be expected that individuals may respond differently to the *CANreduce* treatment program. Hence, the original goal of Study 2 was to explore theoretically-informed potential mediators and moderators of the *CANreduce* treatment program, as was outlined in detail in the original dissertation proposal.

Not unlike many substance use clinical trials (or any treatment studies for that matter), the *CANreduce* project suffered difficulty with both recruiting and retaining participants. These difficulties in gathering a large enough sample were undoubtedly compounded by the time pressures of completing dissertation research in the allotted time and financial constraints of a pilot study without attaining large-scale funding to mitigate study costs. When examining the feasibility of the originally intended Study 2 analyses of using moderators and mediators to examine for whom and under what conditions the program works, it became apparent that the analyses would be significantly underpowered and the results muddied. If there were no significant findings, it would be unclear if it was due to being underpowered or if there was truly a lack of mediation and moderation effects. Although it remains highly important to understand individual factors leading to treatment successes, it needs to be illustrated and conveyed with reasonable certainty, which could not be ascertained in the current treatment sample.

When re-evaluating other potential facets of the *CANreduce* project that could be explored in a more meaningful way, the concept of evaluating the treatment seeking population as a whole came to light. Prior literature published by a committee member, Dr. Mackenzie, had illustrated the difficulties in recruiting a sample for caregiver interventions (Wiprzycka et al., 2011). Given both the recruitment and retainment difficulties experienced in the *CANreduce* project, the idea for a similar paper was conceptualized. Given that participants had completed comprehensive preassessment batteries of questionnaires when signing up for the *CANreduce* trial, a wealth of information was collected on all interested individuals, not just those who were eligible and began treatment. Instead of examining the individual factors establishing who the *CANreduce* program works best for, we were able to examine, through a conceptually-grouped series of regressions, the individual factors that made it more or less likely for an eligible participant to initiate participation in the *CANreduce* program (i.e., defined as those who were eligible and participated in either the therapist-guided introduction or research assistant-guided introduction and received subsequent access to the program), as well as individual factors that contributed to engagement in the program (i.e., percentage of the *CANreduce* program modules completed). Studies examining the predictors of treatment initiation and engagement exist in other similar areas of research (i.e., Brown and colleagues (2010) examining predictors of treatment initiation and engagement in co-occurring serious mental illness and substance use disorders), but there is a relative scarcity of cannabis-specific research. This new study 2 idea

was still consistent with the original rhetoric of gaining better understanding of who the program works for, just in a sense of who accesses the program in the first place instead of who has better outcomes.

Prior research suggests that various sociodemographic factors, like gender and race (Gergov et al., 2024; Vendetti et al., 2002), and other individual- and intervention-level factors are relevant for engaging in psychosocial treatments as a whole (Arnold et al., 2019; McHugh et al., 2013; Grilo et al., 1998). Literature suggests severity of substance use disorder (Brown et al., 2010; Sinadinovic et al., 2020); motives for using substances (Dow & Kelly, 2013); using other substances (Subbaraman et al., 2017); other mental health difficulties (Compton et al., 2003); family history density (Khoddam et al., 2015); motivation for treatment (Alfonsson et al., 2016); and attitudes towards treatment (Pettinati et al., 2003) all have an important influence on an individual's course of treatment. Hence, in the present study, three conceptual predictor groupings using information collected during baseline screening (i.e., to determine eligibility, prior to randomization) were organized based on extant literature to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program: (1) *individual cannabis-specific factors* including cannabis problems as measured by the Cannabis Use Disorders Identification Test – Revised (CUDIT-R; Adamson et al., 2010), family history density, and cannabis motives including for enhancement, conformity, expansion, coping, and social factors as measured by the Marijuana Motives Questionnaire (MMQ; Simons et al., 1998); (2) *Mental health and other substance use factors* including depression as measured by the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001), diagnosed mental illness, lifetime mental illness treatment, alcohol use frequency and alcohol use quantity as measured by the National Institute on Alcohol Abuse and Alcoholism screening questions (NIAAA, 2007); and (3) *treatment belief factors* including attitudes towards treatment as measured by the Attitudes Towards Seeking Professional Psychological Help – Short Form (ATSPPH-SF; Fischer & Farina, 1995), pretreatment importance, pretreatment confidence and pretreatment readiness.

Although much of the established research has focused on how to reduce study attrition and retain participants once they begin a program (Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013), little research has examined factors that impact the transition from interest in treatment to actual engagement in treatment. Hence, the goals of study 2 were to 1) discuss the

practicality of a randomized controlled trial for online heavy cannabis use treatment and to 2) to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program.

For study 2, I hypothesized that individual cannabis-specific factors (i.e., increased problematic cannabis use scores on the CUDIT-R, lower family history density, and higher cannabis motives), mental health and other substance use factors (increased depression, presence of a diagnosed mental illness, presence of lifetime mental illness treatment, increased alcohol use frequency, and increased alcohol use quantity) and treatment belief factors (i.e., more positive attitudes towards treatment seeking, and higher pretreatment importance, confidence and readiness) would predict higher treatment initiation and program engagement.

# CHAPTER 2

# STUDY 1

## Evidence-Based Therapist Introduction to Online Heavy Cannabis use Treatment in Canadian Adults: A Randomized Controlled Trial (RCT)

Chapter 2 is an unrefereed, preprint version of this article:
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## Abstract

*Background*: Many people who engage in heavy cannabis use do not seek treatment, and those who do are often met with long treatment wait times or high cost of services. Online treatment programs reduce barriers to accessing treatment in a timely manner. Online cannabis use treatment programs are effective, showing moderate effect sizes, particularly with text-based therapist support. Literature suggests brief therapist-guided introductions informed by Motivational Enhancement Therapy (MET) may help to bolster and maintain program gains. The current evaluation of MET-informed therapist-guided introduction was conducted with a sample of Canadians who report heavy cannabis use, using a new Canadian version of *CANreduce*, an online treatment program for heavy cannabis use.

*Method*: The intervention was preregistered on clinicaltrials.gov for traceability (ID: NCT04965012). Participants ($N$ = 152) were randomized into 1 of 3 conditions: MET-therapist guided introduction plus 6-week, online, self-guided treatment program; non-MET research assistant introduction plus 6-week, online, self-guided treatment program; or a control condition. Module content to reduce cannabis use was informed by cognitive behavioural therapy and motivational interviewing approaches. Participants completed assessments at baseline, end of treatment (i.e., 6 weeks), and at follow up (i.e., 10 weeks). Data were analyzed using Generalized Estimating Equations.

*Results:* All participants reduced their cannabis consumption frequency (use days in the past week) and quantity, as well as cannabis-related problems, at end of treatment and follow up. Participants in the MET-therapist condition showed significantly greater reductions in quantity of cannabis used over time compared to the waitlist control. Participants in the non-MET research assistant condition showed significantly greater reductions in cannabis problems compared to waitlist control. There were no significant differences between MET-therapist guided conditions and non-MET research assistant conditions. There was no significant effect of condition on cannabis consumption days in the past week, anxiety, depression or quality of life.

*Conclusion*: The present study provides preliminary support for the *CANreduce* program in addition to the MET-therapist guided introduction.



*Keywords:* cannabis use, cognitive behavioural therapy, motivational enhancement therapy, motivational interviewing, online, minimally guided

## Introduction

Before legalization of cannabis in October of 2018, cannabis was listed as the most commonly used illicit substance in Canada (Government of Canada, 2017), with over half of all Canadians reporting having used cannabis at least once in their lifetime (Health Canada, 2018). In the time since legalization, cannabis has continued to be a highly used psychoactive substance among Canadians, with approximately 5.2 million or 17% of Canadians over age 15 reporting using cannabis in the previous 3 months (Statistics Canada, 2019). While many individuals can use cannabis recreationally and without major risks and consequences (Degenhardt & Hall, 2001), some people use cannabis in a manner that puts them at higher risk of cannabis related risks and harms (Windle et al., 2019) such as negative physical effects of cannabis (Baggio et al., 2014; Tetrault et al., 2007), worsened psychiatric comorbidities (e.g., depression, anxiety, etc.; Arendt & Munk- Jørgensen, 2004; Fergusson et al., 2003; Khan et al., 2013; McLaren et al., 2010; Moore et al., 2007; Stefanis et al., 2004), interpersonal or social problems (APA, 2022; Copeland et al., 2001; Leos-Toro et al., 2017), and financial difficulties (Copeland et al., 2001). Cannabis misuse, broadly defined as the use of cannabis in frequent, chronic, or high quantity patterns, can substantially increase risk for associated harms compared to people who use cannabis casually (Calabria et al., 2010).

### Treatment Approaches

There are a variety of treatment programs aimed at reducing cannabis consumption and mitigating the above-mentioned risks and harms associated with cannabis misuse. While there is limited research on the efficacy of pharmacotherapies, psychosocial approaches have been studied extensively (Gates et al., 2016; Jutras-Aswad et al., 2019). Indeed, literature consistently suggests that cognitive behavioural therapy (CBT) and motivational enhancement therapy (MET) are among the most efficacious online and in-person treatments for cannabis use, particularly when they are combined (Gates et al., 2016; Hoch et al., 2014; Rooke et al., 2013; Sabioni & Le Foll, 2018). Effect sizes of combined CBT and MET programs range from small-to-large, with most falling in the moderate range (Gates et al., 2016; Hoch et al., 2014). McHugh et al. (2010) found that treatment for cannabis use disorder had larger treatment effect sizes compared to other substance use treatments (e.g., cocaine, opioids).

Cognitive behavioural therapy (CBT) is a treatment approach that aims to target maladaptive behavioural patterns leading to cannabis misuse, while addressing both motivational

and cognitive barriers to change (McHugh et al., 2010). CBT also focuses on teaching the individual skills relevant to reducing or quitting cannabis use, as well as skills in managing or avoiding other problems that may interfere with positive outcomes (Budney et al., 2007). CBT is one of the most widely used forms of psychosocial treatment for substance use broadly (McHugh et al., 2010), and has been shown to be particularly efficacious in the treatment of cannabis misuse (Copeland et al., 2001; Sabioni & Le Foll, 2018). CBT has also been shown to be effective in in-person (Copeland et al., 2001), telephone (Gates et al., 2012) and online (Amann et al., 2018; Baumgartner et al., 2021; Rooke et al., 2013; Schaub et al., 2015) intervention formats for cannabis misuse. However, CBT frameworks are rarely used as the sole intervention. While CBT can aid the individual to develop skills to reduce cannabis use and manage problems that may interfere with efforts to reduce cannabis use (Budney et al., 2007), it can be difficult for the individual with cannabis misuse to be engaged in treatment (e.g., lack of motivation, ambivalent about change).

CBT is most commonly combined with other frameworks, such as motivation interviewing/motivational enhancement therapy (MI/MET) to help increase engagement in treatment (Guydish et al., 2010).The goal of both motivational interviewing (MI) and motivational enhancement therapy (MET) is to decrease ambivalence and increase motivation for individual change. Beginning a treatment program with MET has been shown to be efficacious in both reducing participant attrition (Philips & Wennberg, 2014) and amplifying cannabis treatment outcomes (Gates et al., 2016). Carroll et al. (2001) demonstrated that participants in a substance use treatment program who received enhanced initial evaluation (i.e., MET) were significantly more likely to attend at least one additional treatment session. Indeed, Carroll et al. (2001) reported that 59% of participants receiving the enhanced initial evaluation continued the program, whereas only 29% of participants who did not receive the enhanced initial evaluation continued the program.

There is growing interest in shifting evidence-based treatments online for reasons such as cost-effectiveness (Budney et al., 2015), mitigating stigma (Richards & Viganó, 2013), and better access to treatment in a timely manner (Sibley & Weiner, 2011). Existing literature on the efficacy of online interventions for wider substance misuse have been promising thus far (Elison et al., 2014; Sanchez & Bartel, 2015; Trudeau et al., 2017), and evidence is growing to support online cannabis use treatment programs (Baumgartner et al., 2021; Budney et al., 2015; Jonas at

el., 2018; Rooke et al., 2013; Schaub et al., 2015; Tait et al., 2013; Tossman et al., 2011). Tait and colleagues (2013) conducted a meta-analysis examining efficacy of online cannabis use treatment across a variety of therapeutic modalities and features (e.g., CBT, MI, person centred therapy, contingency management, computer delivered personalized feedback), and found overall small but significant effect sizes, supporting the employment of online cannabis use programs. Several studies to date have also focused on evaluating the efficacy of CBT and MET/MI treatment programs, given the demonstrated superiority of CBT and MET/MI in in-person formats. Rooke and colleagues (2013) found that individuals who participated in an online, 6-module MI and CBT intervention reported fewer days of cannabis use, lower quantity of cannabis use and fewer symptoms of cannabis abuse compared to controls at a 6-week follow up, and reported fewer and less severe cannabis dependence than control at a 3-month follow up. However, the study by Rooke and colleagues (2013) reported issues with treatment adherence and retention of participants, where the average module completion was 3.5/6 modules, and their retention rate at follow up was 53%. Given that number of treatment modules completed was correlated with reduced frequency of use (Rooke et al., 2013), it may be important to find ways to promote and extend treatment adherence as much as possible in order to maximize and maintain treatment gains.

Of online treatment programs available, some are unguided (i.e., the participant completes the program independently; e.g., Rooke et al., 2013) and others are guided or semi-guided (i.e., the participant completes the program with varying levels of support from research personnel or therapists; e.g., Tossman et al., 2011). Current meta-analyses suggest that guided online treatment programs are generally more effective that unguided (Lam et al., 2024). Guided programs have mostly been supplemented with text-based support, where some find text-based counselling has no impact on cannabis-related treatment outcomes (e.g., Jonas et al., 2018), and others show positive impacts of text-based counselling (e.g., Schaub et al., 2015). *CANreduce*, an online, self-guided treatment program initially developed by Schaub and colleagues (2013) aims to help individuals reduce their cannabis use. The *CANreduce* program is an eight-module program that uses tenets of CBT, MI and behavioural self-management to help individuals learn to identify risky situations for use, manage cravings, deal with and prevent relapses, and learn strategies to maintain changes. In a 2015 study, Schaub and colleagues examined the efficacy of the *CANreduce* program with or without access to chat counselling during a 6-week intervention

period. Chat counsellors were MI trained psychologists or psychiatrists who had at least one year experience providing treatment to patients who used cannabis. Chat counsellors received quarterly supervision. Results from the study demonstrated that individuals in the *CANreduce* program with access to chat counselling reduced the frequency of their cannabis use significantly more than the *CANreduce* program without chat counselling or waitlist control (small effect size, $d = 0.34$), and also reduced the quantity of their cannabis use significantly more than the waitlist group (small effect size, $d = 0.20$). Interestingly, only a quarter of individuals in the access to chat counselling actually received at least one chat session (Schaub et al., 2015). The positive impact of being offered chat counselling despite not receiving it was attributed to the supportive-accountability model, which suggests human support increases accountability to a coach who is seen as trustworthy, benevolent, and having expertise (Mohr et al., 2011).

In a subsequent study, *CANreduce* 2.0 was created to help overcome the issues of low intervention adherence and effectiveness. For *CANreduce* 2.0, Baumgartner and colleagues (2021) examined treatment outcomes for individuals across three treatment arms: completing the program with social presence (i.e., the semiautomated online coach, "Deborah"), completing the program with a service team (i.e., only anonymous semiautomated support, no "Deborah") and waitlist control. In the social presence arm, the semiautomated coach, "Deborah," was present in the program through a series of short introductory videos to modules, had her picture on the program dashboard, and participants were invited to email her directly and receive personalized emails from her, though email responses were written by study collaborators. The goal of using an identifiable semiautomated coach was to provide a "face" that was trustworthy, benevolent, and had expertise, in line with Mohr's (2011) supportive-accountability model. In comparison, participants in the service team arm received the same level of support without it being linked to a specific coach or identity (e.g., for support, participants are instructed to directly email the *CANreduce* collaborators). Results examined patterns from baseline to posttreatment and 3-month follow up. Primary outcome results demonstrated reduced cannabis use days at 3-month follow up across all groups (Baumgartner et al., 2021). Participants in both active treatment conditions (i.e., the social presence and service team conditions) reported significantly greater cannabis use reduction compared to control group immediately after treatment and at 3-month follow up, with participants in the service team condition still reducing their cannabis-use days significantly more. There was no significant difference between the active conditions for

cannabis use reductions. Baumgartner and colleagues (2021) also demonstrated differences in secondary outcomes: all groups decreased their Attention Deficit Hyperactivity Disorder (ADHD) self-report scores and depression without significant intergroup differences: however, both active treatment conditions (i.e., both service team and social presence team) showed greater reductions in general anxiety symptoms compared to control, and only the service team condition showed reduction in cannabis-use disorder severity, and severity of cannabis dependence compared to control.

Given that a participant's perceived control to complete a treatment program predicts the number of treatment modules completed (Wojtowicz et al., 2013), and increased number of treatment sessions attended predicts better treatment outcomes (Copeland et al., 2001), bolstering motivation and autonomy at the outset of online programs may provide additional benefit beyond supportive-accountability. Specifically, integrating an individualized MET-therapist guided introduction to demonstrated effective online CBT programs, such as *CANreduce*, may increase participants' feelings of self-efficacy and self-belief in change, in turn leading to better cannabis use outcomes. The MET-therapist introduction aims to act as a "primer" for subsequent CBT and MI heavy cannabis use treatment. Additionally, given that other online cannabis treatment programs have demonstrated that goal committment is the main predictor of treatment response (Jonas et al., 2019), exploring and setting individualized goals as part of an MET-introduction to treatment is important. To our knowledge, no such therapist guided introduction to a self-guided online cannabis treatment program exists. Hence, the present pilot randomized controlled trial (RCT) aims to examine the efficacy of an MET-therapist guided introduction to a Canadian version of the pre-established 2.0 *CANreduce* treatment program.

**Aims and Objectives**

We took the *CANreduce* program originally tested in Switzerland by Schaub and colleagues (Amann et al., 2018; Baumgartner et al., 2021; Schaub et al., 2013, 2015) and adapted it for use in English-speaking Canadians. We created two alternative guided introductions to the program: a therapist-guided introduction to the program using tenets of Motivational Enhancement Therapy (MET) and Cognitive Behavioural Therapy (CBT) that also showed participants how to use the website, as well as a research assistant-guided introduction to the program that contained no therapeutic components where the purpose was to solely show participants how to use the website. We conducted an RCT with two active treatment groups

(i.e., MET therapist guided, non-MET research assistant guided) and one waitlist control group and obtained outcome data at both end of treatment (i.e., 6 weeks, T1) and follow up (i.e., 10 weeks from baseline, T2).

The hypotheses were as follows:

1. **Hypothesis 1:** Participants who receive either treatment program condition will have significant improvement in primary outcomes (i.e., reduced cannabis consumption days in the past week and quantity of cannabis) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in primary outcomes of interest.
2. **Hypothesis 2:** Participants who receive either treatment program condition will have significantly improved secondary outcomes of interest (i.e., lower cannabis-related problems, lower anxiety, lower depression, higher quality of life) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in secondary outcomes of interest.

## Method

### Design

The research was designed in accordance with the ethical principles of the Declaration of Helsinki and reported in accordance with the CONSORT guidelines for internet-based interventions (Eysenbach and Consort-EHEALTH Group, 2011), and was granted procedural ethics approval from the York University Office of Research Ethics (ORE) (Certificate # 2021-294) as well as the University of Manitoba Human Research Ethics Board (Protocol number HE2021-0145). The intervention was preregistered on clinicaltrials.gov for traceability (ID: NCT04965012) and was updated at each stage of the research process.

The study was an open-label three-arm RCT. Participants were randomly assigned to either the MET therapist-guided introduction ($n$ = 63), the non-MET research assistant guided introduction ($n$ = 52), or to the waitlist control condition ($n$ = 37)[2]. Assessment data were

[2] Note participants were originally assigned at a 1:1:1 randomization across conditions. The listed *n* values represent numbers from an Intent To Treat framework after randomization, hence the unequal values. See Figure 1 for more information.

collected at three distinct timepoints: baseline (i.e., T0), end of treatment (i.e., 6 weeks, T1) and follow-up (i.e., 10 weeks, T2). Participants received a $5 Amazon gift card for each assessment period they completed with an additional $5 Amazon gift card if they completed all three time-points, making the total compensation up to $20 Canadian Dollars. Researchers and participants were not blinded to group assignment. Participants who were eligible to receive student research participant credits at the University of Manitoba or York University also received participant pool credits for each time-point of participation.

## Procedure

### *Participants*

A total of 808 participants were initially screened for participation, but 656 did not meet the eligibility criteria or did not respond to any contact from the *CANreduce* team and were not included. This resulted in a final sample of 152 participants ($M_{age}$ = 30.20, $SD_{age}$ = 10.50, 58.6% female) in the trial, which was composed of treatment completers and noncompleters, as we used an intent to treat (ITT) model. Of this sample, individuals identified as 65.8% White, 7.9% South Asian, 5.9 % Indigenous, 5.9% Middle Eastern, North African, or Central Asian, 5.3% Black, 3.3% East/Southeast Asian or Pacific Islander, 1.3% Hispanic or Latino, and 3.3% specified other. Participants were recruited from October 2022 to August 2023 using various strategies including online (e.g., Google Ads, Reddit), university-based (e.g., posters at university, student research participant pools), and community-based (e.g., posters at health clinics) methods.

Eligibility for the program included: 1) being over the age of 19, 2) currently residing in Ontario or Manitoba, 3) self-reporting difficulties with cannabis as indicated by a score of 8 or more on the Cannabis Use Disorders Identification Test – Revised (CUDIT-R; Adamson et al., 2010), 4) fluency in English, 5) having weekly Internet access with a device that allows for video connection, and 6) self-reporting at least a 6 out of 10 on a rating scale for motivation to reduce cannabis use. Participants were excluded if they self-reported 1) currently engaging in other psychological or pharmacological treatments for cannabis use, 2) elevated suicidality, as defined by scoring greater than minimal risk on a screener (Dube et al., 2010), or 3) current serious psychiatric disorders or history of psychosis, schizophrenia, bipolar disorder. Informed consent for participation was provided electronically on the study website prior to registering for an account.

### *Program Overview*

**Treatment Conditions.**

**Active treatment conditions.** Participants assigned to either of the active treatment conditions (i.e., the MET therapist-guided introduction or the non-MET research assistant-guided introduction) were contacted by email to arrange a time to meet with their assigned *CANreduce* facilitator via online videoconferencing platform. Participants in both of the active treatment conditions received access to the same version of the *CANreduce* treatment program, which was adapted from the newest version of the *CANreduce* treatment program (Amann et al., 2018), which is based on the original *CANreduce* treatment program by Schaub and colleagues (2013, 2015). The program was translated from German to English, modified to fit a Canadian context and altered to reflect a lower reading level (i.e., Flesch-Kincaid reading level of 7) to make it broadly applicable. The program is comprised of eight modules containing strategies of CBT and MI to help participants think about reasons for changing their cannabis use habits; consider benefits and harms of their current level of use, identify goals for cannabis use reduction; learn coping strategies for cravings, triggers, and social pressures; and learn how to prevent slips. Treatment modules also focus on building skills for the participants to better take care of themselves (i.e., better sleep schedules, reducing worry and rumination, and finding positive ways to cope with stress, like relying on friends and family). Participants were given 6 weeks to complete the eight modules and were encouraged to use the cannabis use tracker at a frequency of at least once per week.

**MET-therapist guided introduction.** The current study employed 10 graduate-level clinical psychology students from the University of Manitoba and York University as the program MET-therapists. Each MET-therapist received group training on MET, as well as additional training on the *CANreduce* program and MET-script prior to facilitating sessions. Ongoing MET-supervision was provided on a monthly basis, as well as individual supervision on an as-needed basis. Supervision was provided by two registered clinical psychologists and a senior clinical psychology PhD student trained in MET therapy. Adherence to MET treatment was assessed through live viewing of participant sessions by a supervisor, where a Treatment Fidelity Checklist (Borrelli, 2011; Borrelli et al., 2015) was used to ensure at least 80% treatment fidelity (Borrelli et al., 2005). All five adherence checks passed, with an average score of 99% fidelity.

During the meeting, the participant and MET therapist completed the first module of the program together. The initial meeting took approximately one hour. The therapist's discussion of the module was facilitated by an MET- and CBT-informed script which encouraged facilitating discussion about ambivalence to change, sourcing motivation, helping formulate initial cannabis reduction goals and providing normative feedback on the participant's current level of cannabis use. Discussion also included a general overview of the program features, including how to use the cannabis use diary, where to locate information regarding mental health and crisis supports, and how to contact researchers for further inquiries or troubleshooting.

**Non-MET research assistant guided introduction.** The current study employed the skills of four undergraduate-level psychology students from York University. Each non-MET research assistant received individual training on the *CANreduce* program and the non-MET script prior to facilitating sessions. Non-MET research assistants also attended the monthly MET-supervision sessions, and particular care was given to addressing how to avoid integrating MET responses or questions into their sessions. Given the training received, the facilitators delivering the interventions would not reasonably be expected to introduce uncontrolled added factors that could influence the quality of the interventions beyond what was planned. Adherence to non-MET scripts for introduction were assessed through live viewing of participant sessions by a supervisor, where a Treatment Fidelity Checklist (Borrelli, 2011; Borrelli et al., 2015) was used to ensure at least 80% treatment fidelity (Borrelli et al., 2005). All three adherence checks passed, with an average score of 91% fidelity.

During the meeting, the participant and non-MET research assistant briefly discussed the program without completing the first module of the program together. The initial meeting took approximately fifteen minutes. Discussion included a general overview of the program features, including how to use the cannabis use diary, where to locate information regarding mental health and crisis supports, and how to contact researchers for further inquiries or troubleshooting. The non-MET research assistants followed a script that contained no facets of MET and received ongoing training on how to respond to questions related to cannabis related use or goals in a non-therapeutic fashion.

**Control condition.** Participants assigned to the control group were given psychoeducational material for cannabis use (https://www.camh.ca/-/media/files/pdfs---reports-and-books---research/canadas-lower-risk-guidelines-cannabis-pdf.pdf) and wellbeing (e.g.,

https://cpa.ca/psychologyfactsheets/) that are readily available to the public, as is common practice for similar RCTs. At the 10-week from baseline mark (i.e., T2), participants were automatically given access to treatment modules and offered a meeting with a non-MET research assistant if they were interested.

***Engagement and Accountability Protocol***

Engagement and accountability measures were implemented throughout the study process to maximize participant retention in the program and reduce participant dropout. Recommendations from standardized protocols for treatment retention (Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013) were adapted to the current study needs, which included extensively training staff (e.g., ensuring they are knowledgeable about the study population, teaching rapport building, minimizing bias and assumptions), explaining study procedures to participants in full (e.g., the reason for follow up studies, how collected information will be used) and various office procedures (e.g., tracking each contact with participants, flexible staffing to accommodate participant schedules, case review meetings). Other retention protocols also include using phone calls instead of emails where possible (Wojtowicz et al., 2013), having strong administrative teams with data coordinators (Gul & Ali, 2010), and properly educating program workers responsible for first contact with participants are educated about the aim and process of the study (Gul & Ali, 2010). All participants received reminders about upcoming introductory meetings the day prior. As a feature of the *CANreduce* program, participants received weekly automated emails for *CANreduce* tasks (e.g., weekly email to review progress and encourage participation; prompts to fill out diaries, reminders to fill out questionnaires), to encourage participation (e.g., lagging behind expected program completion, diaries not filled out) and offer personalized feedback based on cannabis use tracking (e.g., offering support or encouragement if cannabis use increased or decreased). Additionally, through the introductory meeting with either an MET therapist or non-MET research assistant, participants were able to ask questions about the program content, process or purpose at the outset, and were individually encouraged to email with any additional questions or problems. Finally, efforts to mitigate participant dropout included personal email and call reminders from research staff. Given that recruiting from a university sample and offering participant research credits can be associated with low longterm follow up, especially when spanning semesters where credits may no longer

be required, Amazon gift cards were also offered to all participants for each time point of data collection.

## Measures

Participants completed all measures in the present study at all three time points (i.e., T0, T1 and T2) with the exception of the demographic questionnaire (T0 only) and Cannabis Use Disorders Identification Test (CUDIT-R; Adamson et al., 2010; T0 and T2 only). Data using other questionnaires assessing personality, attitudes towards treatment, suicidality, and other substance use were also collected as part of a larger study.

### *Primary Outcomes*

The primary outcomes were cannabis consumption days in the past week and quantity of cannabis use, as measured by the The Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU; Cuttler & Spradlin, 2017). Number of cannabis use days was assessed using a single question asking participants to indicate how many days in the past week they used cannabis ranging from 0 to 7. The quantity of cannabis use was calculated by multiplying the participant's typical marijuana use per day by seven to calculate a weekly cannabis total estimate. Participants estimated their typical marijuana use per day referencing a standardized picture from the DFAQ-CU illustrating approximate weight in grams compared to an American dollar bill (Cuttler & Spradlin, 2017). This method of standardization for cannabis use estimation has been used in similar studies (i.e., Schaub et al., 2015).

### *Secondary Outcomes*

**Cannabis Problems.** Cannabis problems were assessed at all time points using the Rutger's Marijuana Problem Index (RMPI; White et al., 2005). Sum scores were calculated, and the RMPI internal consistency over three time points ranged from good to excellent ($\alpha = 0.86$ - 0.90).

**Depression.** Depression was assessed at all time points using the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001). Sum scores were calculated and the PHQ-9 internal consistency over three time points ranged from good to excellent ($\alpha = 0.88 – 0.92$).

**Anxiety.** Anxiety was assessed at all time points using the Generalized Anxiety Disorder Scale (GAD-7; Spitzer et al., 2006). Sum scores were calculated and the GAD-7 internal consistency over three time points was excellent ($\alpha = 0.90 – 0.94$).

**Quality of Life.** Quality of life was measured with the World Health Organization Quality of Life Assessment (WHOQOL-BREF, WHOQOL Group, 1998). The questionnaire includes 26 self-report items that assess quality of life in four distinct domains. The reliabilities of each subscale were: physical health ranged from questionable to good (α = 0.69 - 0.81), psychological ranged from acceptable to good (α = 0.74 – 0.81), social relationships ranged from acceptable to good (α = 0.76 – 0.85), and environment ranged from acceptable to good (α = 0.78 – 0.80).

### *Other Measures*

**Demographics.** Demographic information was collected from participants at T0 to determine eligibility and describe the sample. Information included age, sex, gender, ethnicity, employment status, history and treatment for physical or mental health conditions, and family history of cannabis misuse.

**Cannabis Use Disorder Severity.** The Cannabis Use Disorders Identification Test-Revised (CUDIT-R; Adamson et al., 2010) was used to assess cannabis use disorder severity at baseline. The CUDIT-R is an 8-item self-report measure. Sum scores were calculated, where higher scores indicated more problematic cannabis use. A cut off of 8 on this measure was used for inclusion criteria for the study. The internal consistency of the CUDIT-R at baseline was questionable (α = 0.68).

## Statistical Analysis

### *Power*

Effect sizes reported for cannabis misuse treatment range from small-to-large, varying among different modalities and delivery methods of treatment. For combined CBT & MET/MI treatments, some studies report moderate-to-large effect sizes (Gates et al., 2016; Hoch et al., 2014). In comparison, studies examining online intervention of cannabis use found small but significant effect sizes (Rooke et al., 2013; Tait et al., 2013). The Swiss *CANreduce* treatment program by Schaub et al. (2015) found small effect sizes ($d$ = 0.20 for self-help with chat versus waitlist, and $d$ = 0.34 for self-help with chat versus self-help without chat). Given the wide array of effect sizes across similar studies, it is expected that the current intervention will yield small-to-medium effect sizes. A Power Analysis was conducted for a 3 (within; time) by 3 (between; group) mixed design. Using G*Power, the sample required to detect a small effect with 80% power, $\alpha$ = .05, and a correlation of .60 between repeated measures was 135.

### *Data Analytic Plan*

Data were analyzed using SPSS version 25.0. First, preliminary analyses were run to assess normality, baseline differences, missing data and descriptives to characterize the study sample. These preliminary analyses allowed for observing any potential systematic missingness, which allowed for the inclusion of relevant covariates in the main analyses. Despite study procedures to mitigate dropout (e.g., accountability protocols at sign up, automatic reminders, compensation, etc.), attrition rates at T2 were greater than expected. We predicted that attrition rates at 10 weeks would be approximately 35% attrition rate based on literature and the addition of retention protocols. Our overall dropout rate was 66% between T0 and T2 (i.e., number of participants completing baseline primary outcome measures dropped from 150 at baseline to 51 at follow up; 34% retention rate). Broken down by condition, 28% of participants in the MET-therapist condition remained at T2 (72% attrition), 37% of participants in the non-MET research assistant condition remained at T2 (63% attrition), and 38% of participants in the waitlist control condition remained at T2 (62% attrition). The overall dropout rate is identical to a similarly structured study examining the efficacy of an online self-guided program, *Take Care of Me,* by Frohlich and colleagues (2022) which addresses comorbid alcohol use and emotional problems, which also saw a 66% attrition rate between T0 and T2. Significant attrition is purportedly observed widely among e-health studies (Eysenbach, 2005) and internet-based substance use treatment (e.g., 35% retention rate; Etter, 2005).

We used Generalized Estimating Equations (GEE) within an intent-to-treat (ITT; Gupta, 2011) model, where we included all participants who were randomized and responded to at least one email from the research team regardless of level of participation in the program. Missing data were treated with full maximum likelihood estimation. For each of the main analyses, we used separate mixed models to examine the effects of time (Coded as 0, 1 and 2; within-subjects), intervention (between-subjects) and intervention by time interaction on the primary and secondary outcomes. The trend for time was linear, random intercepts (but not random slopes) were specified, and all outcomes were treated as continuous. Distributions of outcomes were normal. A relevant covariate (i.e., baseline anxiety) based on the missing data analysis (see below in results section) and important pretreatment factors (i.e., age, history of mental illness diagnosis, and baseline cannabis use severity) were included in the models with the goal of reducing potential biases (Preacher et al., 2010).

## Results

### Descriptive Statistics and Missing Data Analysis

See Figure 2.1 for the CONSORT trial flow chart. Demographic information for each of the three conditions is presented in Table 2.1 and can be found in Supplementary material. A large portion ($n$ = 327) of the recruited individuals did not meet the cut off for hazardous cannabis use (as indicated with a score of less than 8 on the CUDIT-R). This is unsurprising given the recruitment method of university participant pool, where students could gain credit for completing questionnaires regardless of cannabis use or interest in the *CANreduce* program. Other reasons for ineligibility for the program included not consenting to participate in the research ($n$ = 2), being under 19 years of age ($n$ = 64), not residing in a province where *CANreduce* was currently being offered ($n$ = 7), insufficient motivation score (as indicated with a score less than 6 on the importance for change scale; $n$ = 95), more than minimal suicide risk ($n$ = 11) or having a current/historical exclusionary mental health issue ( $n$ = 16). For individuals who completed the introductory meeting with either the MET-therapist or non-MET research assistant, the average percent of the program completed was 51.58% ($SD$ = 36.82) with 24.5% ($n$ = 23) completing all 8 modules. Comparing the MET-therapist and non-MET research assistant groups (for only individuals who attended the introductory session, as only these individuals had access to the program) using t-test revealed that individuals did not significantly complete more modules across conditions ($t(92)$ = -.899, $p$ = .185, Cohen's $d$ = -0.19).

Regressions were used to examine relevant auxiliary variables that accounted for missingness. The dichotomous missingness variable was included in Step 1, and relevant covariates (i.e., age, history of mental illness diagnosis, and baseline cannabis use severity; Lev-Ran et al., 2013; Rajapaksha et al., 2020; Statistics Canada, 2018) were included in Step 2. Missing data emerged as a significant predictor of baseline scores in Step 1 for cannabis consumption days in the past week ($R^2$ = .183, $F$[4, 140] = 7.821, $p$ < .001), cannabis problems ($R^2$ = .436, $F$[4, 128] = 24.768, $p$ < .001), anxiety ($R^2$ =.190 , $F$[4, 142] = 8.351, $p$ < .001), depression ($R^2$ = .163, $F$[4, 142] = 6.933, $p$ < .001), and quality of life ($R^2$ = .134, $F$[4, 133] = 5.159, $p$ < .001) but not cannabis quantity ($R^2$ = .050, $F$[4, 131] = .1.709, $p$ = .152). After inclusion of the relevant covariates (i.e., age, history of mental illness diagnosis, and baseline cannabis use severity) most effects became non-statistically significant in Step 2 (i.e, cannabis consumption days in the past week [$p$ = .768]; problems [$p$ = .431]; depression [$p$ = .110];

quality of life [$p$ = .116]). However, the missing effect on anxiety remained statistically significant ($p$ = .024). Therefore, baseline anxiety, age, history of mental illness diagnosis and baseline cannabis use disorder severity were also included as relevant covariates in the GEE models.

Main Trial Analyses

Hypothesis 1: Treatment Effects on the Primary Outcomes

**Cannabis Consumption Days in the Past Week.**

There was a significant main effect of time, where cannabis consumption days in the past week decreased over time for participants in all conditions ($B$ = -0.79, $SE$ = 0.32, $p$ = .01). *Overall*, we did not observe expected follow-up treatment effects on cannabis consumption days in the past week. The time by condition interaction was not significant for the waitlist control versus non-MET research assistant condition ($B$ = -0.60, $SE$ = 0.49 $p$ = .22), the waitlist control versus the MET-therapist condition ($B$ = -0.35, $SE$ = 0.44, $p$ = .44), and between the non-MET research condition versus the MET-therapist condition ($B$ = 0.26, $SE$ = 0.49, $p$ = .60). Results indicated that all three of the groups significantly decreased their cannabis consumption days in the past week, though none of the groups significantly differed from each other. See Table 2.2 for details.

**Cannabis Quantity.**

There was a significant main effect of time, where cannabis quantity decreased over time irrespective of condition ($B$ = -0.28, $SE$ = 0.1.51, $p$ = .03). We found partial support for expected follow up treatment effects on cannabis quantity. The time by condition interaction was not significant for waitlist control versus non-MET research assistant condition ($B$ = -1.52, $SE$ = 2.10, $p$ = .47), and the non-MET research condition versus the MET-therapist condition ($B$ =-2.85, $SE$ = 1.88, $p$ = .13), but the interaction was significant for waitlist control versus the MET-therapist condition ($B$ = -4.37, $SE$ = 1.75, $p$ = .01). Results indicated that although all conditions reduced their cannabis quantity over time, participants who received MET-therapist treatment ($B$ = 12.05, $SE$ = 2.78, $p$ < .001) showed significantly greater reductions in the quantity of cannabis used relative to the waitlist control. See table 2.3 for details.

Hypothesis 2: Immediate Effects on Secondary Outcomes

**Cannabis Problems.**

There was a significant main effect of time, where cannabis problems decreased over time ($B$ = -3.39, $SE$ = 1.12, $p$ = .002). We found partial support for expected follow up treatment effects on cannabis-related problems. The time by condition interaction was not significant for the non-MET research condition versus the MET-therapist condition ($B$ =.71, $SE$ = 1.93, $p$ = .72), and for the time by condition interaction for the waitlist control versus the MET-therapist condition ($B$ = -3.26, $SE$ = 1.75, $p$ = .06). Although the latter was not significant, it approached significance. Hence, for descriptive reasons we probed the interaction, but use caution when interpreting it given that the interaction was not statistically significant. The time by condition interaction was significant for the waitlist control versus non-MET research assistant condition ($B$ = -3.97, $SE$ = 1.80, $p$ = .03). Results indicated that although all conditions decreased their cannabis-related problems over time, participants who received the non-MET research assistant condition ($B$ = 23.10, $SE$ = 1.83, $p$ < .001) experienced significantly reduced amounts of cannabis use problems compared to waitlist control. Participants who received the MET-therapist treatment ($B$ = 12.05, $SE$ = 2.78, $p$ < .001) also decreased their cannabis use problems compared to waitlist control, though not to a traditionally significant amount (i.e., $p$ value less than .05). See Table 2.4 for details.

**Anxiety, Depression and Quality of Life.**

We did not observe any main effect of time, or interaction effects, on the remaining secondary outcomes of anxiety, depression, or quality of life. See Tables 2.5 through 2.7 for more details.

## Discussion

While online programs for cannabis use are relatively new in Canada, available evidence suggests that combined CBT and MI programs have moderate effect sizes in reducing cannabis related outcomes. The present pilot RCT aimed to examine the efficacy of a Canadian version of an established Swiss self-help program, *CANreduce*, as well as any additional benefit of an MET-therapist guided introduction to the program. Although there was significant attrition and challenges with overall sample size, the present study provides preliminary support for both the Canadian version of *CANreduce* and the benefit of the MET-therapist guided introduction.

Regarding primary outcomes, we saw partial support for our first hypothesis. While there was a general reduction in cannabis consumption days in the past week from baseline to follow up across conditions, there were no significant differences between groups (i.e., either active

treatment group compared to waitlist control, or the other active treatment group). However, in examining quantity of cannabis use, participants in the MET-therapist condition showed significantly greater reductions in quantity of cannabis used over time compared to the waitlist control. These findings are in part similar to previous iterations of the *CANreduce* program, where the present study demonstrated significantly greater reductions in cannabis use quantity for the conditions where therapeutic interactions were present compared to waitlist control (i.e., the MET-therapist condition in the present study and the group that had access to chat counselling in Schaub et al., 2015). However, the present study differed from the Schaub et al. (2015) study in that the present study did not also see significant reduction of cannabis use days in the past week. It is possible that the expected reduction of cannabis use days in the past week was not found either due to our small sample size reducing the ability to detect meaningful changes, or by using a broad measure of frequency (i.e., number of days used in the past week) instead of a more sensitive measure (e.g., number of smoking sessions in the past week). It is also possible that because the *CANreduce* program allowed for flexible goal making (either general cannabis reduction *or* abstinence), individuals who successfully reduced their overall quantity of use did not have the goal of having cannabis-free days, hence did not show a reduction in number of cannabis use days in the past week.

Regarding secondary outcomes, we again saw only partial support for our second hypothesis. Significant differences for secondary outcomes between study conditions were only found for cannabis-related problems. Although participants across groups all decreased their cannabis-related problems from baseline to follow up, only participants in the non-MET research assistant condition showed significantly greater reductions in cannabis-related problems compared to the waitlist control. Participants in the MET-therapist condition also showed a reduction in cannabis use problems over time compared to the waitlist control, albeit just above the traditional cut off for significance (i.e., $p = .06$). However, given the relatively small sample size, we may have been underpowered to elucidate these differences within this sample, giving reasonable support to further investigate significance values close to the traditional cutoff. This finding is similar to prior *CANreduce* studies, where the present study demonstrated significant reductions in cannabis use problems for the non-therapeutic support compared to waitlist control (i.e., the non-MET research assistant condition in the present study, and service team support in the Baumgartner and colleagues [2021] study). While the present study and the Baumgartner and

colleagues (2021) examined slightly different constructs of cannabis associated problems (i.e., Baumgartner outcomes included cannabis use disorder and cannabis-dependence severity; the present study examined cannabis-related problems directly), they do examine a similar general construct of cannabis-related problems. This finding of significance in the case of the non-MET research assistant condition and the nearly-significant value in the case of the MET-therapist condition in relation to the waitlist control group, indicate that access to the online treatment program itself is helpful in reducing cannabis-related problems. Given that a diagnosis of Cannabis Use Disorder (CUD) reflects an overall level of impairment to functioning and cannabis-related problems rather than cannabis consumption days in the past week or quantity of cannabis use itself, the demonstrated improvement in cannabis-related problems supports the efficacy of the Canadian version of *CANreduce* for those with CUD.

Somewhat surprisingly, no condition differences were found for anxiety, depression or quality of life. Prior iterations of the Swiss *CANreduce* found support for reduction in anxiety (Baumgartner et al., 2021), and similarly structured research in other substance use areas have typically found support for reduction in negative emotions (i.e., depression and anxiety) and quality of life (Frohlich et al., 2022). The absence of findings for reduction in anxiety, depression and quality of life is also somewhat surprising given the relationship reported in the literature between improvement in cannabis misuse and wellbeing (Tossman et al., 2011; Hser et al., 2017). However, as suggested in other short-term cannabis reduction studies examining quality of life as an outcome, a relatively short survey period may not be adequate time to fully capture changes to quality of life which may take longer to improve (Hser et al., 2017). Prior *CANreduce* studies had a follow up time of 3 months (Schaub et al., 2015; Amann et al., 2018) instead of the Canadian *CANreduce* follow up of only one month, which may have limited our ability to observe quantifiable positive impacts of cannabis use changes. Additionally, the current Canadian *CANreduce* had limited focus specifically on mental health-related constructs, whereas other similar substance use treatment program evaluations more heavily integrated mental health and wellbeing information in their treatment modules and tracked this domain on a week-to-week basis (Frohlich et al., 2022). Similar to primary outcomes, we were likely underpowered to observe some of the changes in secondary outcomes.

**Implications**

Overall, our study offers preliminary support for the Canadian *CANreduce*, an online self-guided treatment program for cannabis use. While our results are modest and sample size is relatively small, the current findings offer some additional support to the growing literature supporting online cannabis use treatments (Baumgartner et al,. 2021; Rooke et al., 2013, Schaub et al., 2015). Given the increasing cost of in-person treatment, limited resources paired with increased demand and reduced access in remote and rural areas (Richards & Viganó, 2013), increasing the availability of evidence-based online self-guided treatments for cannabis use is much needed. Available literature suggests that online-delivered CBT/MET treatment for CUD is equally effective to therapist-delivered CBT/MET but online-delivered are significantly more cost-effective (Budney et al., 2015). Given that potential substance use treatment patients can be lost if treatment is not available or readily accessible (National Institute on Drug Abuse, 2018), timely access to treatment is important. *CANreduce* offers an alternative approach to addressing heavy cannabis use that may help reduce the time between being ready for treatment and receiving treatment.

Additionally, the present study was the first of its kind to develop and integrate a one-hour guided introduction to the program alongside an MET-trained therapist. Prior literature has detailed the benefits of including MET principles at the outset of substance use treatment (Carroll et al., 2001), while also highlighting the significant strain of individualized treatment on the healthcare system (Morgan et al., 2013). Offering a hybrid approach may help to promote balance between the cost-effective online treatments while "priming" the participant to get the most out of the programming available.

**Limitations and Future Directions**

The present study is not without limitations. First, the present study experienced significant attrition and disengagement despite attempts to maximize participation (e.g., adherence protocols, automatic reminders, offering ongoing technical support). Relatedly, participants tended to complete only approximately half of module content offered. Despite weekly automated progress and diary reminders, the proportion of participants who fully completed the program was 24.5%, with no significant completion differences between the two treatment groups. This is similar to other online cannabis treatments (e.g., 3.5/6 modules, Rooke et al., 2013). Although significant participant dropout and disengagement is not uncommon in any online health treatment (Eysenbach, 2005), and especially in both online cannabis use

treatment programs (e.g., Rooke et al., 2013) and wider substance use treatment (Hadjistavropoulos et al., 2020; Frohlich et al., 2022), future research should continue to refine practices to maximize retention such as implementing tenets of contingency management (e.g., giving additional positive reinforcement for completing modules, reinforcing progress towards cannabis reduction or abstinence goals), fully implementing the Engagement, Verification, Maintenance and Confirmation (EVMC) Protocol by Scott (2004), or having scheduled virtual progress check ins with participants instead of offering email progress summaries. Given the integration of the *CANreduce* program with MET-therapists, participants may gain additional benefit from multiple check ins throughout treatment with the MET-therapist. While there is some evidence to suggest that number of treatment sessions does not impact treatment effect size (Davis et al., 2015), multiple check ins with a consistent MET-therapist may foster the therapeutic alliance, which can significantly impact cannabis use and problematic behaviours at posttreatment follow up (Diamond et al., 2006).

Second, the current study's smaller sample size limited our options in posthoc analyses. Conditions under which the study was run (i.e., in the context of a Ph.D. dissertation project with limited budget and restricted time for data collection) prevented larger sample sizes from being recruited. We could not examine whether treatment completers had significantly different primary and secondary outcomes of interest compared to non-completers. Along the same line, the current study's small sample size also limited the ability to examine how various sociodemographic and individual factors related to treatment outcomes. Given that individuals respond differentially to treatment based on various personal factors (Dacosta-Sanchez et al., 2023), future studies should aim to increase sample size through larger data collection projects in addition to mitigating dropout. The small sample size also significantly impacted study power as mentioned throughout the manuscript, as well as generalizability of study results.

## Conclusion

*CANreduce* is one of the first online, CBT and MET self-guided treatment programs for heavy cannabis use available in North America that has an integrated MET-therapist guided introduction. We found preliminary evidence suggesting the guided introduction's version of the program efficacy in reducing cannabis quantity, alongside the general benefit of reducing cannabis-related problems among both the non-guided introduction and the guided introduction (albeit, with marginal significance). In spite of the significant study attrition and small sample

size, the current study offers support to the growing literature for online treatments for heavy cannabis use. Future studies should aim to replicate these findings with a larger sample, examine the efficacy among more varied levels of cannabis users (i.e., not only individuals with hazardous or disordered use), and find the optimal level of therapist engagement for a mostly-self guided program.

**Table 2.1**

Descriptive Statistics of Study Variables by Group at Baseline

| Variable | Intervention | | |
|---|---|---|---|
| | MET-therapist ($n$ = 63) | Non-MET research assistant ($n$ = 52) | Control ($n$ = 37) |
| Age, *M* (SD) | 31.14 (11.42) | 30.63 (11.71) | 27.97 (7.32) |
| Sex, % (*n*) | | | |
| Male | 33.3 (21) | 42.3 (22) | 50 (18) |
| Female | 65.1 (41) | 57.7 (30) | 50 (18) |
| Intersex | 1.6 (1) | 0 (0) | 0 (0) |
| Ethnicity, % (*n*) | | | |
| East Asian, South-East Asian, Pacific Islander (e.g., Chinese, Japanese, Korean, Vietnamese, Thai) | 3.2 (2) | 5.8 (3) | 0 (0) |
| Middle Eastern, North African, Central Asian (e.g., Jordanian, Saudi, Egyptian, Moroccan, Iranian) | 4.8 (3) | 7.7 (4) | 5.7 (2) |
| Hispanic or Latino (e.g., Brazilian, Chilean, Mexican, Cuban) | 0 (0) | 1.9 (1) | 2.9 (1) |
| Caucasian or White (e.g., Russian, German, Latvian, French, Scottish, Italian) | 63.5 (40) | 69.2 (36) | 68.6 (24) |
| Black (e.g., African-American, Nigerian, Haitian, Jamaican, Somali) | 4.8 (3) | 5.8 (3) | 5.7 (2) |
| Indigenous or Aboriginal (e.g., First Nations, Inuit, Metis, Native American, Native Australian) | 11.1 (7) | 3.8 (2) | 0 (0) |
| South Asian (e.g., Indian, Pakistani, Sri Lankan, Nepalese) | 9.5 (6) | 3.8 (2) | 8.6 (3) |
| Other | 3.2 (2) | 0 (0) | 8.6 (3) |
| Cannabis cannabis consumption days in the past week, *M* (SD) | 5.66 (2.39) | 5.90 (2.03) | 6.24 (1.69) |
| Cannabis grams/week, *M* (SD) | 11.02 (14.71) | 9.95 (14.76) | 11.49 (14.07) |
| RMPI, *M* (SD) | 26.36 (10.82) | 26.82 (10.64) | 26.14 (10.34) |

| | | | |
|---|---|---|---|
| GAD-7, *M* (SD) | 11.95 (6.28) | 10.98 (6.21) | 11.78 (6.34) |
| PHQ-9, *M* (SD) | 14.27 (6.62) | 12.38 (6.52) | 13.73 (7.21) |
| QOL, *M* (SD) | 79.80 (13.16) | 83.92 (12.02) | 79.97 (16.36) |
| Mental Illness Diagnosis, % (*n*) | | | |
| No | 33.3 (21) | 45.1 (23) | 48.6 (17) |
| Yes | 66.7 (42) | 54.9 (28) | 51.4 (18) |

*Note.* RMPI = Rutgers Marijuana Problems Index; GAD-7 = Generalized Anxiety Disorder scale; PHQ-9 = Patient Health Questionnaire scale; QOL = World Health Organization Quality of Life Assessment.

**Table 2.2**

*Posthoc GEE Model Results for Primary Cannabis Consumption Days in the Past Week Outcome*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Primary Cannabis Consumption Days in the Past Week Outcome* | | | | | |
| Intercept | 6.03 | 0.46 | 1 | 174.33 | .000 |
| Time | -0.79 | 0.32 | 1 | 6.28 | .012 |
| Anxiety covariate | 0.02 | 0.03 | 1 | 0.22 | .640 |
| CUD severity score covariate | 0.16 | 0.04 | 1 | 17.49 | .000 |
| Mental illness diagnosis covariate | 0.70 | 0.34 | 1 | 4.16 | .041 |
| Age covariate | 0.11 | 0.05 | 1 | 5.03 | .025 |
| Waitlist vs non-MET | -0.17 | 0.37 | 1 | 0.20 | .649 |
| Waitlist vs MET | -0.66 | 0.40 | 1 | 2.74 | .098 |
| Time xWaitlist vs non-MET | -0.60 | 0.49 | 1 | 1.53 | .216 |
| Time x Waitlist vs MET | -0.35 | 0.44 | 1 | 0.61 | .436 |

*Note.* Primary cannabis outcome variables for the cannabis consumption days in the past week (as measured by the DFAQ) at the end of treatment (i.e., T2). Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Table 2.3**

*Posthoc GEE Model Results for Primary Quantity Outcome*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Primary Quantity Outcome* | | | | | |
| Intercept | 11.10 | 3.34 | 1 | 11.02 | .001 |
| Time | -0.28 | 1.51 | 1 | 0.03 | .854 |
| Anxiety covariate | -0.13 | 0.16 | 1 | 0.64 | .424 |
| CUD severity score covariate | 0.32 | 0.18 | 1 | 3.28 | .070 |
| Mental illness diagnosis covariate | 1.80 | 1.72 | 1 | 1.10 | .295 |
| Age covariate | -0.75 | 0.36 | 1 | 4.33 | .037 |
| Waitlist vs non-MET | -0.15 | 2.84 | 1 | 0.00 | .958 |
| Waitlist vs MET | 0.95 | 2.66 | 1 | 0.13 | .721 |
| Time x Waitlist vs non-MET | -1.52 | 2.10 | 1 | 0.53 | .469 |
| **Time x Waitlist vs MET** | **-4.37** | **1.75** | **1** | **6.23** | **.013** |

*Note.* Primary cannabis outcome variables for the quantity (DFAQ) at the end of treatment (i.e., T2). Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Table 2.4**

*Posthoc GEE Model Results for Cannabis Problems*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Secondary Problems Outcome* | | | | | |
| Intercept | 21.25 | 2.07 | 1 | 104.92 | .000 |
| Time | -3.39 | 1.12 | 1 | 9.17 | .002 |
| Anxiety covariate | 0.34 | 0.13 | 1 | 7.15 | .007 |
| CUD severity score covariate | 0.88 | 0.14 | 1 | 40.51 | .000 |
| Mental illness diagnosis covariate | 1.32 | 1.54 | 1 | 0.74 | .390 |
| Age covariate | 0.02 | 0.17 | 1 | 0.01 | .924 |
| Waitlist vs non-MET | 1.86 | 1.82 | 1 | 1.04 | .308 |
| Waitlist vs MET | 0.97 | 1.71 | 1 | 0.32 | .569 |
| **Time x Waitlist vs non-MET** | **-3.97** | **1.80** | **1** | **4.88** | **.027** |
| **Time x Waitlist vs MET** | **-3.26** | **1.75** | **1** | **3.49** | **.062** |

*Note.* Secondary cannabis outcome variables for the cannabis problems (RMPI) at the end of treatment (i.e., T2). Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Table 2.5**

*Posthoc GEE Model Results for Anxiety*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Anxiety* | | | | | |
| Intercept | 11.78 | 1.00 | 1 | 139.30 | <.001 |
| Time | -0.83 | 0.68 | 1 | 1.48 | .224 |
| CUD severity score covariate | 0.36 | 0.09 | 1 | 17.74 | <.001 |
| Mental illness diagnosis covariate | 2.28 | 0.94 | 1 | 5.82 | .016 |
| Age covariate | -0.03 | 0.13 | 1 | 0.04 | .846 |
| Waitlist vs non-MET | -0.59 | 1.27 | 1 | 0.22 | .642 |
| Waitlist vs MET | -0.27 | 1.23 | 1 | 0.05 | .829 |
| Time x Waitlist vs non-MET | -1.43 | 0.89 | 1 | 2.58 | .108 |
| Time x Waitlist vs MET | -0.90 | 1.08 | 1 | 0.70 | .403 |

*Note.* Secondary outcome variables for anxiety (GAD7) at the end of treatment (i.e., T2). Anxiety not included as covariate. Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Table 2.6**

*Posthoc GEE Model Results for Depression*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Depression* | | | | | |
| Intercept | 7.25 | 1.13 | 1 | 41.31 | .000 |
| Time | -1.79 | 0.95 | 1 | 3.52 | .061 |
| Anxiety covariate | 0.58 | 0.07 | 1 | 62.10 | .000 |
| CUD severity score covariate | 0.10 | 0.08 | 1 | 1.46 | .227 |
| Mental illness diagnosis covariate | 1.50 | 0.82 | 1 | 3.29 | .070 |
| Age covariate | 0.05 | 0.11 | 1 | 0.21 | .644 |
| Waitlist vs non-MET | -0.45 | 0.93 | 1 | 0.23 | .631 |
| Waitlist vs MET | -1.36 | 1.00 | 1 | 1.86 | .173 |
| Time x Waitlist vs non-MET | -0.47 | 1.20 | 1 | 0.16 | .694 |
| Time x Waitlist vs MET | 0.47 | 1.25 | 1 | 0.14 | .707 |

*Note.* Secondary cannabis outcome variables for depression (PHQ-9) at the end of treatment (i.e., T2). Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Table 2.7**

*Posthoc GEE Model Results for Quality of Life*

| Parameter | *B* | Std. Error | df | Wald $x^2$ | Sig. |
|---|---|---|---|---|---|
| *Quality of Life* | | | | | |
| Intercept | 85.44 | 2.82 | 1 | 915.51 | .000 |
| Time | 2.38 | 2.03 | 1 | 1.38 | .241 |
| Anxiety covariate | -0.51 | 0.18 | 1 | 8.00 | .005 |
| CUD severity score covariate | -0.33 | 0.22 | 1 | 2.33 | .127 |
| Mental illness diagnosis covariate | -2.03 | 2.28 | 1 | 0.80 | .372 |
| Age covariate | -0.35 | 0.34 | 1 | 1.06 | .304 |
| Waitlist vs non-MET | 1.13 | 2.79 | 1 | 0.16 | .687 |
| Waitlist vs MET | 4.68 | 2.84 | 1 | 2.72 | .099 |
| Time x Waitlist vs non-MET | 1.60 | 2.98 | 1 | 0.29 | .592 |
| Time x Waitlist vs MET | -0.14 | 2.69 | 1 | 0.00 | .959 |

*Note.* Secondary cannabis outcome variables for quality of life (WHOQOL) at the end of treatment (i.e., T2). Waitlist denotes waitlist control, non-MET denotes the non-MET research assistant condition, and MET denotes the MET-therapist condition.

**Figure 2.1**

*CONSORT Trial Flow Chart*

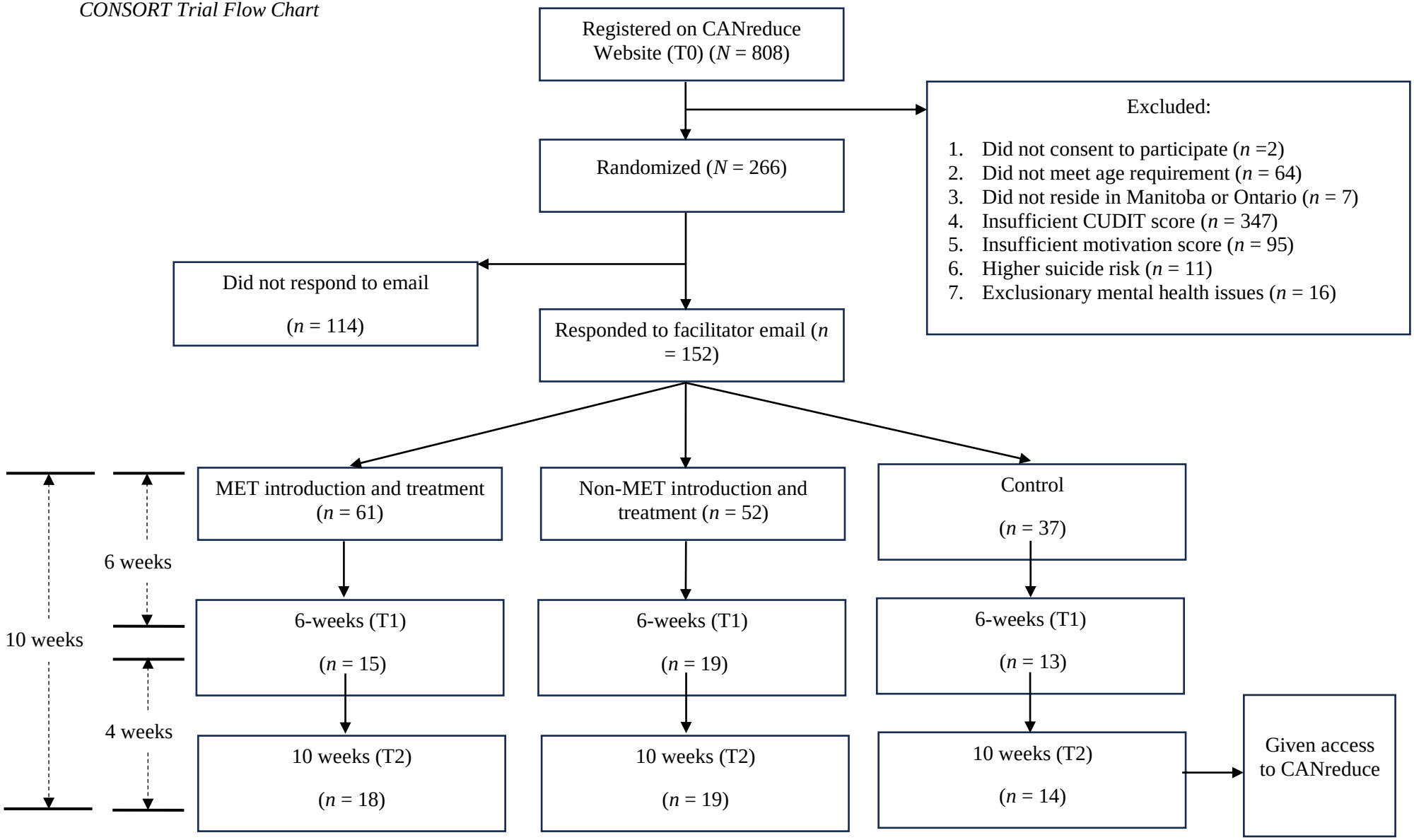
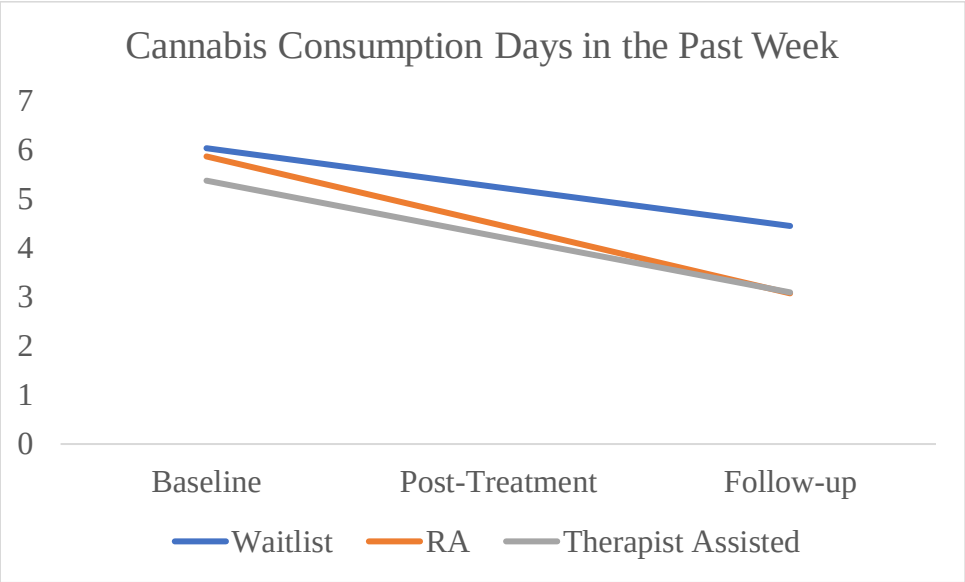
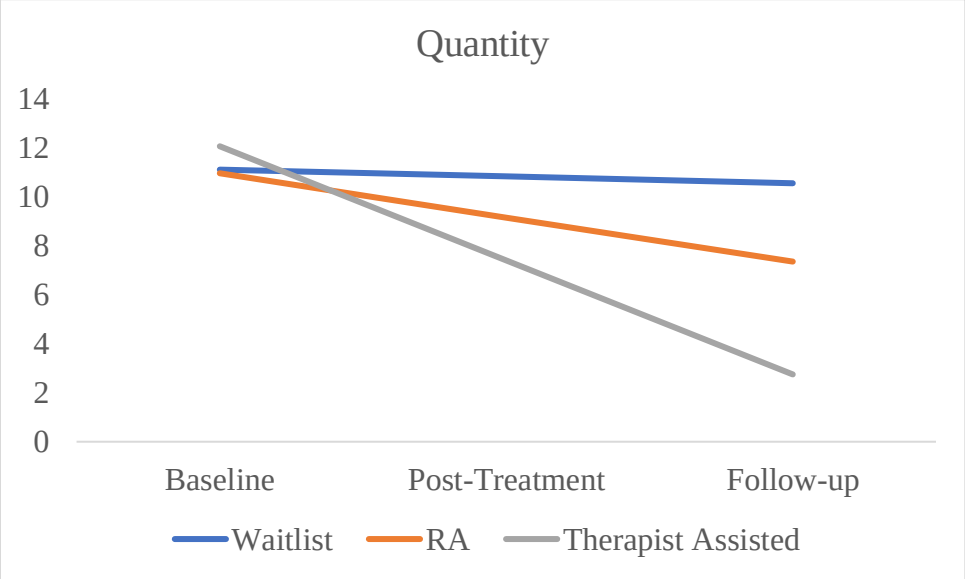


**Figure 2.2**

*Changes in Primary Outcomes (Cannabis Consumption Days in the Past Week and Quantity) Over Time*

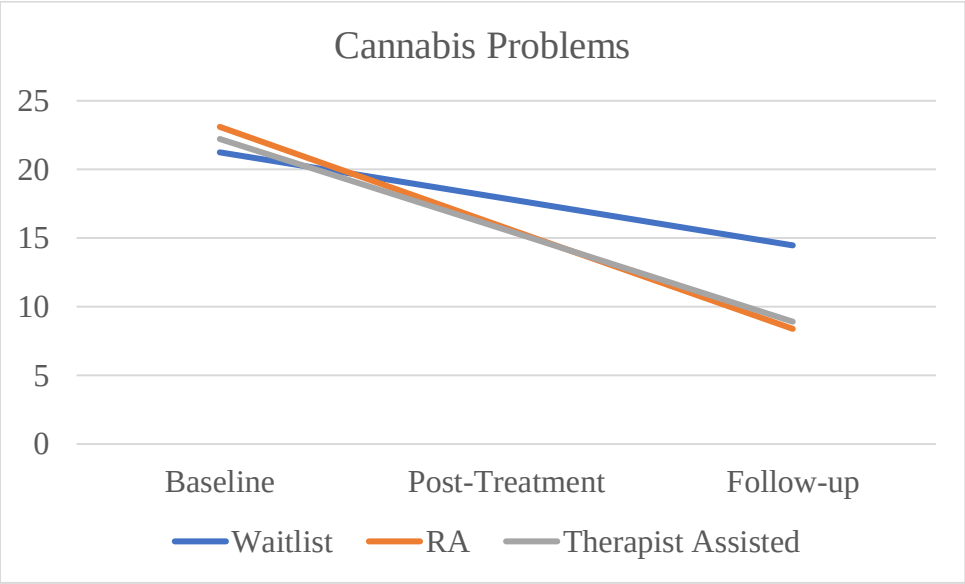



*Note*. Quantity Time x Condition interactions were significant for waitlist versus therapist condition ($p$ = 0.01)

**Figure 2.3**

*Changes in Significant Secondary Outcomes (Cannabis Problems) Over Time*




*Note.* Problems Time x Condition interactions were significant for RA versus waitlist ($p$ = .03) and marginally significant for therapist versus waitlist ($p$ = .06).

# CHAPTER 3
# STUDY 2

## Lessons Learned: Challenges in Recruiting and Engaging People with Heavy Cannabis Use for Online Interventions

Chapter 2 is an unrefereed, preprint version of this article:
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**Abstract**

*Background:* People who seek treatment often disengage between completing screening and starting treatment. Among those who begin treatment, many have low completion of program content and are lost to follow up. Currently, little is known about predictive factors of treatment initiation and engagement. The aims of the present study were to discuss the practicality of a randomized controlled trial for online heavy cannabis use treatment and to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program.

*Method:* The intervention was preregistered on clinicaltrials.gov for traceability (ID: NCT04965012), and the main trial results are currently under review for publication (Rysen et al., under review). Statistical models were organized into 3 conceptual predictor groupings using baseline data: individual cannabis-specific factors, mental health and other substance use factors, and treatment belief factors. Binomial regressions examined which factors predicted treatment initiation in the *CANreduce* treatment program and multiple regression analyses examined which factors predicted percentage of the *CANreduce* program modules completed among participants who initiated treatment.

*Results:* Despite following the core elements of published treatment retention protocols (Gul & Ali, 2010; Scott, 2004), there were recruitment challenges for the main trial. Of 928 people who created a profile on the website and began screeners, 86.3% ($n$ = 801) completed screeners. Of the 801 who completed screeners, 31.3% ($n$ = 251) were eligible for the program. Of those eligible and assigned to active treatment, 54.3% ($n$ = 51) assigned to the therapist condition and 45.7% ($n$ = 43) assigned to the research assistant condition initiated treatment. Treatment initiation predictors included higher cannabis use problems score, lower family history density, increased alcohol use frequency, and more positive attitudes towards treatment. Treatment engagement (percentage of program completed) predictors included increased social motives for cannabis use and more positive attitudes towards treatment.

*Discussion:* Recruiting individuals with heavy cannabis use for treatment is challenging, particularly in the context of a clinical trial to examine treatment efficacy. Several barriers to treatment initiation and engagement exist. Exploration of predictive factors can help mitigate barriers to accessing help earlier in the treatment-seeking pathway.

*Key Words*: cannabis, online intervention, recruitment, treatment initiation, treatment engagement

## Introduction

Nearly half of all Canadians have tried cannabis in their lifetime, making it one of the most used substances by Canadians (Health Canada, 2017). As of 2019, approximately 16.8% of Canadians aged 15 or older reported using cannabis in the past 3 months, and approximately 6% had used it on a daily or almost daily basis (Rotermann, 2020). While many individuals can use cannabis without experiencing associated risks and harms (Degenhardt & Hall, 2001), many individuals who use cannabis in frequent or high quantity proportions may experience consequences of cannabis use including negative effects on working memory, planning, and decision making, response time, accuracy and latency motivation, motor coordination, mood and cognition (WHO, 2016). It is estimated that approximately one in three individuals who use cannabis daily develop Cannabis Use Disorder (CUD; WHO, 2016), and those individuals who experience CUD and are concerned about their use are more likely to seek treatment (Williamson et al., 2022). However, seeking treatment is not synonymous with receiving treatment, for a variety of reasons.

Over time, the demand for cannabis use treatment has increased (Manthey et al., 2021). Data compiled by the WHO indicates cannabis is second only to alcohol for a reason for substance use treatment entry (WHO, 2016). In Western countries, it is estimated that one quarter of individuals entering addiction treatment report cannabis problems, and these individuals are typically young men with a high rate of legal problems (Rush & Urbanoski, 2007). Literature specifically on Canadian treatment seeking rates and individual factors is sparse and often only examines cannabis use being reported as a comorbidity of other substance use treatment seeking (Williamson et al., 2022). Although psychosocial treatment approaches have been studied extensively (Gates et al., 2016), there is a relatively sparse availability of evidence-based treatments for cannabis use (Jutras-Aswad et al., 2019).

Two major problems of evidence-based treatments for heavy cannabis use exist. First, there is still a shortage of evidence-based cannabis treatment programs available, especially those available online (Jutras-Aswad et al., 2019). Despite treatment being in high demand (WHO, 2016), there are only a handful of cannabis treatment programs that have been formally created and tested in the gold-standard, Randomized Controlled Trial (RCT) format (e.g., German “CANDIS”, Hoch & Rohrbacher, 2017; Dutch “ICan”, Olthof et al., 2021; Australian “Reduce Your Use: How to Break the Cannabis Habit, Rooke et al. 2013; Swiss “Can reduce”,

Amann et al., 2018; Baumgartner et al., 2021; Schaub et al., 2013; Canadian *CANreduce*, Rysen et al., under review; German "Quit the Shit", Tossman et al., 2011; Australian "A Way Out of Fog", Tunving et al., 1988). To date, investigation of the efficacy of these treatment programs offers mixed results. Some studies have found cannabis treatment programs are effective in treating cannabis use, and result in changes to various facets of cannabis use such as less cannabis use (Baumgartner et al. 2021; Rooke et al., 2016; Tossman et al., 2011), fewer cannabis use disorder symptoms (Baumgartner et al., 2021), and less cannabis-related problems (Hoch et al., 2014). Alternatively, some studies have not found programs to be effective in treating cannabis use (Sinadinovic et al., 2020), or show modest effects on some areas of cannabis use but not on others (e.g., Rysen and colleagues [under review] found reduction in cannabis quantity, but not frequency of use). Despite some demonstrated efficacy, these programs are not often widely available to treatment seekers. Qualitative studies examining treatment responses suggest themes of cannabis use treatment programs being hard to access, instead of cannabis using individuals being hard to reach (Monaghan et al., 2016).

Second, many individuals who experience CUD do not seek treatment (Roffman & Stephens, 2006), and even those who do may drop out prematurely. Premature treatment dropout is a problem that exists across all substance use treatments, not just for cannabis, with studies citing attrition rates for substance use treatments ranging from 30% to 66% (Etter, 2005; Frohlich et al., 2022; Lappan et al., 2020; Schaub et al., 2015). Factors that may interfere with accessing and completing evidence-based treatment when it is available include worries about stigma (Gates et al., 2012; Monaghan et al., 2016; van der Pol et al., 2013), cost of treatment (Ellingstad et al., 2006), and complicated access in rural or remote areas (Richards & Viganó, 2013). A large body of research examining best practices for maximizing participant retention and increasing engagement in substance use treatment once it begins cites as participant retention as a common issue (Eysenbach, 2005; Etter, 2005; Frohlich et al., 2022; Rysen et al., under review). However, many individuals drop out of cannabis use treatment in the period between completing screening and initiating the program. Cannabis use studies tend to show significant reduction from those who are interested and eligible for treatment, and those who complete the treatment (Norberg et al., 2012). Tossman and colleagues (2011) noted that out of the 863 participants recruited for their cannabis use treatment program and allocated to the intervention condition, 58% did not end up taking part of the study. Noninitiation of treatment can be further

complicated by being placed on a waitlist, a key aspect of gold-standard RCTs, as literature demonstrates that shorter wait times between assessment and treatment increase odds of participating in treatment (Claus & Kindleberger, 2011). Despite the common difficulty of people dropping out of programs between screening and treatment, little literature exists examining the factors that contribute to pretreatment dropout specifically in cannabis treatment programs. A 2002 study by Vendetti and colleagues examined pretreatment dropout factors among 813 eligible study participants with cannabis dependence, finding pretreatment dropout was associated with being younger, unmarried, unemployed, less educated, and being of Asian American or Native American descent. These authors also found that having greater self-perceived dependence on marijuana and using other drugs were associated with not initiating cannabis treatment (Vendetti et al., 2002). Given the widely prevalent problem of treatment noninitiation, more research is needed examining factors that predict pretreatment disengagement.

Once an individual begins a treatment program, low engagement with the program is also a commonly cited issue in substance use research. Discontinuation of treatment is common, with some researchers citing approximately 20-70% discontinuation of general psychosocial treatment (Gearing et al., 2014), and 50% discontinuation over the course of cannabis use treatment (Tossman et al., 2011). Similarly, Sinadinovic and colleagues (2020) found that 35% of their cannabis intervention group participants did not visit the treatment website after the first day. In terms of treatment content completion, the extant cannabis treatment literature reports a range of module completions, including 3.9/13 modules (30%; Sinadinovic et al., 2020), 3.2/8 modules (40%; Schaub et al., 2015), 4.1/8 (51.58%, Rysen et al., under review) and 3.5/6 modules (58.33% Rooke et al., 2013). Given that adherence to treatment programs has been demonstrated to increase positive outcomes generally in mental health treatment (Gearing et al. 2014), and lower cannabis use disorder symptoms at follow up in cannabis use treatments (Sinadinovic et al., 2020), examining factors that predict engagement in treatment is a much needed area of research.

To date, there have been limited studies examining the predictors of treatment initiation and engagement for online cannabis use treatments. While studies examining the predictors of treatment initiation and engagement exist in other similar areas of research (i.e., Brown and colleagues (2010) examining predictors of treatment initiation and engagement in co-occurring

serious mental illness and substance use disorders), there is a relative scarcity of cannabis-specific research. Hence, the goals of the present paper were to 1) discuss the practicality of a randomized controlled trial for online heavy cannabis use treatment and to 2) to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program.

Drawing on wider literature, several factors have been demonstrated to impact general engagement and outcomes in mental health and substance use treatments. Sociodemographic factors, specifically gender and ethnicity, are frequently reported predictors of treatment outcomes (Gergov et al., 2024). While gender findings are inconsistent for which gender benefits most from treatment, studies suggest ethnic minority status may predict poorer treatment outcomes (Gergov et al., 2024). Beyond sociodemographic factors, several key factors may impact treatment initiation and engagement, including severity of substance use disorder (Brown et al., 2010; Sinadinovic et al., 2020); motives for using substances (Dow & Kelly, 2012); using other substances (Subbaraman et al., 2017); other mental health difficulties (Compton et al., 2003); family history density (Khoddam et al., 2015); motivation for treatment (Alfonsson et al., 2016); and attitudes towards treatment (Pettinati et al., 2009). Hence, in the present study, three conceptual predictor groupings using information collected during baseline screening (i.e., to determine eligibility, prior to randomization) were organized based on extant literature to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program: (1) *individual cannabis-specific factors* including cannabis problems as measured by the Cannabis Use Disorders Identification Test – Revised (CUDIT-R; Adamson et al., 2010), family history density, and cannabis motives including for enhancement, conformity, expansion, coping, and social factors as measured by the Marijuana Motives Questionnaire (MMQ; Simons et al., 1998); (2) *Mental health and other substance use factors* including depression as measured by the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001), diagnosed mental illness, lifetime mental illness treatment, alcohol use frequency and alcohol use quantity as measured by the National Institute on Alcohol Abuse and Alcoholism screening questions (NIAAA, 2007); and (3) *treatment belief factors* including attitudes towards treatment as measured by the Attitudes Towards Seeking Professional Psychological Help – Short Form (ATSPPH-SF; Fischer & Farina, 1995), pretreatment importance, pretreatment confidence and pretreatment readiness. Based on extant literature, the hypotheses were as follows:

1. **Hypothesis 1:** Regarding individual cannabis-specific factors, higher treatment initiation and program engagement would be predicted by increased scores on the CUDIT, lower family history density, and higher cannabis motives.
2. **Hypothesis 2:** Regarding mental health and other substance use factors, higher treatment initiation and program engagement would be predicted by increased depression, presence of a diagnosed mental illness, presence of lifetime mental illness treatment, increased alcohol use frequency, and increased alcohol use quantity.
3. **Hypothesis 3:** Regarding treatment belief factors, higher treatment initiation and engagement would be predicted by more positive attitudes towards treatment seeking, and higher pretreatment importance, confidence and readiness.

## Method

### Recruitment Procedures

Over a period of nine months, from October 2022 to August 2023, participants were recruited for the RCT testing the Canadian *CANreduce* program using various strategies, including online (e.g., Google Ads, Reddit), university-based (e.g., posters at university, student research participant pools), and community-based (e.g., posters at health clinics) methods. Interested participants were directed to the *CANreduce* website, where they could register for an account. Participants were required to complete a baseline battery of questionnaires to finalize the registration of their account. After registration was complete, members of the research team used the baseline battery of questionnaires to determine eligibility and contact participants about next steps (i.e., randomization into a study arm if they were eligible, discussion of alternative cannabis use and mental health resources if they were ineligible).

### Eligibility Criteria

Eligibility for the program included: 1) being over the age of 19, 2) currently residing in Ontario or Manitoba, 3) self-reporting difficulties with cannabis as indicated by a score of 8 or more on the Cannabis Use Disorders Identification Test – Revised (CUDIT-R; Adamson et al., 2010), 4) fluency in English, 5) having weekly Internet access with a device that allows for video connection, and 6) self-reporting at least a 6 out of 10 on a rating scale for motivation to reduce cannabis use. Participants were excluded if they self-reported 1) currently engaging in other psychological or pharmacological treatments for cannabis use, 2) elevated suicidality, as defined by scoring greater than minimal risk on a screener (Dube et al., 2010), or 3) current serious

psychiatric disorders, such as a history of psychosis, schizophrenia, and/or bipolar disorder. Informed consent for participation was provided electronically on the study website prior to registering for an account.

## CANreduce Study Overview

Eligible participants were randomized into one of three conditions: (1) a one-hour Motivational Enhancement Therapy (MET)-therapist guided introduction plus 6-week, online, self-guided treatment program; (2) a 15-minute non-MET research assistant introduction plus 6-week, online, self-guided treatment program; or (3) a waitlist control condition. The MET-therapist condition included completion of the first module together using an MET- and CBT-informed script which encouraged facilitating discussion about ambivalence to change, sourcing motivation, helping formulate initial cannabis reduction goals and providing normative feedback on the participant's current level of cannabis use. The MET-therapist introduction also included a brief introduction on how to use the *CANreduce* website. The non-MET research assistant introduction did not include completion of the first module together, contained no MET-therapy in the script, and instead was solely an introduction to how to use the *CANreduce* website. The self-guided *CANreduce* program is comprised of eight modules containing strategies of cognitive behavioural therapy and motivational interviewing approaches to help participants think about reasons for changing their cannabis use habits; consider benefits and harms of their current level of use, identify goals for cannabis use reduction; learn coping strategies for cravings, triggers, and social pressures; and learn how to prevent slips. Treatment modules also focus on building skills for the participants to better take care of themselves (i.e., better sleep schedules, reducing worry and rumination, and finding positive ways to cope with stress, like relying on friends and family). Participants were given 6 weeks to complete the eight modules and were encouraged to use the cannabis use tracker at a frequency of at least once per week.

## Preintervention Assessment Battery

All participants registering for an account were given a comprehensive questionnaire battery, serving as a baseline assessment for the present treatment study. Additional measures not included in the present study were collected as part of a larger data set.

### *Individual cannabis-specific factors*

**Cannabis use disorder severity.** The Cannabis Use Disorders Identification Test-Revised (CUDIT-R; Adamson et al., 2010) was used to assess cannabis use disorder severity at

baseline. The CUDIT-R is an 8-item self-report measure. Sum scores were calculated, where higher scores indicated more problematic cannabis use. The internal consistency of the CUDIT-R at baseline was acceptable ($\alpha = 0.75$).

**Family History Density.** Family history density estimates cannabis use problems prevalence among an individual's immediate family. Family history density was calculated from information collected in the demographic questionnaire, which asked "Do you think your biological mother/biological father/biological grandparents have/had cannabis use problems?" A weighted score was created, similar to alcohol use family history density research by Stoltenberg and colleagues (1998), where both parents and grandparents (i.e., each alcoholic parent received a score of 0.5, and each alcoholic grandparent received a score of 0.25, for a range of 0-2) were considered. However, since our question simply asked if "biological grandparents" as a collective unit had cannabis problems, and not each specific grandparent in a separate question, our calculation and sum score was slightly different than Stoltenberg and colleagues (1998). Parents with probable cannabis use problems were assigned a score of 0.5 each, and endorsement of any grandparent with a probable cannabis use problem was assigned a score of 0.25, for a total possible range of 0 (indicating no family history density) to 1.25 (high family history density).

**Cannabis Motives.** The Marijuana Motives Questionnaire (MMQ; Simons et al., 1998) is a 25-item measures of motives for marijuana use. Participants were asked to indicate the frequency with which they use marijuana for various reasons on a scale from 1 (Almost never or never) to 5 (Almost always or always). Subscales were calculated for the 5 factors (enhancement, conformity, expansion, coping and social motives), where higher scores indicate higher rated motives in each subscale. The internal consistency of the MMQ subscales were all good (enhancement, $\alpha = 0.81$; conformity, $\alpha = 0.83$; coping, $\alpha = 0.83$; social, $\alpha = 0.82$) or excellent (expansion, $\alpha = 0.93$).

**Mental health and other substance use factors**

**Depression.** Depression was assessed using the Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001). Sum scores were calculated where increased score indicated higher depressive symptoms. The PHQ-9 internal consistency was good ($\alpha = 0.89$).

**Diagnosed mental illness.** Participants self-reported the presence of diagnosed mental illness in the demographics questionnaire (0 = no, 1 = yes). Participants were also given the

opportunity to specify mental illness diagnosis, but this information was not included in the present analyses.

**Lifetime mental illness treatment.** Participants self-reported the presence of lifetime treatment for mental illness in the demographics questionnaire (0 = no, 1 = yes). Participants were also given the opportunity to specify mental illness treatment type, but this information was not included in the present analyses.

**Alcohol use frequency.** Alcohol use frequency was assessed using one question on the National Institute on Alcohol Abuse and Alcoholism's (NIAAA, 2007) recommended alcohol use disorder screening questions. Participants were asked how frequently they consumed any kind of drink containing alcohol, with options ranging from never (0) to every day (7). Higher scores indicated higher alcohol use frequency.

**Alcohol use quantity.** Alcohol use quantity was assessed using one question on the National Institute on Alcohol Abuse and Alcoholism's (NIAAA, 2007) recommended alcohol use disorder screening questions. Participants were asked how many standard alcoholic drinks they had on a typical day they drank alcohol, with options ranging from 1 (1) to 25 or more (10). Higher scores indicated higher alcohol use quantity.

### *Treatment belief factors*

**Attitudes towards treatment seeking.** The Attitudes Towards Seeking Professional Psychological Help – Short Form (ATSPPH-SF; Fischer & Farina, 1995) is a 10-item self-report measure that was used to assess attitudes towards seeking treatment. Participants were asked to indicate how strongly each statement about treatment seeking beliefs applies to them on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Sum scores were calculated, where higher scores indicated more positive attitudes towards seeking professional psychological help. The ATSPPH-SF internal consistency was good ($\alpha = 0.85$).

**Pretreatment importance, confidence and readiness.** Scores of the participant's pretreatment self-reported importance, confidence and readiness (DiClemente et al., 2004) were collected by asking participants how important treatment was, how confident they were in their ability to change, and how ready they were to change at that point in time. Possible scores ranged from 0 (Not confident/important/ready) to 10 (Very important/confident/ready). Scores were reported separately for importance, confidence and readiness, no sum scores were created.

## Data Analytic Plan

Data were analyzed using SPSS version 25.0. Statistical models were organized into three conceptual predictor groupings based on the literature: individual cannabis-specific factors, mental health and other substance use factors, and treatment belief factors. Individual cannabis-specific factors included cannabis problems as measured by the CUDIT-R, family history density, and cannabis motives including for enhancement, conformity, expansion, coping, and social factors as measured by the MMQ. Mental health and other substance use factors included depression as measured by the PHQ-9, diagnosed mental illness, lifetime mental illness treatment, alcohol use frequency and alcohol use quantity as measured by the NIAAA. Treatment belief factors included attitudes towards treatment as measured by the ATSPPH-SF, pretreatment importance, pretreatment confidence and pretreatment readiness. Given that gender (Callaghan et al., 2019; Dacosta,-Sanchez et al., 2024; Fairman et al., 2019; Feingold et al., 2024; Rotermann, 2019) and race (Fairman et al., 2014; Feingold et al., 2024; Peters et al., 2014) have been demonstrated to be significant factors in the onset, severity and treatment success of heavy cannabis use, both were included as covariates throughout each of the models explained below. Dichotomous covariates were organized in terms of gender (0 = men, 1 = women[3]) and race (0 = white, 1 = nonwhite).

First, binomial regressions examined which factors predicted treatment initiation in the *CANreduce* treatment program. Group one was defined as those who were eligible for the program but did not attend the introductory session or have access to the program. Group two was defined as those who were eligible and participated in either the therapist-guided introduction or research assistant-guided introduction and received subsequent access to the program. Model fit information was examined to explore if the fit of the model was improved with the addition of predictor variables, and then individual variable contributions were examined.

Second, multiple regression analyses examined which factors predicted engagement in the program, as defined by greater percentage of the *CANreduce* program modules completed. Percentage of program completed was calculated examining how many cumulative pages of modules were completed. Only participants who engaged in the program (i.e., attended either the

[3] Due to the low representation of transgender and nonbinary individuals, we coded their data for this variable as missing.

therapist-guided introduction or the research assistant-guided introduction) gained access to the program, and hence, only these participants were included in this portion of the analysis. We examined the proportion of variance explained in the outcome by the predictors as a set and then individual variable contributions were examined. Variables were entered in a hierarchical method, with two blocks of variables. The first block included covariates of gender and race as predictors, with percentage of program completion as the dependent variable. In block two for each conceptual predictor grouping, the predictors of interest were examined.

## Results

### Recruitment

Refer to Figure 1 for comprehensive flow chart. Over nine months of active recruitment resulted in 928 individuals interested in the *CANreduce* treatment program creating a profile on the *CANreduce* website and beginning to fill out the preintervention assessment battery. Out of 928, 801 (86.3%) completed the battery, indicating that 127 (13.7%) individuals (who were potentially eligible for the program) did not complete the preintervention battery. Of the 801 who completed questionnaires, 550 (68.7%) were excluded for the following reasons: did not consent to participate ($n$ = 2), did not meet age requirement ($n$ = 64), did not reside in Manitoba or Ontario ($n$ = 7), insufficient CUDIT-R score ($n$ = 347), insufficient motivation score ($n$ = 95), higher suicide risk ($n$ = 11), exclusionary mental health issues ($n$ = 16) and voluntary withdrawal from study ($n$ = 8). Removing ineligible participants from the sample left 251 (31.3%) eligible participants that were randomly assigned via random number generator into one of three conditions: MET-therapist guided introduction and access to the treatment program ($n$ = 94); non-MET research assistant guided introduction and access to the treatment program ($n$ = 94) and waitlist control ($n$ = 63). Of participants randomly assigned to the MET-therapist guided introduction, 51 (54.3%) attended the introduction to the program with the MET-therapist, and 43 (45.7%) did not attend (which included either no response to facilitator email or no-showing their arranged appointment). Of participants randomly assigned to the non-MET research assistant guided introduction, 43 (45.7%) attended the introduction to the program with the non-MET research assistant, and 51 (54.3%) did not attend (which included either no response to facilitator email or no-showing their arranged appointment). This indicates that 94 participants (50%) attended either an MET-therapist or non-MET research assistant introduction, and an additional 94 participants (50%) were eligible but did not attend an introduction. All participants

randomly assigned to the waitlist control received automatic access to the *CANreduce* treatment program at 10 weeks regardless of questionnaire completion at end of waiting period or follow up, or further interaction with facilitators. All participants in the waitlist control ($n$ = 63) were also offered a non-MET research assistant introductory meeting after the allotted 10-week waiting period, but only 4 people (6.3%) completed this meeting. Overall, only 10.1% of participants ($n$ = 94) from the full recruitment sample ($N$ = 928), or 50% of eligible participants across randomized treatment groups ($n$ = 94), engaged in one of the two *CANreduce* guided introductions and subsequent treatment program.

**Predictors of initiating treatment**

Binomial regression was performed to see if conceptual predictor groupings predicted the odds of an individual initiating participation in the *CANreduce* treatment program, after controlling for gender and race. The reference group was those who attended the introductory session (coded as 0) compared to those who were eligible but did not attend (coded as 1), hence negative coefficients indicated increased likelihood of attending. Relative to the intercept-only model, the inclusion of individual cannabis-specific factors significantly improved model fit ($X^2$ [9, $N$ = 188] = 22.74, $p$ =.007). Collectively, the individual cannabis-specific factors explained an estimated 16% (Nagelkerke pseudo $R^2$ = 0.162) of the variance in likelihood of attending the program. Results showed that having baseline higher cannabis use problems and lower[4] family density history increased the odds of participating in the *CANreduce* program (see Table 3.2). Relative to the intercept-only model, the inclusion of mental health and other substance use factors did not significantly improve model fit ($X^2$ [7, $N$ = 188] = 13.20, $p$ =.067). Collectively, the inclusion of mental health and other substance use factors explained 13% (Nagelkerke pseudo $R^2$ = 0.131) of the variance in likelihood of attending the program. After controlling for race and gender, results showed increased alcohol use frequency increased the odds of participating in the *CANreduce* program (see Table 3.3). Relative to the intercept model, the inclusion of treatment belief factors significantly improved model fit ($X^2$ [6, $N$ = 188] = 18.07, $p$ =.006). Collectively, the treatment belief factors explained 13% (Nagelkerke pseudo $R^2$ = 0.132) of the variance in likelihood of attending the program. Results showed more positive attitudes

[4] Due to variable coding, Table 2 states higher family history density predicts lower treatment initiation. To keep discussion consistent with factors that predict higher treatment initiation, this is discussed in text as lower family history density predicting higher treatment initiation.

towards seeking psychological help increased the odds of participating in the *CANreduce* program (see Table 3.4).

**Predictors of percentage of program completed**

Multiple regression analyses were conducted to evaluate the extent to which the conceptual predictor groupings could predict percentage of the program completed. Gender and race were included as covariates in block one for each model. Individual cannabis-specific factors explained approximately 18.4% of the variance in percentage of program completion. Among the factors, greater social motives for cannabis use significantly predicted a greater percentage of the program being completed (see Table 3.5). Mental health and other substance use factors explained approximately 11% of the variance in percentage of program completion. After controlling for race and gender, no factors significantly predicted a greater percentage of the program being completed (see Table 3.6). Treatment belief factors explained approximately 14% of the variance in percentage of program completion. More positive attitudes towards treatment seeking significantly predicted a greater percentage of the program being completed (see Table 3.7).

## Discussion

One primary observation of this study is that recruiting individuals with heavy cannabis use for treatment is a demonstrated difficult endeavor, particularly in the context of a clinical trial to examine treatment efficacy. Only a small proportion (approximately 10%) of those initially in contact with the *CANreduce* program engaged in one of the two *CANreduce* guided introductions and subsequent treatment program. Most of the attrition in the current study took place during eligibility screening. While part of the initial recruitment difficulty may have been drawing on university participant pool subjects where participants may have completed questionnaires for course credit rather than treatment seeking for cannabis use problems (as illustrated by the $n = 347$ for insufficient cannabis use that were excluded from participating), a significant proportion (50%) of individuals who were eligible for the program and hence, had at least moderate cannabis use problems, still did not engage in the offered treatment. Additionally, it is possible that individuals with less than moderate cannabis use were interested in engaging in the program but were screened out due to RCT inclusion and exclusion criteria. Given than a wide spectrum of cannabis use severity can benefit from online, self-guided treatments, future studies could examine the outcomes of offering the individuals with less than moderate severity

cannabis use the online modules as a brief intervention without the guided introduction. Beyond the scope of this paper, but important when looking at engagement in the *CANreduce* program, results from the initial *CANreduce* study (Rysen et al., under review) demonstrated 66% participant dropout from study engagement to 4-week follow up using an Intent-to-Treat analysis (inclusion in the ITT population was determined based on contact with facilitators at least once via email). Further, for those individuals who engaged in either the MET-therapist or non-MET research assistant, the average percent of the online *CANreduce* program content completed was 51.58% (*SD* = 36.82) with 24.5% (*n* = 23) of participants completing all 8 modules with no significant differences between the two conditions (Rysen et al., under review). Together, attrition at any stage during the treatment significantly affects participants' treatment outcomes.

A primary aim of the present paper was to address factors that affect treatment initiation and engagement in the *CANreduce* program. By having participants complete comprehensive preintervention assessment batteries prior to engaging in the program, we were able to examine meaningful differences between treatment seekers who showed interest in the program but did not participate, and those who followed through with participation, as well as factors that contributed to engagement in the program, as defined by percentage of the online program completed.

Treatment initiation factors from the present study included higher cannabis use problems score, lower family history density, increased alcohol use frequency, and more positive attitudes towards treatment. Higher cannabis use problems predicting treatment initiation for the program is consistent with literature that suggests individuals who are concerned about the harm caused to them by cannabis use are more likely to seek treatment. (Williamson et al., 2022). Additionally, lower family history density predicted more treatment initiation in the program. Leaning on literature regarding injunctive norms, if cannabis use in an individual's immediate social circle is normative, the individual may be more likely to accept regular cannabis use as acceptable, or encounter increased barriers to change (e.g., more readily available cannabis, increased motives for cannabis use). Literature suggests that family history density plays an important role in cannabis use behaviours (Khoddam et al., 2016), and that parental CUD (but not parental cannabis use that is not at the CUD level of severity) is associated with adolescent cannabis use (Hill et al., 2018). Alcohol use frequency was found to be a statistically significant treatment initiation factor, where increased alcohol frequency increased the odds of participating in the

program. Couse of alcohol and cannabis can have significantly greater negative outcomes than using either substance on their own (Yurasek et al., 2017), demonstrate heavier use (Thompson et al., 2021) and may increase harms such as drunk driving, social consequences and harm to self (Subbaraman & Kerr, 2015). Given the increased severity of symptoms and impact on co-using participants' lives, they may have been more likely to see treatment as a worthwhile option. Finally, attitudes towards treatment were found to be statistically significant in predicting odds of engaging in the program. Previous literature suggests that cannabis help seekers hold a more positive attitude towards treatments (van der Pol et al., 2013). Given that individuals who have greater treatment expectancies tend to have better treatment outcomes (Raylu & Kaur, 2011), especially when paired with client self-efficacy (Kuusisto et al., 2011), it is unsurprising that those with more positive attitudes towards treatment predicted treatment initiation.

Factors predicting engagement in the program, as defined by percentage of the online *CANreduce* program completed, included increased social motives for cannabis use and more positive attitudes towards treatment. Increased social motives predicting increased percentage of the program completed is interesting, given that in other addiction literature, social motives have been shown to hinder treatment seeking efforts as resolving the addiction may reduce the social aspect of the use (Sztainert et al., 2014). However, given that a large proportion of the *CANreduce* program that aimed to address changing normative perceptions of cannabis use among the general population and specifically navigating social situations without cannabis use, perhaps these individuals were able to better engage in the program and were interested in adapting how they were meeting their social needs with cannabis use. It is possible that addressing social motives for cannabis use over the course of the program made the program content more approachable, whereas content addressing other more challenging motives tied more directly to CUD severity (e.g., coping motives, Moitra et al., 2015), may have led to more disengagement in the program. Similar to predicting treatment initiation, positive attitudes towards treatment also predicted increased percentage of program completed. This is consistent with wider literature that suggests individuals who have negative perceptions of care show less engagement in treatment (McLean et al., 2022; Sturgess et al., 2015).

In sum, the present paper illustrates the difficulties in both recruiting and engaging individuals with heavy cannabis use in an online treatment with facilitator contact prior to self-help therapy modules for cannabis use. While there is great need and evidence of effective

evidence-based treatment, several barriers to getting an individual to attend treatment exist, as illustrated by the present study's findings of significant pretreatment factors affecting treatment initiation and engagement. To combat the difficulties in recruiting and engaging individuals to begin treatment, the authors make the following suggestions. While it is important to control for external factors when examining the efficacy of newly developed treatment programs through inclusion and exclusion criteria characteristic of RCT's (e.g., including participants with moderate difficulties in target substance areas, and controlling for comorbidities or outside treatment), strict criteria can impact enrollment in the program and narrow the scope on who can potentially benefit from the treatment. Restricting who meets enrollment criteria in the program affects both the researcher's ability to evaluate the program with a large enough sample size in a timely manner (and make good use of study resources) as well as the potential benefits the participants could gain from completing the program. Several individuals who completed the eligibility survey in the current study had just below moderate cannabis difficulties, and hence were ineligible to participate in the study. However, given the wider literature and the stepped-care approach to treatment, individuals across the substance use intensity spectrum (i.e., mild or moderate towards more severe problems) do not have differential dropout rates from treatment programs (Dacosta-Sanchez et al., 2019) and may benefit from online (self- or guided) treatment (Riper et al., 2014, Eék et al., 2023). Moving towards including a wider range of cannabis use severity may help expand the benefits of cost-effective, easily accessible online treatment programs to a wider range of individuals. Given that online programs can benefit a wide spectrum of cannabis use severities and increased cannabis use problems predicted engagement in the guided introduction and program, future studies could examine the outcomes of admitting individuals with less than moderate cannabis problems directly into the self-guided program, while having individuals with moderate severity or higher cannabis use into a therapist-guided introduction and subsequent program.

Second, while we could not control individual factors affecting participation, more can be done to address factors associated with pretreatment dropout earlier in the treatment-seeking pathway. As an example, it is only in the second last module of the Canadian *CANreduce* program where navigating cannabis among close social relationships is addressed. Given that family history density (and likely resulting social norms and situations) impacted treatment initiation, providing brief information upon registration (e.g., having a welcome email with

topics to expect, or addressing frequently asked questions [i.e., “If my family and friends still use cannabis, is it harder for me to stop?”]) may offset these dropout factors. This may be particularly helpful, given that individuals who initiated the program and had higher social motives for use ended up more fully engaging in the program as illustrated by increased percentage of program completed. Future research should consider tailoring the delivery of intervention content in a method that is more individualized and address individual risk factors earlier in the pathway to mitigate treatment initiation and engagement difficulties (e.g., if coping is the primary reason for cannabis use, providing earlier information on alternative coping methods may be warranted). Approaches to individualized treatment, such as the ecological momentary assessment and intervention (EMA/EMI) has been used in other areas of substance use treatment (e.g., alcohol use), show that tailoring programs to risk factors and delivering that information in a timely manner helps to decrease substance use and associated motives for substance use over time (Blevins et al., 2021). More research is needed to better understand how to intervene earlier in the treatment seeking pathway to address the wide array of pretreatment dropout factors demonstrated in this study, as well as other studies in various substance use areas.

The present study is not without limitations. First, the sample in the present study comprised mainly white, young-to-middle aged women who were employed fulltime. Given the significant differences in treatment access, cannabis use patterns, and treatment outcomes among populations underrepresented in this study, the generalizability of these results is limited. Future research should aim to more adequately represent a broader segment of the population over that in the study sample. Second, the present study only examined treatment engagement by calculating only percentage of program modules completed. While this metric gave us a standardized comparison to draw on across all participants given access to the program, several other factors could be considered to give a more well-rounded evaluation of participation. As an example, all participants in the *CANreduce* program were asked to track their cannabis use using a daily cannabis use diary, a tool which also helped them to set and give feedback on their reduction goals. Future research could examine how regularly participants used this tracker and used the information to modify their cannabis use behaviours as another metric of participation. Other metrics of participation may include external observation ratings of participation (e.g., by the therapist or research assistant during initial meeting), frequency and duration of visits to the

*CANreduce* modules and trackers, or self-ratings of engagement with the material after each module. Additionally, the trajectory of these changes should be tracked over time to better elucidate the relationship between treatment engagement and treatment gains on a more granular level, whereas the current study only evaluated only one metric of engagement calculated at the end of the treatment program.

Overall, our findings reflect the well-documented difficulties in recruiting and engaging participants for online cannabis use research. The present study elucidated several pretreatment factors that played significant roles in both treatment initiation and treatment engagement in the *CANreduce* treatment program, one of the first online, CBT and MET self-guided treatment programs for heavy cannabis use available in North America that has an integrated MET-therapist guided introduction. Future research should consider using findings from the present study on pretreatment factors to minimize dropout in the critical period between screening and treatment initiation, as well as to maximize treatment participation and engagement.

**Table 3.1**

*Descriptive Statistics of Study Variables by Group at Baseline*

| Variable | Grouping | |
|---|---|---|
| | Eligible who attended ($n$ = 94) | Eligible with no participation ($n$ = 94) |
| Age, *M* (SD) | 32.05 (10.92) | 27.44 (9.08) |
| Gender, % (*n*) | | |
| Man | 38.3% (36) | 34% (32) |
| Woman | 58.5% (55) | 63.8% (60) |
| Transgender | 2.1% (2) | 1.1% (1) |
| Nonbinary | 1.1% (1) | 1.1% (1) |
| Race, % (*n*) | | |
| East Asian, South-East Asian, Pacific Islander (e.g., Chinese, Japanese, Korean, Vietnamese, Thai) | 5.3% (5) | 7.4% (7) |
| Middle Eastern, North African, Central Asian (e.g., Jordanian, Saudi, Egyptian, Moroccan, Iranian) | 6.4% (6) | 5.3% (5) |
| Hispanic or Latino (e.g., Brazilian, Chilean, Mexican, Cuban) | 1.1% (1) | 3.2% (3) |
| Caucasian or White (e.g., Russian, German, Latvian, French, Scottish, Italian) | 70.2% (66) | 53.2% (50) |
| Black (e.g., African-American, Nigerian, Haitian, Jamaican, Somali) | 4.3% (4) | 10.6% (10) |
| Indigenous or Aboriginal (e.g., First Nations, Inuit, Metis, Native American, Native Australian) | 7.4% (7) | 6.4% (6) |
| South Asian (e.g., Indian, Pakistani, Sri Lankan, Nepalese) | 4.3% (4) | 9.6% (9) |
| Other | 1.1% (1) | 4.3% (4) |
| Pretreatment Importance, *M* (SD) | 9.09 (1.27) | 8.88 (1.34) |

| | | |
|---|---|---|
| Pretreatment Confidence, *M* (SD) | 5.85 (2.31) | 6.51 (2.61) |
| Pretreatment Readiness, *M* (SD) | 7.69 (2.13) | 7.97 (2.10) |
| NIAAA Alcohol frequency, *M* (SD) | 2.69 (2.19) | 2.09 (1.88) |
| NIAAA Alcohol quantity, *M* (SD) | 2.69 (1.28) | 2.91 (1.31) |
| CUDIT-R, *M* (SD) | 22.54 (5.57) | 20.38 (6.35) |
| PHQ, *M* (SD) | 13.72 (6.67) | 14.30 (6.92) |
| MMQ Enhancement motives, *M* (SD) | 2.92 (0.69) | 2.75 (0.84) |
| MMQ Conformity motives, *M* (SD) | 1.13 (0.26) | 1.24 (0.54) |
| MMQ Expansion motives, *M* (SD) | 1.99 (0.94) | 2.07 (1.03) |
| MMQ Coping motives, *M* (SD) | 2.96 (0.79) | 2.96 (0.90) |
| MMQ Social motives, *M* (SD) | 1.93 (0.79) | 1.96 (0.82) |
| ATSPPH-SF, *M* (SD) | 40. 31 (6.30) | 36.72 (7.03) |
| Family history density, *M* (SD) | 0.14 (0.27) | 0.19 (0.32) |
| Mental Illness Diagnosis, % (*n*) | | |
| No | 35.1% (33) | 48.9% (46) |
| Yes | 63.8% (60) | 51.1% (48) |
| Mental illness treatment history, % (*n*) | | |
| No | 37.2% (35) | 51.6% (48) |
| Yes | 61.7% (58) | 47.9% (45) |

*Note.* PHQ-9 = Patient Health Questionnaire – 9; NIAAA = National Institute on Alcohol Abuse and Alcoholism's recommended alcohol use disorder screening questions; CUDIT-R = Cannabis Use Disorder Identification Test - Revised; MMQ = Marijuana Motives Questionnaire; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help- Short Form.

**Table 3.2**

Binomial Regression Results for Individual Cannabis Factors Predicting Treatment Initiation

| Factor | *B* | Std. Error | Wald $x^2$ | df | Sig. | Odds Ratio [95% CI] |
|---|---|---|---|---|---|---|
| Intercept | 1.623 | 1.117 | 2.112 | 1 | .146 | |
| Gender (Cov) | -0.214 | 0.351 | 0.373 | 1 | .541 | 0.807 [0.406 - 1.605] |
| Race (Cov) | -0.479 | 0.341 | 1.972 | 1 | .160 | 0.619 [0.317 - 1.209] |
| **Cannabis problems (CUDIT)** | **-0.093** | **0.033** | **7.969** | **1** | **.005**** | **0.911 [0.854 - 0.972]** |
| **Family history density** | **1.300** | **0.607** | **4.580** | **1** | **.032*** | **3.669 [1.116 - 12.066]** |
| MMQ Enhancement motives | -0.555 | 0.288 | 3.727 | 1 | .054 | 0.574 [0.327 - 1.008] |
| MMQ Conformity motives | 0.702 | 0.477 | 2.167 | 1 | .141 | 2.017 [0.792 - 5.133] |
| MMQ Expansion motives | 0.095 | 0.215 | 0.195 | 1 | .658 | 1.100 [0.722 - 1.676] |
| MMQ Coping motives | 0.372 | 0.229 | 2.637 | 1 | .104 | 1.451 [0.926 - 2.275] |
| MMQ Social motives | 0.152 | 0.263 | 0.333 | 1 | .564 | 1.164 [0.695 - 1.950] |

*Note.* Cov = covariate; CUDIT-R = Cannabis Use Disorder Identification Test - Revised; MMQ = Marijuana Motives Questionnaire. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite.

Substantive significant predictors are bolded where * denotes significance at 0.05 level; ** denotes significance at 0.01 level.

**Table 3.3**

*Binomial Regression Results for Mental Health and Other Substance Use Factors Predicting Treatment Initiation*

| Factor | *B* | Std. Error | Wald $x^2$ | df | Sig. | Odds Ratio [95% CI] |
|---|---|---|---|---|---|---|
| Intercept | 0.265 | 0.905 | 0.086 | 1 | .770 | |
| Gender (Cov) | 0.298 | 0.397 | 0.564 | 1 | .453 | 1.347 [0.619 - 2.932] |
| Race (Cov) | -0.810 | 0.414 | 3.834 | 1 | .050* | 0.445 [0.198 - 1.001] |
| **Alcohol use frequency (NIAAA)** | **-0.249** | **0.123** | **4.072** | **1** | **.044*** | **0.779 [0.612 - 0.993]** |
| Alcohol use quantity (NIAAA) | 0.276 | 0.158 | 3.038 | 1 | .081 | 1.317 [0.996 - 1.796] |
| Diagnosed mental illness | -0.708 | 0.573 | 1.528 | 1 | .216 | 0.493 [0.160 - 1.514] |
| Lifetime mental illness treatment | 0.404 | 0.592 | 0.466 | 1 | .495 | 1.498 [0.469 - 4.784] |
| Depression (PHQ-9) | -0.005 | 0.030 | 0.031 | 1 | .861 | 0.995 [0.938 - 1.055] |

*Note.* Cov = covariate; PHQ-9 = Patient Health Questionnaire – 9; NIAAA = National Institute on Alcohol Abuse and Alcoholism's recommended alcohol use disorder screening questions. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite. Substantive significant predictors are bolded where * denotes significance at 0.05 level; ** denotes significance at 0.01 level.

**Table 3.4**

*Binomial Regression Results for Treatment Belief Factors Predicting Treatment Initiation*

| Variables | *B* | Std. Error | Wald $x^2$ | df | Sig. | Odds Ratio [95% CI] |
|---|---|---|---|---|---|---|
| Intercept | 2.663 | 1.521 | 3.064 | 1 | .080 | |
| Gender (Cov) | 0.357 | 0.338 | 1.116 | 1 | .291 | 1.429 [0.737 - 2.772] |
| Race (Cov) | -0.442 | 0.342 | 1.670 | 1 | .196 | 0.643 [0.329 - 1.257] |
| **Attitudes towards treatment (ATSPPH-SF)** | **-0.078** | **0.027** | **8.453** | **1** | **.004**** | **0.925 [0.877 - 0.975]** |
| Pretreatment importance | -0.088 | 0.131 | 0.456 | 1 | .500 | 0.915 [0.708 - 1.183] |
| Pretreatment confidence | 0.049 | 0.071 | 0.475 | 1 | .490 | 1.050 [0.914 - 1.205] |
| Pretreatment readiness | 0.070 | 0.087 | 0.646 | 1 | .421 | 1.072 [0.905 - 1.271] |

*Note.* Cov = covariate; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help- Short Form. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite.

Substantive significant predictors are bolded where * denotes significance at 0.05 level; ** denotes significance at 0.01 level.

**Table 3.5**

*Hierarchical Regression Results for Individual Cannabis Factors Predicting Percentage of Completion*

| Factor | *B* | Std. Error | *t* | *Sig* |
|---|---|---|---|---|
| Gender (Cov) | 5.747 | 8.093 | 0.710 | .480 |
| Race (Cov) | 8.016 | 8.808 | 0.910 | .366 |
| Cannabis problems (CUDIT-R) | 0.911 | 0.839 | 1.086 | .281 |
| Family history density | -22.274 | 15.367 | -1.449 | .151 |
| MMQ Enhancement motives | -9.962 | 7.182 | -0.134 | .894 |
| MMQ Conformity motives | 18.653 | 16.116 | 1.157 | .251 |
| MMQ Expansion motives | -6.719 | 5.330 | -1.261 | .211 |
| MMQ Coping motives | -3.096 | 5.359 | -0.578 | .565 |
| **MMQ Social motives** | **15.815** | **6.253** | **2.529** | **.014*** |

*Note.* Cov = covariate; CUDIT-R = Cannabis Use Disorder Identification Test - Revised; MMQ = Marijuana Motives Questionnaire. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite.

Substantive significant predictors are bolded where * denotes significance at 0.05 level; ** denotes significance at 0.01 level.

**Table 3.6**

*Hierarchical Regression Results for Mental Health and Other Substance Use Factors Predicting Percentage of Completion*

| Factor | *B* | Std. Error | *t* | *Sig* |
|---|---|---|---|---|
| Gender (cov) | 5.339 | 9.348 | 0.571 | .570 |
| Race (cov) | 23.422 | 10.974 | 2.134 | .037* |
| Alcohol use frequency (NIAAA) | 1.997 | 2.857 | 0.699 | .487 |
| Alcohol use quantity (NIAAA) | -1.502 | 3.904 | -0.385 | .702 |
| Diagnosed mental illness | -13.846 | 12.995 | -1.066 | .291 |
| Lifetime mental illness treatment | 9.892 | 13.409 | 0.738 | .464 |
| Depression (PHQ-9) | -0.879 | 0.756 | -1.163 | .249 |

*Note.* Cov = covariate; PHQ-9 = Patient Health Questionnaire – 9; NIAAA = National Institute on Alcohol Abuse and Alcoholism's recommended alcohol use disorder screening questions. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite. Substantive significant predictors are bolded where * denotes significance at 0.05 level

**Table 3.7**

*Hierarchical Regression Results for Treatment Belief Factors Predicting Percentage of Completion*

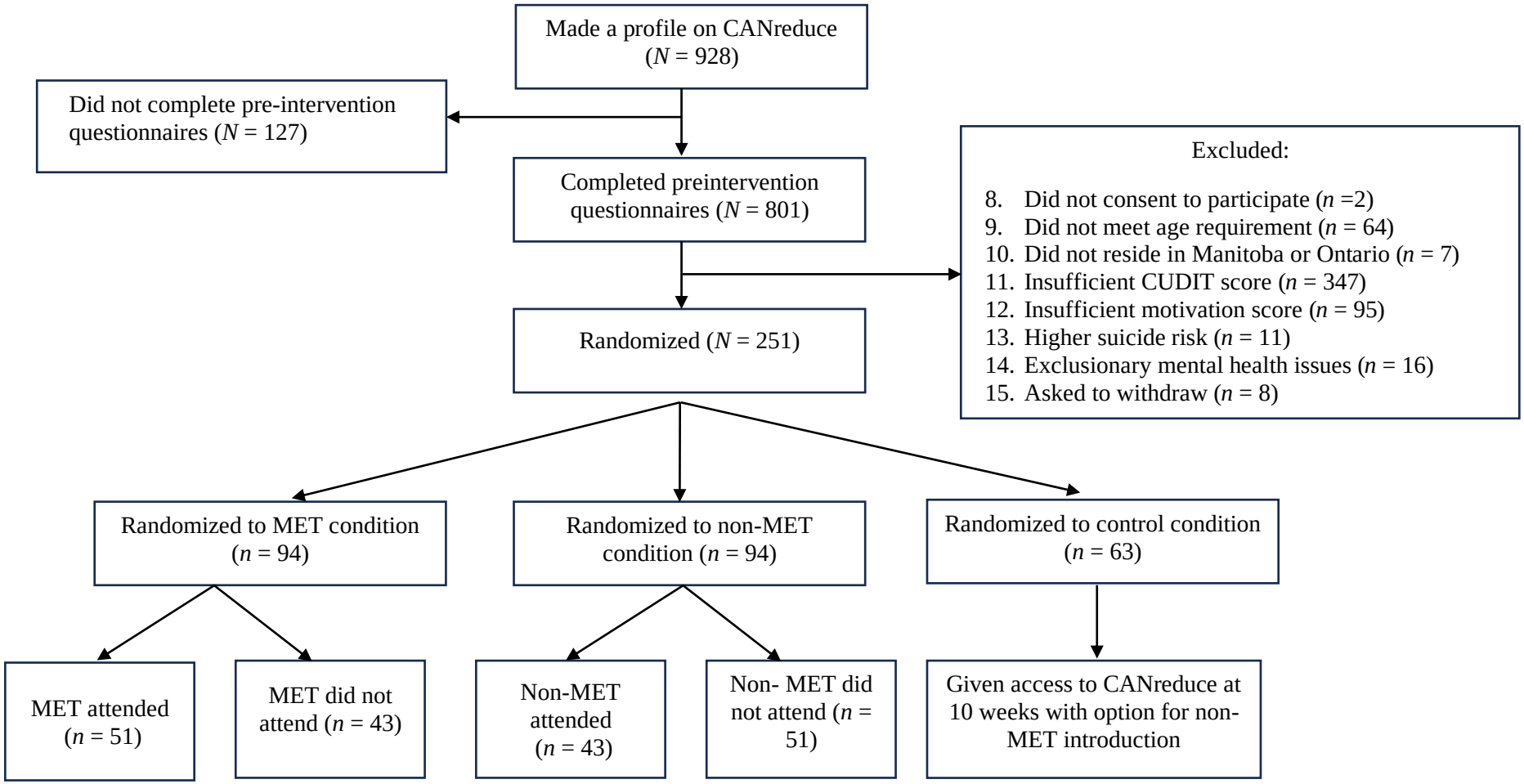
| Factor | *B* | Std. Error | *t* | *Sig* |
|---|---|---|---|---|
| Gender (Cov) | 8.670 | 7.953 | 1.090 | .279 |
| Race (Cov) | 9.029 | 8.585 | 1.052 | .296 |
| **Attitudes towards treatment (ATSPPH-SF)** | **1.738** | **0.638** | **2.723** | **.008*** |
| Pretreatment importance | -4.312 | 3.181 | -1.356 | .179 |
| Pretreatment confidence | -1.683 | 1.737 | -0.969 | .336 |
| Pretreatment readiness | 2.759 | 2.042 | 1.351 | .181 |

*Note.* Cov = covariate; ATSPPH-SF = Attitudes Toward Seeking Professional Psychological Help- Short Form. Gender coded as 0 = men, 1 = women; and race coded as 0 = white, 1 = nonwhite.

Substantive significant predictors are bolded where * denotes significance at 0.05 level; ** denotes significance at 0.01 level.

**Figure 3.1**

*Trial Flow Chart*



# CHAPTER 4
# GENERAL DISCUSSION

## Summary of Findings

There continues to be a growing demand for accessible, evidence-based treatments for heavy cannabis use (Jutras-Aswad et al., 2019; WHO, 2016). Although many individuals may benefit from accessing a treatment program, there are many barriers at the treatment seeking, treatment initiation, and continued engagement stages of any given program. Therefore, the overarching goal of this dissertation was to gain initial evidence for an online, minimally guided treatment program for heavy cannabis use. To examine this evidence, I created a CBT/MET treatment program based on the Swiss self-help program, *CANreduce* (Amann et al., 2018; Schaub et al., 2013, 2015), that is cost-effective, evidence-based, and accessible to individuals across Canada. I then created a therapist-guided MET-informed introduction to supplement the first module of the program. Using a three-arm RCT, I examined the primary and secondary outcome differences among participants enrolled in the one-hour MET-therapist guided introduction, a brief 15-minute non-MET research assistant introduction, or waitlist control. Data were collected over a period of nine months, from October 2022 to August 2023.

The results of this dissertation offer preliminary support for the efficacy of the *CANreduce* treatment program, in terms of reducing cannabis quantity and cannabis-related problems. Preliminary support was also evident for the application of an MET-therapist guided introduction to the program. This dissertation also provided insight into the recruitment, treatment initiation and treatment engagement difficulties among participants in an online treatment for heavy cannabis use, highlighting key factors that affect pretreatment dropout and engagement. Overall, the results add to the growing literature on the efficacy of evidence-based, online treatment programs for heavy cannabis use, and have implications for wider substance use treatment recruitment, retention and engagement.

### *Study 1*

The primary goal of study 1 was to examine the efficacy of the Canadian *CANreduce* program, a 6-week, online, self-guided intervention for heavy cannabis use, as well as any additional benefit of an MET-therapist guided introduction to the program. The Canadian *CANreduce* program was created through modification from the original Swiss *Canreduce*

program (Schaub et al., 2015), which involved translation from German to English, modifying materials for a Canadian context, and making material more accessible at a Flesch-Kincaid reading level of 7. Eligible participants were randomized on a 1:1:1 basis into one of three study arms: MET-therapist guided introduction plus access to the self-guided program; non-MET research assistant guided introduction plus access to the self-guided program, or waitlist control.

We hypothesized that participants who receive either treatment program condition would have significant improvement in primary outcomes (i.e., reduced cannabis consumption days in the past week and quantity of cannabis) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in primary outcomes of interest. This hypothesis was partially supported, as only participants in the MET-therapist condition showed greater reductions in quantity of cannabis used over time compared to waitlist control. There were no differences in terms of cannabis consumption days across groups. Interestingly, all participants, including waitlist control, showed a general decrease in their cannabis consumption days in the past week and quantity of cannabis, which may have impacted the ability to elucidate differences across groups. The reduction in quantity of cannabis use over time was consistent with the previous iterations of the *CANreduce* program, where the present study demonstrated significantly greater reductions in cannabis use quantity for the conditions where therapeutic interactions were present compared to waitlist control (i.e., the MET-therapist condition in the present study and the group that had access to chat counselling in Schaub et al., 2015). However, unlike the Schaub and colleagues (2015) study, the present study did not also see co-occurring decreases in cannabis use days. This finding of the MET-therapist condition showing greater reductions in quantity of cannabis use, but not the non-MET research assistant condition, suggests there was something about the introductory session with the MET-therapist that positively affected change for quantity of cannabis use. Taking from prior literature, several facets of the initial MET-session could have influenced these changes, including providing comparative norms of use to the participant (e.g., telling the participant that their daily use is within the top 10% of cannabis users for rate of use in Canada), helping the participant to formulate reasonable and achievable cannabis use reduction goals, exploring motivations to change behaviours, or providing a normalizing experience of their struggles to reduce their use on their own. Another factor that may have influenced reduction of cannabis quantity provided

by the MET-therapist introduction is accountability. Following the supportive accountability model, where human support increases accountability to a coach who is seen as trustworthy, benevolent, and having expertise (Mohr et al., 2011). By meeting and discussing their cannabis use with a therapist, they may have developed a sense of accountability for their cannabis reduction goals. Regarding lack of significant results for cannabis use frequency, as measured by cannabis use days in the last week, there may be several explanations. We may not have been able to detect findings due to small sample size, or by using a frequency assessment in terms of days (as opposed to number of sessions). Additionally, it is also possible that because the *CANreduce* program allowed for flexible goal making (either general cannabis reduction *or* abstinence), individuals who successfully reduced their overall quantity of use did not have the goal of having cannabis-free days, hence did not show a reduction in number of cannabis use days in the past week. Future iterations should have a more fine-tuned method of evaluating both frequency and quantity of use, perhaps through ecological momentary assessment (EMA)-style studies. This method of surveying may help the participant to give a more detailed account of frequency and use than the present study's use of retrospective questionnaires (Serre et al., 2012).

We also hypothesized that participants who receive either treatment program condition will have significantly improved secondary outcomes of interest (i.e., lower cannabis-related problems, lower anxiety, lower depression, higher quality of life) at the end of treatment (i.e., 6 weeks) and at follow up (i.e., 10 weeks) compared to the control condition, with participants in the MET therapist-guided introduction showing the greatest improvement in secondary outcomes of interest. Again, this secondary hypothesis was only partially supported. Participants in the non-MET research assistant condition showed significantly greater reductions in cannabis-related problems compared to waitlist control. Participants in the other active treatment condition, the MET-therapist guided condition, also showed reduction in cannabis-related problems compared to waitlist control, but only to a nearly-significant value (i.e., $p = .06$). Again, the reduction in cannabis-related problems was similar to previous iterations of the *CANreduce* program, (i.e., the non-MET research assistant condition in the present study, and service team support in the Baumgartner and colleagues (2021) study). Although it was not to the traditionally significant degree of $p = .05$, the reduction in the MET-therapist guided condition still offers evidence of some meaningful change in scores. Wider literature has begun to suggest

moving away from null hypothesis significance testing (i.e., relying on *p* values) and instead towards effect sizes, confidence intervals or estimation plots (Cumming, 2014; Ho et al., 2019).

Given the significant results for the non-MET research condition and the nearly-significant results for the MET-therapist guided condition, this may suggest that the *CANreduce* program itself helped contribute to reduction of cannabis-related problems instead of the introduction content. The program content in *CANreduce* helps the participant to recognize the impact cannabis has on various facets of their life, and also suggests modifications to use to meet their goals, so it may make sense that the program itself helps to reduce these problems. No significant results were found for the other secondary outcomes of interest (i.e., anxiety, depression, quality of life), which was surprising given prior iterations of *CANreduce* and other substance use treatments typically exhibiting significant impacts on these areas (Baumgartner et al., 2021; Frohlich et al., 2022). However, this may have been due to our relatively short follow-up time, and the fact that subsequent changes to mood and wellbeing may take additional time to improve (Hser et al., 2017). While our program included some information about general mental health and wellbeing (e.g., Module 3 on general physical and mental health needs), our program did not directly focus on addressing and improving secondary outcomes of interest. Future iterations of the program should discuss more directly the impact of cannabis on mood and wellbeing, as the reciprocal impact has been well-established (Cheung et al., 2010; Feingold et al., 2015; Goldenberg et al., 2017). Future research would also ideally follow participants over a longer follow-up period, and continue to track cannabis use habits, mood, and wellbeing.

Despite the implementation of several features of established retention protocols (Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013), the *CANreduce* project experienced significant attrition. Attempts to mitigate attrition were included at each stage of the study, including extensively staff training (e.g., ensuring they are knowledgeable about the study population, teaching rapport building, minimizing bias and assumptions), explaining study procedures to participants in full (e.g., the reason for follow up assessments, how collected information will be used) and various office procedures (e.g., tracking each contact with participants, flexible staffing to accommodate participant schedules, case review meetings), and individual reminders to complete questionnaire batteries. Elements of Scott's (2004) Engagement, Verification, Maintenance and Confirmation Protocol (EVMC) to ensure continuity of contact over time were also included, such as clear communication about participant responsibilities (e.g., what needs to

be done and when), verifying contact information in a timely manner and providing consistent reminders ahead of required participation. Our target sample size was also increased by 35% to help mitigate anticipated study dropout. Despite these efforts, the overall study attrition rate across study groups from baseline to follow-up was 66%. While this rate of attrition is on par for similar studies for internet-based substance use treatment (Etter, 2005; Frohlich et al., 2022), it limited options for Posthoc analyses, impacted study power, and affected the generalizability of results. Several potential reasons for the high rate of dropout in the current study exist. First, as mentioned above, online substance use treatment programs naturally have high rates of attrition. While the online format can offer a sense of anonymity (Richards & Viganó, 2013) and flexibility to complete material when available, it also can create a lack of accountability for follow through. Self-guided studies tend to have higher dropout rates that therapist facilitated treatments (Cujipers et al., 2011; Richards & Richardson, 2012). Given that the contact with research personnel (i.e., therapist or research assistant) was minimal and occurred only during the beginning of the program, the supportive accountability offered by their presence may not have lasted for the duration of the program. Second, given that the present study ran from October 2022 to August 2023, attrition could have been impacted by the COVID-19 pandemic on the participant's ability to engage. The WHO had only declared the end of the emergency phase of the COVID-19 pandemic in May 2023 (Kupferschmidt & Wadman, 2023), and some individuals continued to struggle with returning to work and daily life. Research during the pandemic suggested that individuals with mental health concerns had increased stress about returning to pre-pandemic routines (Nigatu et al., 2021), which may have complicated an individual's ability to engage in the *CANreduce* program. Additionally, given that the majority of the sample in the present study was women, and women were described as bearing the burden of care for children and families during the pandemic (Power, 2020), it is possible that a general lack of time, resources, or bandwidth to engage in treatment was minimal leading to dropout.

Overall, the *CAN*reduce study is one of the first online, CBT and MET self-guided treatment programs for heavy cannabis use available in North America that has an integrated MET-therapist guided introduction. The findings from study 1 of this dissertation offer preliminary support for the effectiveness of this program in reducing cannabis quantity and cannabis-related problems. Despite difficulties with retention, this offers preliminary support for the integration of therapist-guided introductions to self-guided programs for heavy cannabis use.

***Study 2***

Despite including key elements from multiple study retention protocols (i.e., Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013), the *CANreduce* project experienced significant attrition with approximately only 34% retention from baseline to follow up. Unfortunately, this magnitude of attrition severely limited our ability to examine relevant mediators and moderators in the *CANreduce* program as originally intended. However, this attrition gave rise to an alternative idea to further examine the timeline in which people had dropped out of the program and investigate key factors that impacted treatment initiation and engagement. Attrition is a common experience in substance use treatment literature (Etter, 2005; Frohlich et al., 2022; Lappan et al., 2020), and the current study's attrition rate is similar to prior iterations of the Swiss *CANreduce* (62% attrition by 3 month follow up; Schaub et al., 2015). A great deal of the available literature addresses methods for promoting participant and engagement once the participant is involved in the treatment program. However, little research has examined participant dropout in the period between first steps of engaging in treatment (i.e., signing up for treatment, completing screening questionnaires) and beginning to take part in the treatment (i.e., meeting with study personnel and beginning the program). Of the limited information available regarding cannabis use treatment initiation, research has only focused on limited sociodemographic and severity of use factors (Vendetti et al., 2002). Hence, the aims of study 2 were to 1) discuss the practicality of a randomized controlled trial for online heavy cannabis use treatment and to 2) to examine predictors of treatment initiation and engagement in the Canadian *CANreduce* program.

To better understand the comprehensive picture of participant engagement in the *CANreduce* program, we examined the flow of participants beginning when they signed up for a *CANreduce* profile and began filling out questionnaires through to the 1-month follow up period. Initial recruitment of 928 potentially eligible, interested individuals resulted in 94 individuals attending the treatment introduction (randomized into either the MET-therapist introduction or the non-MET research assistant introduction) and gaining subsequent access to the *CANreduce* program. To break it down further, sample sizes dwindled from 928 potentially eligible participants who were interested and began the questionnaires, to 801 who completed the questionnaires. From these 801 individuals, 550 of them were excluded due to meeting exclusionary criteria, leaving 251 eligible individuals. Individuals were excluded most

commonly due to insufficient CUDIT score (i.e., a score of less than 8 on the CUDIT-R; *n* = 347), insufficient motivation score (i.e., a score of less than 6 for importance for change; *n* = 95), and not meeting age requirement for the study (i.e., over age of 19; *n* = 64). Other less common reasons included having exclusionary mental health issues (*n* = 16), higher suicide risk (*n* = 11), voluntary withdrawal from study (*n* = 8), not residing in Manitoba or Ontario (*n* = 7), or not consenting to participate (*n* = 2). While some of these exclusionary criteria were outlined as per gold-standard RCT guidelines to minimize bias (Rothwell, 2005), some of the exclusionary criteria were a factor related to offering psychological treatment within the constraints of the present dissertation (i.e., our registered psychologist supervisors were only registered in Ontario and Manitoba; age of legal use in these provinces is age 19).

The 251 eligible were randomly assigned to one of three conditions (i.e., MET-therapist guided, non-MET research assistant or waitlist control), and of those assigned to active treatment, only 50% (*n* = 94) met with a program facilitator and gained subsequent access to the program. Unfortunately, 50% of the sample that was eligible for the treatment was lost in the critical period between signing up and initiating the treatment. This information gathered from reviewing the overall participant trajectory from initial interest through to follow-up offered evidence that seeking treatment is not synonymous with receiving treatment. The information gathered by reviewing this pattern of attrition also adds to wider literature through quantifying pretreatment dropout rates, which is rarely reported in literature, as extant literature mainly focuses on study attrition after treatment has begun. From a practicality point, this wider scope of study attrition data from Study 2 may be helpful to future researchers when planning their recruitment strategies, estimating overall target sample sizes, anticipating nonengagement, and comparing attrition rates across target populations. To illustrate, when planning the present study, we increased the target sample size by 35% to help mitigate study dropout based on estimated attrition rates from similar studies, which in the end was still not sufficient to counterbalance dropout at pretreatment, initiation and follow-up dropout rates.

Results from Study 2 analyses revealed significant predictors of treatment initiation (i.e., engaging in the introductory meeting and gaining subsequent access to the program) and engagement (i.e., percentage of program completed) in the Canadian *CANreduce* program, after controlling for typical sociodemographic variables (i.e., gender and race) that have been demonstrated to impact both cannabis use habits and treatment seeking behaviours (Gergov et

al., 2024). Treatment initiation predictors included higher cannabis use problems score, lower family history density, increased alcohol use frequency, and more positive attitudes towards treatment. Treatment engagement predictors included increased social motives for cannabis use and more positive attitudes towards treatment. Overall, the significant predictors of treatment initiation and engagement are consistent with wider literature, which demonstrates differing rates of program engagement based on individual factors (Brown et al., 2010; Vendetti et al., 2002). Each of the significant predictors in Study 2 were also in line with extant literature, demonstrating that individuals with increased cannabis use problems were more likely to seek treatment (Williamson et al., 2022), that family history played a role in substance use severity (Khoddamn et al., 2015), substance couse impacts severity of problematic substance use (Yurasek et al., 2017), as well as more positive attitudes towards treatment by treatment seekers (van der Pol et al., 2013). Increased social motives predicting increased engagement in the program may have been function of directly addressing social motives for use in the *CANreduce* program, rather than a pretreatment determining factor, as increased motives for cannabis use in general can be an obstacle to behaviour change (Jonas et al., 2019).

The nonsignificant findings of some factors, such as pretreatment measures of motivation to change, were interesting, given that other literature cites commitment to quitting cannabis use as the strongest predictor for treatment response (Jonas et al., 2019). However, given that the *CANreduce* program and therapist-guided introduction are strongly based in MET and MI, perhaps motivation to change was addressed and modified over the course of treatment, and hence was not a significant predictor of engagement as a preintervention measure. Other factors, such as depression, diagnosed mental illness, past treatment for mental illness and alcohol quantity were also not significant in the present study despite being significant treatment-related factors in other substance use literature (Compton et al., 2003; Subbaraman et al., 2017). Potential reasons for lack of significance may include online format removing barriers for participation often associated with depression or mental illness (i.e., stigma, amotivation; Mohr et al., 2010), positive attitudes towards treatment being a larger factor in treatment initiation and engagement than treatment experiences in the past, and frequency of alcohol consumption being more of a factor than quantity of consumption. Regardless of reason, perhaps the lack of significance of certain factors may indicate that the program is more applicable to a heterogenous sample of individual (i.e., regardless of pretreatment motivation towards change, level of

depression, mental illness presence or prior treatment, or alcohol use quantity), rather than better suited to those who have factors that increased likelihood of engagement. Alternatively, perhaps other factors that were not captured in the present study (e.g., preference for in-person treatment, preference for ongoing therapeutic support) may have played a significant role in predicting initiation and engagement. More research is needed to better understand the full spectrum of reasons for an individuals' initiation and engagement in online cannabis use programs.

As discussed in Study 2, more research is needed to add to the generalizability of these results. First, while the sample was recruited using multiple recruitment strategies across Ontario and Manitoba, the eligible sample was mostly comprised of white, young-to-middle aged women who were employed full-time. Having a majority of the sample be treatment-seeking women is an interesting occurrence, given that traditionally, men present for heavy cannabis use treatment (Rush & Urbanoski, 2007). However, other more recent literature suggests men are less likely to seek drug treatment when they need it, even after adjusting for sociodemographic characteristics and co-occurring disorders (Blanco et al., 2015), so perhaps the literature of primarily men presenting for treatment has been a function of disproportionate male rates of use in older literature. Given that womens' rate of cannabis use in Canada is rapidly approaching that of men (Government of Canada, 2017), more women may be presenting for treatment as of recently. Further, women progress from casual use to disorder and accessing treatment more rapidly than men and face more severe complications from use (Hernandez-Avila et al., 2004). In addition, literature suggests men tend to list recreational motives for using cannabis, which is likely linked to normative use and lack of accessing treatment, whereas women feel pressured into seeking treatment due to stigma of cannabis use (Wright et al., 2023). Given that the online nature of *CANreduce* may have provided a sense of anonymity and privacy, women may have been more drawn to accessing the online treatment. Second, eligibility for *CANreduce* only included individuals with a score of at least moderate cannabis use difficulties in the study. Given that even individuals with lower-risk (or nondisordered) cannabis consumption patterns still experience adverse psychosocial events from use though to a lesser extent than increased use (Sultan et al., 2023), they may benefit from accessing treatment. However, more research is needed on how programs such as *CANreduce* can benefit individuals with a broader spectrum of cannabis use and associated problems.

Overall, the findings from Study 2 provide additional support to the recruitment and engagement difficulties that many substance use treatment studies experience, and quantified pretreatment dropout rates for the *CANreduce* study. Findings from study 2 also revealed several pretreatment factors that played a significant role in determining both treatment initiation and treatment engagement in the *CANreduce* treatment program.

## Implications

### *Theory and Research*

The present study contributes to the current state of theory and research of heavy cannabis use in three main areas. First, study 1 found preliminary support for the online Canadian *CANreduce* program in treating heavy cannabis use. Participants in either active treatment condition (i.e., access to the online program) demonstrated various improvements in cannabis-related use and problems compared to waitlist control; the MET-guided introduction demonstrated greater reductions in quantity of cannabis used over time compared to waitlist control, and the non-MET research assistant conditions showed significantly greater reductions in cannabis-related problems compared to waitlist control (as did individuals in the MET-therapist condition, albeit not to a traditionally significant degree). Given the improved outcomes in terms of quantity of cannabis used in the MET-therapist condition, it is possible that the therapist-guided introductions to online self-guided treatment programs provide additional benefit, over and above a brief 15-minute non-therapeutic introduction in treating heavy cannabis use. During the guided introduction, the MET-therapist and the participant explored their motivations for cannabis use, reservations about making change, and also helped the participant set reasonable and achievable goals for cannabis reduction in a collaborative manner. These participants who completed this introduction had decreased cannabis use quantity over the course of treatment compared to waitlist control. One explanation for this mechanism may be the supportive-accountability model, which states that human support increases accountability to a coach who is seen as trustworthy, benevolent, and having expertise (Mohr et al., 2011). This increase in accountability may have helped the participant stay on track with their cannabis reduction goals, long after their initial session. One common sentiment from participants as conveyed through the research personnel was that they hoped for more prolonged contact with the MET-therapist over the course of treatment. Future research could examine the impact of ongoing support from an MET-therapist in tandem with completion of the online self-guided

treatment, and provide further evidence for the supportive-accountability model. Future research should also examine the cost-efficiency of the guided introduction to the program. Although the MET-therapist introduction offered some additional benefit above and beyond the non-MET introduction in terms of improvements to cannabis use quantity, the time and monetary cost of providing this introduction to all individuals enrolled in the program may not be justified given the modest edge on the non-MET introduction. Perhaps the MET-guided introduction is best suited for a certain subset of participants that may need additional guidance and help in initial stages of treatment (e.g., those ambivalent to treatment, more severe cannabis use, comorbid complexities), though more research is needed to examine who the MET-guided introduction may work best for.

The present study also contributes to the current state of research through the findings of study 2, which examined the difficulty recruiting and engaging participants in treatment. While the strict criteria characteristic of the gold-standard RCTs (e.g., restricting participant characteristics like sociodemographic factors, problem severity, other physical and mental health difficulties) functions to maximise certainty that trial outcome is due to the researcher intervention and not outside factors which could bias results, this can complicate research processes and generalizability (Rothwell, 2005). Given that a small proportion of individuals who use cannabis actually seek treatment (Roffman & Stephens, 2006), taking an even smaller proportion of those individuals due to strict eligibility criteria narrows the pool from which the study sample is drawn. In the case of the present study, over 800 individuals were screened, with 550 being screened out due to being ineligible for various reasons, primarily due to insufficient cannabis use problem ratings. While part of the individuals screened out in the present study may have been that participants were seeking credit (monetary or course credit compensation for completing questionnaires) instead of seeking treatment, a large proportion of other cannabis clinical trials also face significant numbers of individuals being screened out due to strict eligibility criteria (Okuda et al., 2010). This process of screening out large groups of individuals hosts two main difficulties. First, it is not time or resource efficient to be recruiting, screening, and coordinating with individuals who do not engage in the study. Second, the narrowing of study participants decreases the generalizability of the study results (Okuda et al., 2010). Prior literature suggests that through strict eligible screening procedures, the final study sample is not representative of typical cannabis users in the general community (Rosen et al., 2018). Given

that individuals across a wide range of cannabis use intensities can benefit from online (self- or guided) treatment (Riper et al., 2014, Eék et al., 2023), having individuals with a wider range of cannabis use behaviours may have allowed us to further investigate who this intensity of program works best for. Future research should consider recruiting a more generalizable sample of typical cannabis users, so that study resources and generalizability of results are maximized.

Study 2's examination of factors contributing to participant engagement also contributes to wider literature on theory and research. Through study 2, it was evidenced that certain individual-level factors significantly impacted the individuals' treatment initiation and engagement in the *CANreduce* program. Given that the default question of most RCTs examining the efficacy of a program is "does this program work," perhaps a shift is needed to better understand "for whom does this program work" or "under what conditions does this program work." This shift towards an idionomic (i.e., individual-focused) approach to examining and qualifying the efficacy of a given treatment program has begun to be increasingly highlighted in research (Hayes et al., 2022; Piccirillo et al., 2019; Sahdra et al., 2024). While examining potentially relevant mediators and moderators of treatment in the *CANreduce* program was the original intent for study 2 of the present dissertation that was made unfeasible by the substantial attrition rate, the present study was still able to examine a facet of what subset of the population benefits from the *CANreduce* program as indicated by characterizing who initiates and engages in treatment. Future research should examine additional idionomic factors through methods such as ecological momentary assessment (EMA) to better understand an individual's change trajectory over the course of treatment (Sahdra et al., 2024). Additionally, statistical methods of analysis that can more accurately examine treatment efficacy and change on a individual level are needed (Piccirillo & Rodebaugh, 2019). Sahdra and colleagues (2024) demsontrated that idiographic autoregressive integrative moving average models with an exogenous variable (i-ARIMAX) outperformed nomothetic approaches in capturing within-person heterogeneity. Other methods of idiographic-focused statistics include multilevel vector autoregression (VAR). multilevel structural equation modeling and multilevel dynamic factor modeling, and multilevel dynamic structural equation modeling (DSEM), and time varying autoregression (TV-AR), to name a few (Piccirillo & Rodebaugh, 2019).

***Clinical***

In addition to theory and research implications, there are also several important clinical implications of this research. First, the findings from study 1 of the *CANreduce* program support that online programs for heavy cannabis use can significantly positively impact cannabis reduction and related problems. Results of study 1 found that individuals in the MET-therapist guided condition significantly reduced their cannabis quantity compared to waitlist control over the study period, and that participants in the non-MET research assistant condition (as well as participants in the MET-therapist guided condition, to a nearly-significant degree) significantly reduced cannabis-related problems compared to waitlist control. Together, these demonstrate the efficacy of both the program and additional benefit of the therapist-guided introduction. Given the increasing need for cannabis use treatment programs (WHO, 2016), evidence-based treatment programs such as *CANreduce* should be implemented and accessible to the public. Evidence-based online programs are particularly valuable, as the online format helps remove barriers to accessible treatment, such as stigma, waittimes, and rural/northern living (Oser et al., 2011; Pullen & Oser, 2014; Richards & Viganó, 2013).

Another important clinical implication is in addressing those eligible participants who did not attend treatment. According to results from study 2, these individuals who were eligible but did not follow through with treatment were individuals who had lower cannabis use problems, higher family history density, more negative attitudes towards seeking treatment, and less alcohol frequency. Although these individuals had less cannabis use problems, they were still endorsing at least moderate difficulties with cannabis use as per the CUDIT-R (Adamson et al., 2010), and hence, may have still benefitted from learning skills to adjust and decrease their cannabis use. Taken from this, these factors may be important to address earlier in the treatment trajectory, and may include information such as normalizing that treatment is not reserved only for severe difficulties, discussing the difficulties of making changes when others around you may not be ready to change, having open dialogue about expectations and outcomes of treatment, as well as making room to discuss co-occurring substance use, if applicable.

**Future Directions**

The present study on *CANreduce* is the first of its kind in Canada to examine an online, self-guided treatment program with the addition of an MET-therapist guided introduction. Given the pilot nature of this study, there are several areas for future consideration that will continue

expanding knowledge in the area of heavy cannabis use, and address operational and methodological difficulties the present study encountered.

First, the present study only addressed changes in terms of dried cannabis product. While dried cannabis is the most commonly used form of cannabis (Goodman et al., 2020), several other forms of cannabis are growing in popularity including oils, edibles and vaporizers. The *CANreduce* diary log embedded in the treatment program offered equivalency charts for participants to convert their other forms of cannabis use to grams of dried flower, however, information from questionnaire battery forms for the purpose of statistical analysis only assessed dried cannabis flower use. Additionally, the present study did not take into account the THC potency in the products being used by participants. Given that use of high-potency products has been shown to predict dependence more than low-potency products (Freeman & Winstock, 2015), gathering and analyzing data regarding potency may have important implications. Additionally, switching to using lower-THC content products is a suggested form of harm reduction for cannabis use (Fischer et al., 2017), and is discussed during the therapist-guided introduction as a way to meet participant reduction goals, so by not tracking this information, potential positive changes towards participant cannabis reduction goals may have been lost.

Second, the present study experienced significant attrition. Attrition is common among all online delivered interventions for mental health programs (Linardon et al., 2020). The 66% attrition rate estimated in Study 1 is characteristically higher than wider nonsubstance use treatment (e.g., estimated 24% attrition at short follow up and 35% attrition at long follow up; Linardon et al., 2020) and at the high end of attrition typical in substance use treatments (e.g., 30-66%; Etter, 2005; Frohlich et al., 2022; Lappan et al., 2020; Schaub et al., 2015). Although the significant attrition experienced in the present study was not uncommon among this type of research, more needs to be implemented to increase participant retention. The present study used various facets of several retention protocols (i.e., Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013), but still experienced significant dropout at pretreatment, engagement and follow up phases of the study. Improvements to future research protocols for online heavy cannabis use include providing participants with an individualized timeline of completion expectations and questionnaire battery deadlines, individualized nonautomated email check ins, dedicated study personnel to be contacted instead of a general email, and having an on-call study personnel to be available by phone to discuss any program-related difficulties on an as-needed basis. Another

feature that may help boost engagement and reduce attrition is gamification of treatment. Gamification has been shown to improve online learning and adherence to online education programs (Antonaci et al., 2019; Fleming et al., 2023). Implementing features on the existing website, such as earning badges, having leaderboards with scoring, or offering rewards for reaching milestones may help keep participants engaged (Bagot et al., 2019). While gamification of treatment programs is a relatively new area (Brown et al., 2016), more research is needed to determine its efficacy it mitigating treatment dropout. Finally, meta-analyses on wider literature for online mental health treatment programs suggest that attrition rates are higher among trials that used online enrollment methods relative to telephone or in-person enrollment (Linardon et al., 2020). Future studies should aim to have the enrollment as part of a collaborative process between an interested individual and program facilitator, as this may increase accountability to treatment and better directly illustrate some of the important concepts outlined in the retention protocols (e.g., knowledgeable study staff, personal interactions, directly conveying timelines and expectations; Gul & Ali, 2010; Scott, 2004; Wojtowicz et al., 2013).

Third, the importance of examining relevant mediators and moderators of treatment remains. Although the initial intention of study 2 of this dissertation was to examine nine evidence-based mediators and moderators (i.e., gender, adherence to treatment program, other drug use, alcohol use, age of cannabis use onset, baseline depression, baseline anxiety, attitude towards online treatment and motives for cannabis use), the significant attrition of the study made this unfeasible. A larger trial of *CANreduce* among Canadian adults is needed to examine these factors with confidence.

Fourth, a common sentiment among participants was an expressed wish for ongoing contact with study personnel. While participants were encouraged to connect with the research team at any time with questions or concerns, participants may have benefitted from ongoing offers of individualized support over the course of the 6-week program. Prior iterations of the *CANreduce* trials offered ongoing text support to participants, and found that although few participants used it, they reduced the frequency of their cannabis use significantly more than the *CANreduce* program without chat counselling or waitlist control and also reduced the quantity of their cannabis use significantly more than the waitlist group. Other literature regarding web-based interventions outside of the substance use literature suggest that having facilitator-led components may result in higher retention (Winter et al., 2022) and improved treatment

outcomes (Lam et al., 2024). Researchers should consider facilitating *CANreduce* workshops, or ongoing individual support checkings, via videoconferencing with participants over the course of the program. Following the supportive-accountability model (Mohr et al., 2011), individuals with ongoing contact may increase accountability to make changes. This increase in accountability may also help to improve participant retention, number of program modules completed, and questionnaire batteries being filled out in a timely manner.

Fifth, module content should be expanded to include more direct information regarding mood, physical health and overall wellbeing. While the current version of the Canadian *CANreduce* program offers some information on these important topics, it would likely be beneficial to the participant to have a more well-rounded module that covers these areas in an integrated way. Similar programs, like *Take Care of Me*, which offered a self-guided online treatment program for alcohol and comorbid mood issues, had several modules of integrated information. Findings from the *Take Care of Me* trial showed reductions in depression and increase in quality of life, as well as several alcohol use indicators over the course of their treatment. Given that in study 1, no significant outcomes were found for anxiety, depression, or quality of life, more of this information could be included in future iterations of the program to better target these areas.

## Conclusion

In sum, there is a growing need for evidence-based, accessible, online treatment programs for heavy cannabis use. Through this dissertation, a Canadian treatment program for heavy cannabis use was developed and tested, in addition to an MET-guided introduction to the program. The current research provides preliminary support for the Canadian *CANreduce* program in reducing cannabis-related problems, with additional benefit of the MET-guided introduction in reducing cannabis use quantity. The current research also highlighted the difficulty in recruiting and engaging a sample of cannabis-using individuals for RCTs, and explored the factors affecting treatment initiation (i.e., cannabis use problems, family history density, attitudes towards seeking treatment, and alcohol frequency) and engagement (i.e., social motives, attitudes towards seeking treatment). Overall, this research provides support to the growing literature for evidence-based online programs, and the effectiveness of incorporating therapist-based components into otherwise self-guided treatments, despite challenges in recruitment and engagement. Future research is needed to better capture a wider variety of

cannabis use, increase engagement and decrease attrition, examine who these programs work best for and under what conditions, and find and ideal balance of self-guided to therapist-enhanced treatment.

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