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Reductions in alcohol use following medical cannabis initiation: results from a large cross-sectional survey of medical cannabis patients in Canada

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ABSTRACT

Background: Evidence details how cannabis can influence the use of other psychoactive substances, including prescription medications, alcohol, tobacco and illicit drugs, but very little research has examined the factors associated with these changes in substance use patterns. This paper explores the self-reported use of cannabis as a substitute for alcohol among a Canadian medical cannabis patient population.

Methods: Data was derived from a survey of 2102 people enrolled in the Canadian medical cannabis program. We included 973 (44%) respondents who reported using alcohol on at least 10 occasions over a 12 month period prior to initiating medical cannabis, and then used retrospective data on the frequency and amount of alcohol use pre-and post medical cannabis initiation to determine which participant characteristics and other variables were associated with reductions and/or cessation of alcohol use.

Results: Overall, 419 (44%) participants reported decreases in alcohol usage frequency over 30 days, 323 (34%) decreased the number of standard drinks they had per week, and 76 (8%) reported no alcohol use at all in the 30 days prior to the survey. Being below 55 years of age and reporting higher rates of alcohol use in the pre-period were both associated with greater odds of reducing alcohol use, and an intention to use medical cannabis to reduce alcohol consumption was associated with significantly greater odds of both reducing and ceasing alcohol use altogether.

Conclusions: Our findings suggest that medical cannabis initiation may be associated with self-reported reductions and cessation of alcohol use among medical cannabis patients. Since alcohol is the most prevalent recreational substance in North America, and its use results in significant rates of criminality, morbidity and mortality, these findings may result in improved health outcomes for medical cannabis patients, as well as overall improvements in public health and safety.

Background

Globally, alcohol use causes substantial morbidity and mortality. According to the World Health Organization, alcohol-related harms result in three million deaths per year and is a causal factor in over 200 diseases and injury conditions. Approximately 5.1% of total global burden of accidental injury is attributable to alcohol, and there is a causal relationship between alcohol use and a range of communicable and non-communicable diseases, including mental health and behavioral disorders, resulting in significant impacts on public health and safety, and social and economic losses (Shield, Parry, & Rehm, 2013; World Health Organization, 2018; Zhou et al., 2016). In Canada, alcohol is the most commonly used psychoactive substance and in 2014 it directly contributed to 14,826 deaths, or 22% of all substance use-related fatalities, and was implicated in an additional 655 automobile-related mortalities (Brown, Vanlaar, & Robertson, 2017; CCSA, 2019). In 2017, 78.2% of Canadians aged 15 and over reported past year consumption, and alcohol caused hospitalizations at a rate of 249 per 100,000, which is higher than hospitalizations associated with heart attacks (243 per 100,000) (CCSA, 2019; Taylor, 2016). Unfortunately,

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studies suggest that patients affected by chronic health conditions like chronic pain and mental health challenges may be more susceptible to alcohol-related harms, dependence, and relapse (Alford et al., 2016; Apkarian et al., 2013; Berglund & Ojehagen, 1998; Boden & Fergusson, 2011; Bradizza, Stasiewicz, & Paas, 2006; Egli, Koob, & Edwards, 2012).

Cannabis and alcohol have been found to be both complements and substitutes under different contexts and circumstances (Cameron & Williams, 2001; Chaloupka & Laixuthai, 1994; Pape, Rossow, & Storvoll, 2009a; Reiman, 2009; Subbaraman, 2014). The co-use of alcohol and cannabis is common due a number of sociological, behavioural and biological factors (Yurasek, Aston, & Metrik, 2017). Physiologically, cannabis may slow absorption of ethanol, potentially reducing alcohol's psychoactive effects (Lukas et al., 1992). However, alcohol can increase levels of tetrahydrocannabinol (THC, the primary psychoactive component of most cannabis) in plasma if the two are used simultaneously or within a short duration of each other (Downey et al., 2013; Lukas & Orozco, 2001).

The co-use of cannabis and alcohol may be particularly prevalent in adolescents and young adults. A study of U.S. high school seniors found that 23% reported any simultaneous use, increasing to 62% in those that reported past year cannabis use (Terry-McElrath, O'Malley, & Johnston, 2013). A survey of 14 to 20 year old youth in Norway reported that about 80% of cannabis use events included alcohol use, leading the authors to suggest the two substances may be complements (Pape, Rossow, & Storvoll, 2009b).

There is evidence that the co-use of cannabis and alcohol can lead to greater potential harms than the individual use of either. A survey of university freshman in the United States found moderate drinkers who reported recent use of cannabis were more likely to drink more than intended and reported more associated problems such as blackouts, injuries and driving while impaired (Haas et al., 2015). A prospective population-level study of adults in the U.S. found that cannabis use was associated with higher rates of alcohol use disorder (AUD) onset and persistence over a three year period (Weinberger, Platt, & Goodwin, 2016). A study of 307 young adults diagnosed with a cannabis use disorder (CUD), AUD, or dual use disorder (DUD, combining both) found that those with DUD reported greater problems with alcohol and/or cannabis than both singly-diagnosed groups (Hayaki, Anderson, & Stein, 2016).

However, there is also evidence that cannabis may reduce the use of alcohol, mitigate alcohol-related harms, or even be a useful substitute or treatment for those with AUD. Reviews focused on pre-clinical *in vitro* and *in vivo* research suggests that the endocannabinoid system plays a significant role in alcohol intake and motivation to use, and could be a beneficial pharmacological target to treat alcohol dependence (Colombo, Serra, Vacca, Carai, & Gessa, 2005; Pava & Woodward, 2012).

Population-level research has also found a strong association between cannabis and alcohol access and use, and there is evidence that under some circumstances, cannabis may act as a substitute for alcohol. A study examining the impact of increasing the alcohol drinking age on substance use in high school seniors in the U.S. found that while it did lead to reductions in alcohol use, there was an associated increase in cannabis use, suggesting the two may be substitutes (DiNardo & Lemieux, 2001). Other studies have found that the implementation of medical cannabis regulations is often associated with reductions in alcohol sales, use and associated harms. An examination of the impact of medical cannabis legalization in 16 U.S. states found that passing such laws was associated with declines of alcohol sales and consumption, and a 9% reduction in traffic fatalities involving alcohol (Anderson, Hansen, & Rees, 2013). An examination of alcohol purchasing data in U.S. states from 2006-2015 before and after medical cannabis laws were introduced found a 15% decline in alcohol sales associated with medical cannabis laws, suggesting that cannabis and alcohol are substitutes (Baggio, Chong, & Kwon, 2017).

There also exists a good body of observational, individual-level data focused on the impacts of medical cannabis access and use on alcohol consumption rates. A case series by a California physician who had been using medical cannabis to treat alcohol use disorder suggests that 83 (90%) of his 92 patients found it was “effective” or “very effective” (Mikuriya, 2004). These findings are consistent with those of cross-sectional studies examining self-reported cannabis substitution for alcohol in patient populations in both Canada and the U.S. (Lucas et al., 2016; Lucas, Baron, & Jikomes, 2019; Lucas et al., 2013; Reiman, 2009).

There is also some evidence that alcohol is a common substitute for cannabis amongst individuals who use cannabis for non-medical reasons. Two U.S.-based studies involving non-treatment seeking individuals using cannabis daily found that alcohol use increased significantly during cannabis abstinence among those with a previous alcohol dependence diagnosis or those with low alcohol consumption at baseline (Hughes, Peters, Callas, Budney, & Livingston, 2008; Peters & Hughes, 2010). A more recent Australian study found that alcohol and tobacco use increased in non-treatment seeking dependent individuals using cannabis who voluntarily abstained from cannabis use, and that both decreased once cannabis use resumed (Allsop et al., 2014). However, other research has found that some, but not all, levels of cannabis use can negatively impact alcohol treatment outcomes (Subbaraman, Metrik, Patterson, & Swift, 2016).

Although there is a lack of clinical research examining cannabis as a potential treatment for AUD, a randomized trial of various treatments for cigarette smoking cessation in heavy drinkers found that those participants reporting weekly cannabis use decreased drinking at a faster rate than non-users at the eight week follow-up, although this group also reduced their cannabis use by more than 24%, suggesting that lower cannabis use may lead to better alcohol outcomes, and that the two substances may be complementary (Metrik, Spillane, Leventhal, & Kahler, 2011). Finally, a literature review that assessed whether or not cannabis might be considered a substitute medicine for alcohol in the treatment of alcohol use disorder (AUD) found that all seven criteria examined were either satisfied or partially satisfied, though the authors note that since most of the studies relied on retrospective data from medical cannabis patients and a lack of accounting for factors such as severity of alcohol problems no firm conclusions can be reached, and therefore it would be premature to prescribe cannabis as a treatment for individuals with AUD (Subbaraman, 2014).

Whereas previous observational and clinical studies have identified a potential association between cannabis and alcohol use, this study aims to expand the current state of knowledge by comparing retrospective self-reported, individual-level rates of alcohol use in authorized cannabis patients before and after medical cannabis initiation, and including novel variables such as “intent”, as well as potential confounders such as involvement with other alcohol cessation treatments.

Methods

A 392-question cross-sectional survey was designed to gather comprehensive information from Canadian federally-authorized medical cannabis patients registered with Tilray, a Canadian Licensed Producer (LP) of medical cannabis. In Canada, once a patient and physician or nurse-practitioner agree that medical cannabis is a viable treatment option, the health care practitioner writes a recommendation for the patient, which is then sent to an LP such as Tilray from which the patient can subsequently obtain medical cannabis products via mail (Health Canada, 2019). The survey included questions on participant demographics, patterns of cannabis use, and self-reported use of prescription drugs, alcohol, tobacco, and illicit substances before and after medical cannabis initiation. All respondents who provided informed consent and took the survey were entered into a draw to receive one of five $1000 credits applicable towards the purchase of medical cannabis. Data was gathered on REDCap (Vanderbilt University, Nashville, TN,

USA), a secure online electronic data capture system. The inclusion criteria included being an authorized medical cannabis patient registered with Tilray, aged 18 years or over, capable of reading and understanding English and of legally consenting to participate in the study.

The survey received approval from the University of Victoria' Human Research Ethics Board on December 19, 2018. On January 11, 2019, an invitation to participate in the survey was sent to 16,664 federally-authorized medical cannabis patients who provided email addresses to Tilray. Individuals could participate in the survey from January 11 to 18, 2019.

Measures

The survey began by gathering self-reported demographic data, including: gender, age, current relationship status, highest education level completed, annual household income, and Canadian province/territory of residence. We also assessed the primary condition for which participants used medical cannabis by providing a list of common conditions associated with medical cannabis use (Lucas et al., 2019; Lucas & Walsh, 2017; Reiman, Welty, & Solomon, 2017; Walsh et al., 2013) that included an option of clicking "other", prompting a textual response (Table 1).

For this particular series of sub-analyses, the primary inclusion criteria was "regular" past/present alcohol use by participants, which we defined as using alcohol on 10 days or more over at least one 12 month period over a lifetime. A total of 973 participants responded positively to past/present lifetime use, and this sample formed the basis of the remaining analyses. We assessed both frequency and amounts of alcohol used pre-and-post medical cannabis initiation, as both are relevant in assessments of problematic patterns of alcohol use/alcohol use disorder (Gmel & Rehm, 2004; Sobell & Sobell, 2004).

Frequency was assessed by inquiring about the number of days in a typical 30 day period when participants would have had at least one alcoholic beverage, with one drink defined in the survey as "1 drink = 1 beer/cider, 1 glass of wine, or 1 liquor drink", both prior to initiating medical cannabis use and in the 30 days prior to the survey. Amount was assessed by inquiring about the average number of drinks per 7 day week prior to medical cannabis initiation, as well as in an average 7 day week in the 30 days preceding the survey, with the following categorical ranges provided via multiple choice: 0; less than 5 drinks per week; 5-10 drinks per week; 11-20 drinks per week; 21-30 drinks per week; 31-40 drinks per week; 41-50 drinks per week; over 50 drinks per week. A reduction in frequency of use was therefore defined as lower self-reported use in the 30 days prior to the survey compared to the pre-medical cannabis period, and a response of "0" days of use in the 30 days prior to the survey was interpreted as complete cessation of alcohol use. Since alcohol and tobacco/nicotine use have been found to be complementary substances (Allsop et al., 2014; Room, 2004; Tauchmann, Lenz, Requate, & Schmidt, 2013), tobacco/nicotine use was assessed in a similar manner, except the questions focused on "uses per day" and "days of use" over 30 days prior to initiating medical cannabis and in the 30 days prior to the survey, with no use in the last 30 days interpreted as complete cessation of use.

We gathered cannabis use information via multiple choice questions. Primary method of use was assessed by providing a list of common methods of use (i.e., vaporizer/flower, oral oil/drops, oral capsules, oral edibles, oral tincture, joint, pipe, waterpipe/bong, vape pen, concentrates, topical, juicing, and "other") limited to a single response. Those who identified flower use were asked about days per week of use, as well as typical rates of use per day, from "0.25 grams or less" to "4 grams or more". Participants were also asked to identify preferred flower types (i.e., indica, sativa, hybrid, 1:1 balanced CBD/THC; high CBD/low THC; or no favourite). Those that identified extract use (i.e., drops or capsules) answered questions specific to these products, including what type of extract they used most (i.e., high THC/low CBD, high CBD/low THC, and 1:1 THC/CBD options). Frequency of use for extracts was assessed by inquiring about "days per past week" use and "times per day" use. We also assessed how long participants had been using medical cannabis by asking how old they were when they first began to use medical cannabis, and then subtracting that number from their age at the time of the survey.

Additionally, for all substances, including alcohol, the level of deliberate intent to use cannabis as a potential reduction/cessation strategy was assessed via single-answer multiple choice with the following options: I was surprised to find that my use of _____ changed after I began to use medical cannabis; I deliberately used medical cannabis with the goal of reducing my use of _____; My MD recommended medical cannabis in order to reduce my use of _____; My MD recommended medical cannabis and then worked with me to develop a specific tapering program to help reduce my use of _____; None of the above.

Participants were also asked about their potential use of other alcohol reduction strategies via multiple choice and the ability to click any or all of the following options: Alcoholics Anonymous; pharmacological treatment (i.e., Antabuse, residential addiction treatment; inpatient addiction treatment; outpatient addiction treatment; addiction counselling; other (prompting a textual response); none of the above.

Analysis

In these analyses, we sought to assess the relationship between changes in alcohol use and medical cannabis initiation and patterns of use, as well as associated variables. Our analyses included an examination of potential variables associated with either reduction or cessation in alcohol use due to their known or theoretical relationship with the primary outcome of interest.

First, using descriptive statistics, we assessed all participant sociodemographic characteristics possibly associated with alcohol use and/or reduction, including tobacco/nicotine (T/N) cessation, involvement with traditional alcohol cessation strategies, frequency and type of cannabis use (e.g. CBD vs. THC; oral use vs. inhalation) and degree of self-reported intent to reduce or quit alcohol use, the latter of which was ultimately amalgamated into two binary groups to compare intent vs. no intent, with the former grouping consisting of participants who checked any of the following: *I deliberately used medical cannabis with the goal of reducing my use of alcohol; My MD recommended medical cannabis in order to reduce my use of alcohol; My MD recommended medical cannabis and then worked with me to develop a specific tapering program to help reduce my use of alcohol*; and the latter composed of those who checked either: *I was surprised to find that my use of alcohol changed after I began to use medical cannabis,* or *none of the above*. We then used Chi-square or Fisher's exact test as appropriate to assess the relationship between each independent variable and the primary binary outcomes of interest. Significance of the change in alcohol frequency/amounts in the entire cohort was assessed using the sign test, and comparison between subgroups was based on Kruskal-Wallis test.

Next, we proceeded with univariate and multivariate logistic regression analyses to estimate the association between potential covariates and the outcomes of interest: decreased alcohol frequency/amounts (yes vs. no), and cessation of alcohol use (yes vs. no). We included the following variables in our crude and adjusted logistic regression analyses: intent to use cannabis to reduce alcohol use (yes vs. no); gender (male vs. female), age (<55 vs. ≥ 55), top 3 primary condition type (pain, mental health and insomnia, all yes vs. no), preferred type of cannabis (THC vs. CBD), daily cannabis use (yes vs. no), primary method of use (orally ingested vs. inhaled), use of other alcohol reduction strategies (yes vs. no), alcohol use frequency per month (per day increase), number of drinks per week in the pre-period (11-30 vs. 1-10, and >30 vs. 1-10), and cessation of T/N use in the post-cannabis period (yes vs. no). Effect measures were presented as odds ratios with 95% confidence interval, and only those findings with $p<0.05$ were

considered significant. Missing data lead to variations in the sample sizes across comparisons in the univariate analysis (n = 803-972), and the multivariate analysis only included patients with no missing data for all variables (n = 696-710). In order to ensure that the exclusion of participants in the multivariate analysis did not effect the primary outcomes of interest, we used Chi-square test to compare reductions in alcohol frequency/amounts and rates of cessation post medical cannabis initiation between those included in the multivariate analysis and those excluded.

Additionally, in order to assess for any potential bias or confounders that may have been associated with the increased period between the pre-and-post medical cannabis assessments, we conducted a sensitivity analysis restricted to those patients that initiated medical cannabis within the past 5 years to see if there were any obvious differences in outcomes between those with more recent medical cannabis use compared to those reporting a longer history of use.

Finally, when the regression analysis found that intent to use cannabis to reduce alcohol use and both frequency and amounts of alcohol used prior to medical cannabis were the variables with the strongest statistical association with reductions in alcohol use, we used the Wilcoxon rank sum test to examine the relationship between these variables to determine if they were indeed associated.

All analyses were conducted in SAS 9.4 (SAS Institute, Cary NC). All statistical tests were two-sided, with significance levels of 0.05 unless otherwise indicated.

Results

Between January 11 and 18 2019, 2102 individuals were recruited and completed the survey, 973 of which reported past/present alcohol use and were therefore included in this study. The primary socio-demographic and health-related characteristics of the sample are reported in Table 1. Individuals using alcohol were mostly male (59.6%; n = 544), and the median age was 48 years old (IQR 37-58). A significant majority were married or equivalent (71.4%; n = 691), white (91.7%, n = 889), and 81.1% (n = 787) reported having a college degree or higher. In terms of residence, Alberta and Ontario were over-represented in the sample, which is consistent with Health Canada data on the geographic distribution of medical cannabis patients in Canada (Health Canada, 2019).

The five most common primary conditions cited by participants were chronic pain (30.1%; n = 293), insomnia (14%; n = 136), anxiety (12.1%; n = 118), arthritis (11.3%; n = 110), and depression (4.4%; n = 43). In fact, when combined, pain, insomnia and mental health issues accounted for 84.4% (n = 822) of all participants, which is consistent with past research on authorized medical cannabis patients in Canada and in other jurisdictions around the world (Boehnke et al., 2019; Campbell et al., 2018; de Hoop, Heerdink, & Hazekamp, 2018; Hazekamp, Ware, Muller-Vahl, Abrams, & Grotenhermen, 2013; Lucas et al., 2019; Reiman et al., 2017; Walsh et al., 2013). (Table 1)

Table 2 highlights some of the primary patterns of cannabis use in this population. On average, the median age of medical cannabis initiation was 43 years (IQR 32-55), and participants report having used medical cannabis for a median of 3 years (IQR 1.0-5.0). In regards to patterns of cannabis use, 692 (72.8%) reported daily cannabis use, with a median of 14 (IQR 7.0-21.0) uses per week. The primary method of use reported by participants was via oral solution/drops (34.6%; n = 336), followed by vaporization of cannabis flower (24.1%; n = 234) and joints (18.5%; n = 180). In total, 654 (67.3%) participants reported non-smoked methods of ingestion as their primary method of use, while 312 (32.1%) reported smoking in one form or another.

A majority (78.6%; n = 764) reported using flower/bud, with a median of 5 grams per week (IQR 2.0-10.0). Most reported using extract products (59.5%; n = 572), and overall 387 (55.1%) participants cited a preference for high THC flower or extract products, 180 (25.6%) preferred high CBD, 135 (19.2%) preferred products with similar amounts

Table 1
Characteristics of 973 participants reporting alcohol use pre-medical cannabis initiation.

Characteristics	n (%)
Gender	
Unknown	60
Male	544 (59.6)
Female	366 (40.1)
Other	3 (0.3)
Age	
Unknown	148
Median (IQR)	48.0 (37.0, 58.0)
Range	(20.0, 83.0)
Current relationship status, n (%)	
Unknown	5
Widowed/Single/Divorced/Single, never married	277 (28.6)
Married/In a domestic partnership or civil union /Single, but cohabiting	691 (71.4)
Ethnicity, n (%)	
Unknown	4
Caucasian	889 (91.7)
Hispanic	4 (0.4)
Asian/South Asian	18(1.8)
Black	7 (0.7)
Aboriginal/First Nation/Metis	10 (1.0)
Other	41 (4.2)
Highest degree completed, n (%)	
Unknown	2
High school or lower	184 (18.9)
College or higher	787 (81.1)
Annual household income, n (%)	
Unknown	21
Less than $40,000	194 (20.4)
$40,000 - $69,999	253 (26.6)
$70,000 - $99,999	161 (16.9)
$100,000 - $129,999	161 (16.9)
$130,000 or more	183 (19.2)
Province/Territory, n (%)	
Unknown	4
AB	442 (45.6)
BC	155 (16.0)
MB	35 (3.6)
NB/NS/PEI/NL	61 (6.3)
NWT/YT/NU	4 (0.4)
ON	244 (25.2)
QC	8 (0.8)
SK	19 (2.0)
Primary condition, n (%)	
Unknown	0
ADD/ADHD	9 (0.9)
Addiction/dependence/withdrawal	1 (0.1)
AIDS/HIV	3 (0.3)
Anxiety	118 (12.1)
Arthritis	110 (11.3)
Autism	1 (0.1)
Brain Injury	1 (0.1)
Cancer/Leukemia	18 (1.8)
Chronic Pain	293 (30.1)
Crohn's Disease	12 (1.2)
Depression	43 (4.4)
Diabetes	5 (0.5)
Eating Disorder	2 (0.2)
Epilepsy	5 (0.5)
Fibromyalgia	41 (4.2)
Gastrointestinal Disorder	22 (2.3)
Glaucoma	0 (0.0)
Headache/migraine	27 (2.8)
Hepatitis	1 (0.1)
Insomnia	136 (14.0)
Mental Health Condition (other than anxiety, depression, OCD or PTSD)	14 (1.4)
Movement Disorder	7 (0.7)
Multiple Sclerosis	31 (3.2)
Obsessive Compulsive Disorder (OCD)	0 (0.0)
Osteoporosis	6 (0.6)
Post Traumatic Stress Disorder (PTSD)	40 (4.1)
Seizure Disorder	2 (0.2)
Skin Condition	5 (0.5)
Other	20 (2.1)

Table 2
Patterns of cannabis use and level of intent to use medical cannabis to reduce alcohol use in 973 participants reporting alcohol use pre-medical cannabis.

Characteristics	n (%)
Number of days per week used cannabis	
Unknown	23
<7	258 (27.2)
7	692 (72.8)
Number of days per week used cannabis, n (%)	
# missing	23
Median (IQR)	7.0 (6.0, 7.0)
Range	(1.0, 7.0)
Frequency of cannabis use per week, n (%)~	
# missing	57
Median (IQR)	14.0 (7.0, 21.0)
Range	(1.0, 87.5)
Primary method of use, n (%)	
Unknown	1
Vaporizer - cannabis flower/bud	234 (24.1)
Oral Oil/Drops	336 (34.6)
Oral Capsules	27 (2.8)
Oral edibles	20 (2.1)
Oral tincture	8 (0.8)
Joint	180 (18.5)
Pipe	78 (8.0)
Waterpipe/bong	54 (5.6)
Vape pen	7 (0.7)
Concentrates	14 (1.4)
Topical	7 (0.7)
Juicing	1 (0.1)
Other	6 (0.6)
Used cannabis flower, n (%)	
Unknown	1
No	208 (21.4)
Yes	764 (78.6)
Cannabis flower per week (grams)	
# missing	11
Median (IQR)	5.0 (2.0, 10.0)
Range	(0.5, 35.0)
Cannabis flower per day for medical purposes (grams)	
# missing	19
Median (IQR)	0.75 (0.13, 2.00)
Range	(0.13, 5.00)
Currently using Tilray extract, n (%)	
Unknown	11
No	390 (40.5)
Yes	572 (59.5)
Favorite type of flower cannabis & extract currently using the most, n (%)	
Unknown	74
No preference	197 (21.9)
High THC	387 (55.1)
Balance CBD/THC	135 (19.2)
High CBD	180 (25.6)
Level of intention to use cannabis to reduce alcohol use, n (%)	
No intent	634 (65.2)
Surprised alcohol usage changed after medical cannabis	201 (20.7)
Deliberately used medical cannabis to reduce use of alcohol	131 (13.5)
MD recommended medical cannabis	3 (0.3)
MD recommended medical cannabis and developed tapering program	3 (0.3)

of THC and CBD, and 197 (21.9%) cited no specific preference.

In assessing the overall intention of participants to use cannabis to reduce their use of alcohol, 835 (85.9%) reported no such intent or being surprised their alcohol use changed after initiating medical cannabis use, while 131 (13.5%) deliberately used cannabis to reduce their alcohol use, and 6 (0.6%) reported some physician involvement in using cannabis as an alcohol reduction strategy (Table 2).

Table 3 highlights the changes in alcohol use frequency and number of drinks per week following medical cannabis initiation. In terms of frequency, 419 (43.5%) participants reported a decrease in alcohol use days, 347 (36%) stayed the same, 198 (20.5%) saw an increase in frequency. Median drinking days went from 10.5 (IQR 5.0-20.0) prior to medical cannabis, to 8.0 days (IQR 3.0-15.5). In regards to the number of drinks per week, 323 (34.1%) reported a decrease, 559 (59%) reported no change, and 66 (7%) increased the number of drinks per week. Overall, the median number of drinks per week went from 7.5 (IQR 3.0-15.5) to 3.0 (IQR 3.0-7.5). Additionally, 76 (7.8%) of participants reported using no alcohol at all in the 30 days prior to the survey, and were therefore classified as having ceased use altogether.

Table 4 examines the changes in alcohol use by participant characteristics. Both gender and age were strongly associated with reductions in alcohol use, but not with cessation. More men than women reported reductions in the number of drinks per week (40.5%; n = 213 vs. 27.2%; n = 98; p < 0.001). In regards to age, a higher proportion of those below 55 years of age reported reducing the frequency of drinking days (49.5%; n = 267 vs. 30.6%; n = 85, p < 0.001) and the number of drinks per week (38.3%, n = 204 vs. 26.3%; n = 71, p < 0.001) than those 55 or over.

Of the three most common primary condition types reported by participants, those with mental health challenges were more likely than those with pain or insomnia to report reductions in the frequency of use over 30 days (p = 0.014), number of drinks in a week (p = 0.007), and cessation of use (p < 0.001). Cannabis type was also associated with rates of reduction. Those reporting a preference for high THC (vs. high CBD) products saw a higher proportion reducing frequency of use (45.7%; n = 174 vs. 34.1%, n = 61, p = 0.01), drinks per week (39.0%; n = 147 vs. 22.6%; n = 40, p < 0.001) and ceasing alcohol use altogether (8.8%; n = 34 vs. 2.2%; n = 4, p = .004). Similarly, those reporting inhalation as a primary method of use saw a higher proportion reducing frequency of use (47.4%; n = 265 vs. 37.3%; n = 146, p = 0.002), drinks per week (37.9%; n = 209 vs. 28.9%; n = 111, p = 0.004), as well as greater rates of cessation (9.9%; n = 56 vs. 4.8%; n = 19, p = 0.004) (Table 4).

We also found a linear association between greater frequency and amounts of alcohol use pre-medical cannabis initiation and reductions post-medical cannabis initiation. In regards to frequency, those reporting drinking from 21 to 30 days per month in the pre-period saw a higher percentage reporting reductions in frequency (59.1%; n = 130) compared to those that drank between 11 to 20 days (51.1%; n = 134) or 1 to 10 days (32.2%; n = 155) (p < 0.001). Rates of cessation followed a similar pattern, with 12.1% (n = 27) of those reporting from 21 to 30 days of drinking ceasing use altogether, compared to 6% (n = 16) of those who drank from 11 to 20 days, and 6.8% (n = 33) of those who drank from 1 to 10 days prior to medical cannabis association (p = 0.023). We also found a strong linear correlation between greater number of drinks per week and rates of reduction and cessation, with 70.4% (n = 50) of those who reported over >30 drinks per week prior to medical cannabis citing reductions in use, with 83.6% (n = 61) reporting reductions in weekly drinks, and 27.4% (n = 20) ceasing use altogether when compared to 1-10 drinks and 11-30 drinks per week (p < 0.001) (Table 4).

Both specific intent to use cannabis to reduce alcohol use as well as experience with other alcohol reduction strategies were strongly associated with greater rates of reduction and cessation. Those reporting actual intent to use cannabis to reduce alcohol consumption saw a greater percentage reducing frequency of use (69.4%, n = 93 vs. 39.2%, n = 325, p < 0.001), drinks per week (67.4%, n = 89 vs. 28.6%, n = 233, p < 0.001), and ceasing use altogether (21.9%, n = 30 vs. 5.4%, n = 45, p < 0.001). Those with experience with traditional alcohol reduction strategies also saw a higher percentage reporting reductions in alcohol use frequency (80%, n = 16, vs. 42.4%, n = 394, p < 0.001), drinks per week (88.9%, n = 16 vs. 32.7%, n = 299, p < 0.001), and alcohol cessation (33.3%, n = 7 vs. 7%, n = 66, p < 0.001) (Table 4).

Finally, in light of the high rate of alcohol and tobacco/nicotine co-use reported by participants (32.2% of individuals using alcohol also reported T/N use in the pre-period, n = 314) and evidence suggesting

Table 3
Changes in alcohol use frequency and number of drinks pre-and-post medical cannabis use among 973 participants.

Variable	Pre-Medical Cannabis	Post-Medical Cannabis
Alcohol – number reporting change in days using alcohol per 30 days pre vs. post medical cannabis, n = 964*		**n (%)**
Increased		198 (20.5)
Decreased		419 (43.5)
Stayed the same		347 (36.0)
Days used alcohol per month, n = 964*	**Median (IQR)**	**Median (IQR)**
	10.5 (5.0, 20.0)	8.0 (3.0, 15.5)
Alcohol – number reporting change in number of drinks per week, pre vs. post medical cannabis, n = 948*		**n (%)**
Increased		66 (7.0)
Decreased		323 (34.1)
Stayed the same		559 (59.0)
Median number of drinks per week^, n = 948*	**Median (IQR)**	**Median (IQR)**
	7.5 (3.0, 15.5)	3.0 (3.0, 7.5)
Alcohol - complete cessation, post-medical cannabis, n = 973		**n (%)**
Yes		76 (7.8)
No		897 (92.2)

* Sample size was reduced due to missing frequency or dosage data.
^ Mid-point of the reported range was used in the calculation. Those who reported using over 50 drinks were assumed to be using 1.25 × 50 = 62.5 drinks per week.

Table 4
Changes in alcohol use stratified by primary socio-demographic, behavioural, health- and cannabis use-related characteristics among 973 participants.

Characteristics	Reduction in usage frequency Percentage	P*	Reduction in number of drinks Percentage	P*	Complete cessation Percentage	P*
All £	419/964 (43.5)	-	323/948 (34.1)	-	76/973 (7.8)	-
Gender		**0.080**		**<0.001**		**0.136**
Male	253/537 (47.1)		213/526 (40.5)		49/544 (9.0)	
Female	150/364 (41.2)		98/360 (27.2)		23/366 (6.3)	
Age		**<0.001**		**<0.001**		**0.142**
<55	267/539 (49.5)		204/533 (38.3)		47/546 (8.6)	
≥55	85/278 (30.6)		71/270 (26.3)		16/279 (5.7)	
Primary condition		**0.014**		**0.007**		**<0.001**
Pain	183/467 (39.2)		140/456 (30.7)		26/471 (5.5)	
Mental health issues	115/214 (53.7)		93/214 (43.5)		31/217 (14.3)	
Insomnia	59/136 (43.4)		40/132 (30.3)		6/136 (4.4)	
Preferred type of cannabis		**0.010**		**<0.001**		**0.004**
High THC	174/381 (45.7)		147/377 (39.0)		34/387 (8.8)	
High CBD	61/179 (34.1)		40/177 (22.6)		4/180 (2.2)	
Primary method of use		**0.002**		**0.004**		**0.004**
Inhaled	265/559 (47.4)		209/551 (37.9)		56/567 (9.9)	
Orally ingested	146/391 (37.3)		111/384 (28.9)		19/392 (4.8)	
Usage frequency in the pre period		**<0.001**		**<0.001**		**0.023**
1-10 days per month	155/482 (32.2)		97/466 (20.8)		33/483 (6.8)	
11-20 days per month	134/262 (51.1)		101/262 (38.5)		16/265 (6.0)	
21-30 days per month	130/220 (59.1)		125/218 (57.3)		27/223 (12.1)	
Number of drinks per week in the pre period		**<0.001**		**<0.001**		**<0.001**
1-10 drinks	248/670 (37.0)		132/664 (19.9)		37/673 (5.5)	
11-30 drinks	119/218 (54.6)		130/211 (61.6)		19/221 (8.6)	
>30 drinks	50/71 (70.4)		61/73 (83.6)		20/73 (27.4)	
Intent to use cannabis to reduce alcohol use		**<0.001**		**<0.001**		**<0.001**
None/Surprised	325/829 (39.2)		233/815 (28.6)		45/835 (5.4)	
Deliberately/MD recommended/MD developed	93/134 (69.4)		89/132 (67.4)		30/137 (21.9)	
Any alcohol reduction strategies		**<0.001**		**<0.001**		**<0.001**
No	394/929 (42.4)		299/915 (32.7)		66/937 (7.0)	
Yes	16/20 (80.0)		16/18 (88.9)		7/21 (33.3)	
Tobacco - complete cessation (among pre-users only)		**0.326**		**0.027**		**0.030**
Yes	50/89 (56.2)		45/90 (50.0)		18/90 (20.0)	
No	109/218 (50.0)		79/217 (36.4)		24/223 (10.8)	

* For comparison between subgroups, p value was based on Chi-square test, Fisher's exact test or Kruskal-Wallis test as appropriate.
£ For assessing the change in the entire cohort, sign test with one-sided alternative hypothesis of median less than zero was used.

that these two substances are complementary (Allsop et al., 2014; Room, 2004; Tauchmann et al., 2013), we examined the association between tobacco/nicotine (T/N) cessation and alcohol reduction/cessation, finding that while T/N cessation was not associated with reductions in alcohol use frequency (p = 0.326), it was associated with a greater number reporting reductions in alcohol drinks per week (p = 0.027), and with nearly double the rates of alcohol cessation (20%, n = 18 vs. 10.8%, n = 24, p = 0.03) (Table 4).

Table 5 presents the results of the univariate and multivariate logistic regression analyses of the primary variables associated with alcohol reduction: intent, gender, age, primary condition, preferred type of cannabis, daily cannabis use, primary method of use, use of alcohol reduction strategies, alcohol use frequency and amounts, and tobacco/nicotine cessation. This analysis found that greater intent to use cannabis to reduce alcohol consumption, and greater frequency and amounts of alcohol use in the pre-period were the primary variables

Table 5
Sociodemographic, behavioural, health and cannabis use-related factors associated with changes in alcohol usage among 973 participants.

Variable and comparison	Reduction in use frequency per 30 days				Reduction in number of drinks per week				Complete cessation			
	Univariate (n = 817-949)*		Multivariate (n = 706)*		Univariate (n = 803-948)*		Multivariate (n = 696)*		Univariate (n = 825-972)*		Multivariate (n = 710)*	
	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P
Level of intention to use cannabis to reduce alcohol use												
Deliberately/MD Recommended/MD Developed vs. None/Surprised	3.52 (2.37, 5.21)	< 0.001	2.02 (1.25, 3.27)	0.004	5.17 (3.48, 7.67)	< 0.001	2.54 (1.49, 4.33)	< 0.001	4.93 (2.98, 8.15)	< 0.001	2.57 (1.28, 5.14)	0.008
Gender												
Male vs. Female	1.27 (0.97, 1.66)	0.080	1.09 (0.78, 1.53)	0.598	1.82 (1.36, 2.43)	< 0.001	1.36 (0.92, 2.00)	0.122	1.46 (0.88, 2.43)	0.146	1.35 (0.70, 2.62)	0.371
Age												
< 55 vs. ≥ 55	2.23 (1.64, 3.03)	< 0.001	2.12 (1.46, 3.09)	< 0.001	1.74 (1.26, 2.40)	< 0.001	1.35 (0.89, 2.06)	0.163	1.52 (0.85, 2.71)	0.159	0.86 (0.42, 1.75)	0.677
Primary condition												
Pain – Y vs. N	0.80 (0.60, 1.08)	0.146	1.04 (0.72, 1.50)	0.829	0.81 (0.59, 1.10)	0.182	1.00 (0.67, 1.52)	0.982	0.58 (0.33, 1.00)	0.049	0.67 (0.33, 1.35)	0.266
Mental health issues – Y vs. N	1.63 (1.15, 2.31)	0.006	1.44 (0.94, 2.22)	0.097	1.56 (1.09, 2.24)	0.015	1.46 (0.90, 2.36)	0.126	2.02 (1.18, 3.46)	0.011	1.99 (0.99, 4.01)	0.053
Insomnia – Y vs. N	0.99 (0.66, 1.49)	0.966	0.84 (0.51, 1.39)	0.494	0.80 (0.51, 1.23)	0.305	0.70 (0.39, 1.26)	0.229	0.47 (0.20, 1.11)	0.085	0.38 (0.13, 1.11)	0.078
Preferred type of cannabis												
THC vs. CBD	1.63 (1.12, 2.35)	0.010	1.01 (0.62, 1.64)	0.979	2.19 (1.45, 3.29)	< 0.001	1.44 (0.81, 2.55)	0.216	3.83 (1.41, 10.42)	0.009	2.32 (0.72, 7.46)	0.160
Used cannabis daily												
Yes vs. No	1.10 (0.82, 1.47)	0.525	1.07 (0.74, 1.53)	0.732	1.41 (1.03, 1.93)	0.031	1.11 (0.74, 1.68)	0.613	1.83 (1.00, 3.36)	0.050	1.24 (0.60, 2.55)	0.568
Primary method of use												
Inhaled vs. Orally ingested	1.51 (1.16, 1.97)	0.002	0.98 (0.67, 1.45)	0.934	1.50 (1.14, 1.99)	0.004	0.85 (0.55, 1.33)	0.487	2.12 (1.24, 3.60)	0.006	1.13 (0.55, 2.33)	0.741
Use of other alcohol reduction strategies												
Yes vs. No	4.98 (1.70, 14.60)	0.003	2.35 (0.68, 8.14)	0.177	13.58 (3.44, 53.65)	< 0.001	4.72 (0.93, 23.96)	0.061	6.78 (2.66, 17.29)	< 0.001	4.20 (1.21, 14.66)	0.024
Alcohol use frequency per month in the pre period												
Per day increase	1.05 (1.04, 1.07)	< 0.001	1.05 (1.03, 1.07)	< 0.001								
Number of drinks per week in the pre period												
11-30 vs. 1-10					6.47 (4.62, 9.06)	< 0.001	5.34 (3.52, 8.11)	< 0.001	1.63 (0.92, 2.89)	0.091	0.99 (0.48, 2.05)	0.984
> 30 vs. 1-10					20.49 (10.72, 39.15)	< 0.001	10.47 (5.10, 21.47)	< 0.001	6.50 (3.54, 11.96)	< 0.001	3.04 (1.32, 7.03)	0.009
Cessation of tobacco/nicotine												
Yes vs. No	1.28 (0.78, 2.10)	0.326	1.21 (0.65, 2.23)	0.546	1.75 (1.06, 2.87)	0.028	1.60 (0.81, 3.16)	0.177	2.08 (1.07, 4.03)	0.031	2.04 (0.83, 5.03)	0.119

* Sample size in the univariate analysis varied across comparisons due to missing data. Multivariate analysis only included patients with no missing data for all variables.
Odds ratio was based on logistic regression

associated with alcohol reduction following medical cannabis initiation. Identifying specific intent to use cannabis to reduce alcohol resulted in Adjusted Odds Ratio (AOR) of 2.02 (95% CI 1.25-3.27) of reducing the number of drinking days, and an AOR of 2.54 (95% CI 1.49-4,33) of reducing the number of drinks per week. Additionally, intent was associated with greater adjusted odds of complete cessation of alcohol use (AOR 2.57, 95% CI 1.28-5.14). Regression analysis of the association between the frequency and amount of alcohol use in the pre-period showed a consistent positive association with reductions in use post-medical cannabis, but not with actual cessation. Every per day increase in alcohol use frequency over 30 days in the pre-period was associated with AOR 1.05 (95% CI 1.04-1.07) of reducing use frequency in the 30 days prior to the survey. Similarly, the greater the number of drinks per week reported in the pre-period, the greater the odds of reducing or ceasing use: >30 compared to 1-10 resulted in AOR 10.47 (95% CI 5.10-21.47) of reducing use, and AOR 3.04 of ceasing alcohol use altogether (95%%CI 1.32-7.03) (Table 5).

Additionally, being below age 55 was also associated with greater adjusted odds of seeing a reduction in the frequency of use over 30 days (AOR = 2.12, 95% CI: 1.46-3.09) compared to those 55 or over. In examining the impact of the top three primary condition types on alcohol reduction and cessation, univariate analysis found that mental health was associated with reduction and cessation of use, however multivariate analysis suggested no significant association with reductions, but did identify a borderline statistical association with cessation (AOR 1.99, 95% CI 0.99-4.01, p = 0.053). As noted earlier, we also used Chi-square test to compare reductions in alcohol frequency/amounts and rates of cessation post medical cannabis initiation between those included in the multivariate analysis and those excluded, finding no statistically significant difference in these primary outcomes (Appendix 1).

Table 6 highlights the relationship between the two primary variables associated with alcohol reduction: intent to use medical cannabis to reduce alcohol use, and amount and frequency used pre-and-post medical cannabis. This exploratory analysis found a strong association between these characteristics, with those intending to use medical cannabis to reduce alcohol use reporting far greater median frequency of days using alcohol over 30 days in the pre-period compared to those reporting no intent (median 20.0 (IQR 10.0-30.0) vs. 10.0 (IQR 5.0-20.0), (p < 0.001); and greater median drinks per week in the pre-period as well (median 15.5 (IQR 7.5-25.5) vs. 7.5 (IQR 3.0-7.5), (p < 0.001). Additionally, intent was also associated with fewer median days per month of alcohol use post-medical cannabis initiation compared to no intent (median 7.0 (IQR 1.0-15.0) vs. 8.0 (IQR 3.0-18.0)), (p = 0.017), although no such association was found in the number of drinks per week (p = 0.203).

Finally, in noting the significant period of time between medical cannabis initiation and the 30 days prior to the survey reported by some participants (median 3 yrs, IQR 1.0-5.0), we conducted a sensitivity analysis comparing the results of the multivariate analysis in those that initiated medical cannabis within the past 5 years with those of the full study population, and the outcomes remained similar (Appendix 2).

Table 6
The relationship between frequency and amounts of alcohol used and intent to use medical cannabis to reduce alcohol use pre-and-post medical cannabis initiation.

	Unintentional	Intentional	P*
Alcohol usage days per month in the pre-period			< 0.001
Median (IQR)	10.0 (5.0, 20.0)	20.0 (10.0, 30.0)	
Mean (SD)	13.0 (9.4)	18.4 (9.8)	
Range	(1.0, 30.0)	(1.0, 30.0)	
Number of drinks per week in the pre-period			**< 0.001**
Median (IQR)	7.5 (3.0, 7.5)	15.5 (7.5, 25.5)	
Mean (SD)	9.6 (10.2)	20.2 (16.1)	
Range	(3.0, 62.5)	(3.0, 62.5)	
Alcohol usage days per month in the post-period			**0.017**
Median (IQR)	8.0 (3.0, 18.0)	7.0 (1.0, 15.0)	
Mean (SD)	10.8 (8.9)	9.2 (8.9)	
Range	(0.0, 30.0)	(0.0, 30.0)	
Number of drinks per week in the post-period			**0.203**
Median (IQR)	3.0 (3.0, 7.5)	3.0 (3.0, 7.5)	
Mean (SD)	7.0 (7.7)	7.4 (10.0)	
Range	(0.0, 62.5)	(0.0, 62.5)	

* For comparison between subgroups, p value was based on Chi-square test, Fisher's exact test or Kruskal-Wallis test as appropriate.

Discussion

In this study using data from a large survey involving 973 medical cannabis patients who reported past or current alcohol use, we observed significant self-reported reductions in alcohol use following medical cannabis initiation. In examining variables associated with alcohol reduction, we found a linear association between frequency and amount of use in the pre-period, and rates of decline in both post-medical cannabis initiation. In fact, greater pre-initiation rates of use and a specific intent to use medical cannabis to reduce alcohol use were the most consistent variables resulting in alcohol reduction and/or cessation, potentially suggesting that those who used more alcohol were also likely impacted by greater rates of alcohol-related problems, and therefore identified a greater intent to explore cannabis as an alcohol-reduction strategy. We tested this theory by examining the relationship between greater rates of use in the pre-period and a stated intent to use cannabis to reduce/cease use, and found that there was indeed a strong statistical relationship (p < 0.001) between these variables (Table 6). Previous longitudinal research has found that the deliberate intent to use cannabis as a substitute for crack cocaine was effective in reducing use (Socías et al., 2017), and studies assessing treatment outcomes for substance use disorders have consistently reported a relationship between motivation/intent to change and treatment success (Breda & Heflinger, 2007; McKay & Weiss, 2001; Shields et al., 2014). The significant association between the intention to use cannabis to reduce alcohol and greater subsequent rates of reduction/cessation in this study adds to these previous findings, and suggests a need to conduct more comprehensive assessments of intent/motivation for cannabis use in polysubstance use research. Such investigations could be particularly relevant for those that have either had poor success with, or are looking for alternatives, to abstinence-based treatment options.

The higher rates of reduction/cessation in those reporting mental health conditions has significant implications, since mood disorders and substance use disorders (including AUD) are common psychiatric comorbidities (Boden & Fergusson, 2011; Petrakis, Gonzales, Rosenheck, & Krystal, 2002; Quello, Brady, & Sonne, 2005; Shield et al., 2013; Shivani, Goldsmith, & Anthenelli, 2002; Zhou et al., 2016). Furthermore, those with a dual diagnosis of alcohol use disorder comorbid with additional mental health conditions are at higher risk for suicide (Berglund & Ojehagen, 1998), and are at greater risk of relapse when attempting to stop using alcohol (Bradizza et al., 2006). Since research has found an association between the implementation of state-level medical cannabis laws and reductions in the rate of suicides in some populations theoretically due to reduced alcohol consumption (Anderson, Rees, & Sabia, 2012), the high rate of medical cannabis use for mental health disorders (Turna, Simpson, Patterson, Lucas, &

Van Ameringen, 2019; Walsh et al., 2017) and the association between starting medical cannabis and reducing and/or eliminating alcohol use documented in our study and other observational research (Lucas et al., 2019, 2013; Reiman, 2009) is notable and suggests further research is warranted to better elucidate the relationship between mental health conditions, alcohol and cannabis use.

Finally, while the present results do not speak to the desirability of substituting cannabis for alcohol, there exists significant evidence that the personal and public health burden of cannabis use is far less than that of alcohol. A Swiss study found that while alcohol use was associated with a relative risk of injury of 3.00 (CI 1.78-5.04) compared with no alcohol use, cannabis use was associated with a reduced risk of injury (RR: 0.33; CI 0.12-0.92). An assessment of drug harms in the United Kingdom conducted by the Independent Scientific Committee on Drugs (ISCD) applied multicriteria decision analysis (MCDA) modeling to assess the harms of 20 commonly-used licit and illicit substances (Nutt, King, & Phillips, 2010). They employed 16 weighed criteria—nine focused on harms to the individual, and seven assessing harms to others—scoring substances out of 100 points, with higher scores indicating greater harms. Overall, researchers scored alcohol the highest at 72, followed by heroin at 55. Cannabis scored 20, recognizing the relatively modest harms associated with its use compared to other substances. A more recent comparative risk assessment of alcohol, tobacco, cannabis and other illicit drugs used a Margin of Exposure (MOE) approach (Lachenmeier & Rehm, 2015). The MOE is the ratio between the point on the dose response curve that characterizes adverse effects in human or animal studies and the estimated human intake of the substance. Therefore, the lower the MOE, the larger the risk to people who use the substance. Using this criteria, cannabis was found to have the highest MOE and considered relatively safer than prescription drugs like diazepam and methadone, while alcohol and heroin had the lowest and were therefore considered to present the greatest biological risk to end users.

Furthermore, there's growing evidence that cannabis/cannabinoids may mitigate alcohol related harms. While a study of vaporization of cannabis with and without alcohol found that combining alcohol and cannabis leads to higher THC bioavailability and is associated with greater impairment (Hartman et al., 2016), those findings also suggest that those individuals who co-use may be able to reduce their use of alcohol and/or cannabis while achieving the same level of impairment, potentially reducing short-and-long-term harms associated with both substances. Additionally, preclinical studies suggest that CBD can reduce alcohol consumption and potentially protect against certain harmful effects of alcohol, such as liver and brain damage (Nona, Hendershot, & Le Foll, 2019), and other research has found that cannabis can reduce inflammation associated with alcohol use (Karoly, Bidwell, Mueller, & Hutchison, 2018). Ultimately, whether cannabis represents a viable harm reduction strategy for alcohol use or potential treatment for AUD is beyond the scope of the current study, but certainly remains a pertinent question for future research. In light of the considerable public safety and health impacts associated with alcohol use, particularly in populations affected by chronic health conditions, these findings add a new dimension to the growing literature examining the impact of cannabis on the use of other substances, and perhaps suggest a previously unexplored avenue by which increased access to medical cannabis might benefit public health by subsequently reducing alcohol use amongst patients with chronic health conditions.

Limitations of this study include restricting the population to patients registered with Tilray as their provider of medical cannabis. While this was a national sample, it may have yielded data not representative of the broader population of medical cannabis patients in Canada, and since this sample was drawn from patients registered with a medical cannabis company, participants may be more likely to report positive effects related to the medical use of cannabis.. Additionally, as all information regarding the use of cannabis or alcohol was self-reported and did not benefit from biological drug detection to verify substance use or non-use, this data is vulnerable to recall bias, socially desirable responding, and other biases associated with self-report retrospective surveys. In particular, since the average duration of medical cannabis use in this population at the time of the survey was 5 years (median of 3 years), self-reported estimates of substance use frequency and amounts pre-medical cannabis may be particularly vulnerable to recall bias as well as other unobserved variables and confounders that may have impacted alcohol use in the interim. However, the sensitivity analysis we conducted to compare outcomes of those who had initiated medical cannabis use within the past five years with the total study population found similar outcomes in both groups, suggesting that the time span between pre-and-post data points do not appears to have impacted the outcomes of the study.

Further, it is unknown if results from a medical cannabis patient study are generalizable to a non-patient population, as there may be characteristics inherent to a patient population – including an active intent to improve personal health outcomes – that may not be mirrored in a non-patient cannabis use population. Prospective studies examining changes in alcohol use in non-medical populations following cannabis initiation could better assess what role cannabis contributes to alcohol cravings, withdrawals and rates of reduction/cessation. Finally, social policy changes may have also impacted patient patterns of use as well as some of the outcomes of this study. Since the non-medical adult use of cannabis was legalized in Canada prior to this survey, and as there are many regulated and unregulated sources of cannabis available to Canadian patients, it is highly probable that some participants used sources of cannabis other than those accounted for in this study.

However, the large sample size, detailed measurement of alcohol use frequency and amounts pre-and-post medical cannabis use, inclusion of a measurement of intent to use medical cannabis to reduce alcohol use as well as potential confounders such as participation in other substance use treatment programs in the analysis addresses some of these limitations and previous cross-sectional surveys examining the impact of cannabis use on the use of alcohol and other substances, and could inform future studies of this kind. In light of these limitations, it would be premature to promote cannabis-based therapies for alcohol reduction/cessation, and these results should be interpreted with caution pending replication by research that employs more systematic recruitment, longitudinal designs and biological drug testing.

Authors' Contributions

PL designed the study and survey, coordinated its administration and analysis, and is the primary author of this manuscript. SB, MJM and ZW reviewed and edited the manuscript.

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Appendix 1. Comparison of primary outcomes between those included and those excluded due to missing data in the multivariate analysis in Table 5

	Included	Excluded	P*
Alcohol analysis			
Reduction in use frequency per 30 days	311/706 (44.1)	108/258 (41.9)	0.544
Reduction in number of drinks per week	245/696 (35.2)	78/252 (31.0)	0.222
Complete cessation	54/710 (7.6)	22/263 (8.4)	0.695

* p based on Chi-square test.

Appendix 2. Multivariate analysis of change in alcohol use among participants that initiated medical cannabis use within the past 5 years

	Reduction in use frequency per 30 days		Reduction in number of drinks per week		Complete cessation	
	Multivariate (n = 533)		Multivariate (n = 527)		Multivariate (n = 536)	
Variable and comparison	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P
Level of intention to use cannabis to reduce alcohol use						
Deliberately/MD recommended/MD developed vs. None/Surprised	2.22 (1.23, 3.99)	0.008	2.10 (1.13, 3.93)	0.020	2.98 (1.24, 7.19)	0.015
Gender						
Male vs. female	1.08 (0.74, 1.59)	0.687	1.37 (0.87, 2.15)	0.169	1.40 (0.61, 3.26)	0.429
Age						
<55 vs. ≥55	2.09 (1.35, 3.22)	<0.001	1.21 (0.74, 1.96)	0.448	0.73 (0.31, 1.75)	0.479
Primary condition						
Pain – Y vs. N	1.06 (0.69, 1.62)	0.784	1.04 (0.64, 1.68)	0.871	0.57 (0.24, 1.34)	0.197
Mental health issues – Y vs. N	1.36 (0.82, 2.24)	0.231	1.42 (0.81, 2.47)	0.222	2.03 (0.87, 4.77)	0.103
Insomnia – Y vs. N	0.60 (0.33, 1.10)	0.097	0.57 (0.28, 1.15)	0.115	0.20 (0.04, 1.02)	0.053
GI – Y vs. N	1.44 (0.50, 4.13)	0.494	1.80 (0.59, 5.53)	0.305	3.32 (0.71, 15.39)	0.126
Movement Disorder – Y vs. N	0.61 (0.23, 1.61)	0.321	0.44 (0.14, 1.37)	0.157	2.77 (0.69, 11.13)	0.150
Preferred type of cannabis						
THC vs. CBD	1.01 (0.58, 1.77)	0.963	1.16 (0.61, 2.22)	0.645	1.95 (0.55, 6.92)	0.300
Used cannabis daily						
Yes vs. No	1.18 (0.78, 1.79)	0.427	1.04 (0.65, 1.66)	0.868	0.88 (0.39, 2.01)	0.764
Primary method of use						
Inhaled vs. Orally ingested	1.13 (0.71, 1.79)	0.601	0.97 (0.57, 1.64)	0.909	0.96 (0.39, 2.37)	0.922
Use of other alcohol reduction strategies						
Yes vs. No	2.06 (0.48, 8.91)	0.331	4.39 (0.79, 24.50)	0.092	4.71 (0.94, 23.59)	0.059
Alcohol use frequency per month in the pre period						
Per day increase	1.05 (1.03, 1.07)	<0.001				
Number of drinks per week in the pre period						
11-30 vs. 1-10			5.77 (3.54, 9.41)	<0.001	1.31 (0.54, 3.19)	0.555
>30 vs. 1-10			9.21 (4.06, 20.87)	<0.001	3.53 (1.23, 10.12)	0.019
Cessation of tobacco/nicotine						
Yes vs. No	1.30 (0.59, 2.88)	0.520	1.84 (0.77, 4.43)	0.171	1.94 (0.55, 6.87)	0.303

Appendix 3. Multivariate analysis examining changes in alcohol use among 973 participants by primary condition via pairwise comparisons

Primary Conditions	Reduction in use frequency per 30 days		Reduction in number of drinks per week		Complete cessation	
	Multivariate		Multivariate		Multivariate	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Mental health issues vs pain	1.18 (0.74, 1.89)	0.490	1.17 (0.69, 1.98)	0.562	2.43 (1.07, 5.52)	0.034
Insomnia vs pain	1.00 (0.57, 1.76)	0.996	0.73 (0.38, 1.41)	0.353	0.63 (0.18, 2.22)	0.476
GI vs pain	0.67 (0.23, 1.90)	0.448	1.03 (0.35, 3.06)	0.960	3.22 (0.69, 14.98)	0.135
Movement disorder vs pain	0.55 (0.21, 1.44)	0.225	0.54 (0.19, 1.56)	0.256	3.16 (0.82, 12.14)	0.095
Other vs pain	1.30 (0.69, 2.47)	0.416	0.98 (0.48, 1.98)	0.952	0.44 (0.08, 2.41)	0.347
Insomnia vs Mental health issues	0.85 (0.46, 1.56)	0.596	0.63 (0.31, 1.27)	0.194	0.26 (0.08, 0.89)	0.031
GI vs Mental health issues	0.56 (0.19, 1.67)	0.301	0.88 (0.28, 2.73)	0.825	1.33 (0.29, 6.16)	0.719
Movement disorder vs Mental health issues	0.47 (0.17, 1.26)	0.135	0.46 (0.15, 1.40)	0.173	1.30 (0.33, 5.03)	0.706
Other vs Mental health issues	1.10 (0.55, 2.20)	0.779	0.84 (0.39, 1.79)	0.648	0.18 (0.03, 0.98)	0.047
GI vs Insomnia	0.67 (0.22, 2.05)	0.479	1.40 (0.42, 4.61)	0.581	5.08 (0.84, 30.77)	0.077
Movement disorder vs Insomnia	0.55 (0.20, 1.55)	0.259	0.74 (0.23, 2.35)	0.607	4.97 (0.98, 25.20)	0.053
Other vs Insomnia	1.30 (0.61, 2.77)	0.494	1.33 (0.57, 3.11)	0.509	0.70 (0.10, 4.74)	0.715
Movement disorder vs GI	0.83 (0.21, 3.28)	0.791	0.53 (0.12, 2.28)	0.391	0.98 (0.15, 6.38)	0.982
Other vs GI	1.96 (0.61, 6.28)	0.259	0.95 (0.28, 3.24)	0.937	0.14 (0.02, 1.13)	0.065
Movement disorder vs Other	2.36 (0.80, 6.98)	0.122	1.80 (0.54, 5.99)	0.335	0.14 (0.02, 1.05)	0.056

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