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Are Cannabis Use Problems Comparable Across Individuals Using for Recreational and Medical Purposes? An International Cross-Sectional Study of Individuals Who Use Self-Grown Cannabis
--Manuscript Draft--

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Methods: Data (n = 5,347) were collected from a subsample of the Global Cannabis Cultivation Research Consortium project, focusing on small-scale cannabis growers in 18 countries. Robust regressions analyzed differences in SDS scores across the three use motivation groups.
Results: Compared with respondents reporting only recreational motivations of cannabis use, those with medical (with and without recreational) motivations were associated with lower SDS scores (B: -0.190 and B: -0.459, p < 0.001 respectively). Daily use was associated with significantly higher SDS scores across all cannabis motivation groups, albeit the magnitude of the association was significantly smaller among individuals with medical motivations of use.
Conclusion: The extent to which people experience cannabis use problems, and the determinants of these problems may differ depending on whether cannabis use is motivated by recreational or medical purposes. As such, the findings of the current study suggest that public education efforts, harm reduction approaches and policy responses should be tailored depending on whether cannabis is used for recreational |

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We would like to thank the reviewers and the editor for helpful and constructive comments. Since the comments were provided directly into the word document we have responded to each of the comments in the comments (annotated/trach changes version of the paper). If you prefer that we write the responses in a response letter we can do that instead.

Best,

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Are Cannabis Use Problems Comparable Across Individuals Using for Recreational and Medical Purposes? An International Cross-Sectional Study of Individuals Who Use Self-Grown Cannabis

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Abstract

Background: Little is known about cannabis use problems among individuals who use cannabis for medical purposes and whether rates and determinants of cannabis use problems in medical users differ to those observed among individuals using for recreational reasons. This study examines whether Severity of Dependence Scale (SDS) scores differ across individuals who use self-grown cannabis for the following reasons: "recreational only", "medical and recreational" and "medical only". Furthermore, the study tests whether cannabis use frequency, cannabis strain,

and type of cannabis influences the strength of the association between purpose of use and cannabis use problems.

Methods: Data (n = 5,347) were collected from a subsample of the Global Cannabis Cultivation Research Consortium project, focusing on small-scale cannabis growers in 18 countries. Robust regressions analyzed differences in SDS scores across the three use motivation groups.

Results: Compared with respondents reporting only recreational motivations of cannabis use, those with medical (with and without recreational) motivations were associated with lower SDS scores (B: -0.190 and B: -0.459, $p < 0.001$ respectively). Daily use was associated with significantly higher SDS scores across all cannabis motivation groups, albeit the magnitude of the association was significantly smaller among individuals with medical motivations of use.

Conclusion: The extent to which people experience cannabis use problems, and the determinants of these problems may differ depending on whether cannabis use is motivated by recreational or medical purposes. As such, the findings of the current study suggest that public education efforts, harm reduction approaches and policy responses should be tailored depending on whether cannabis is used for recreational or medical purposes.

Keywords: Severity of Dependence Scale; Recreational Cannabis Use; Medical Cannabis Use; Cannabis Growers; Risk Factors.

Introduction

Cannabis is one of the most commonly consumed substances worldwide (UNODC,

2021), primarily used recreationally for its psychoactive effects, although therapeutic use is becoming more common in jurisdictions such as the U.S., Israel, Canada where medical use is legalized (Boehnke, Dean, Haffajee, & Hosanagar, 2022; Myran, et al., 2023; Sznitman, 2020). Cannabis use has a relatively low risk of harm (e.g., mental health, toxicity, accidents) compared to use of other psychoactive substances such as alcohol, nicotine, amphetamines, or cocaine (Boden, Dhakal, Foulds, & Horwood, 2020; Nutt, King, & Phillips, 2010), especially regarding the risk of dependence (Lopez-Quintero, et al., 2011). Nevertheless, it has been estimated that 22% of people who use cannabis recreationally meet DSM-V criteria for cannabis use disorder (CUD) (American Psychiatric Association, 2013; Leung, Chan, Hides, & Hall, 2020), defined as continued cannabis use despite significant functional impairment, loss of control, or withdrawal symptoms when use is discontinued (Patel, 2021). The demand for CUD treatment is substantial and increasing in North America, Europe, and Oceania across some population groups (Askari, Keyes, & Mauro, 2021; Manthey, 2019; UNODC, 2021). While reasons for the increase are varied, including greater availability and use overall (Rose, 1992), increased treatment offerings and court referrals, evidence suggests that it also partly relates to a genuine rise in cannabis use-related problems (Hamilton & Monaghan, 2019; McCulloch, 2017).

Cannabis use problems are often tied to motives for use. Motivational theories of substance use are founded on the idea that people turn to substances in pursuit of distinct desired outcomes, which can vary from one individual to another (Cooper, 2015). While various motivations for use have been linked to cannabis use problems, meta-analytic evidence shows that coping (e.g. use to forget problems) and conformity (e.g. use because of peer pressure) are most strongly associated with the development of cannabis use problems (Bresin & Mekawi, 2019).

Another way to classify motives for cannabis use, especially against the backdrop of ongoing cannabis liberalization, is whether the intention to use is for recreational or medical purposes, although the evidence for how these motives may relate to cannabis use problems remains inconclusive. Choi et al. (2017) reported proportionately more cannabis use problems among people using cannabis medically (32.88%) than those using it recreationally (25.25%). Sznitman (2017), however, found the opposite: individuals using for recreational purposes faced more cannabis-related problems (mean = 0.63 versus mean = 0.54). Mills et al. (2022) found that among individuals who used cannabis for both recreational and medical purposes, a relative increase in the proportion of use for recreational versus medical purposes was associated with a significant reduction in experience of CUD criteria. Still, other studies have failed to find a significant difference in cannabis use problems between those who use for recreational versus medical reasons (Bonn-Miller, Boden, Bucossi, & Babson, 2014; Lin, Ilgen, Jannausch, & Bohnert, 2016), so the evidence is inconclusive.

Although many people who use cannabis daily experience few clinical problems, frequency of use has been found to be a strong predictor of cannabis use problems (Compton, Saha, Conway, & Grant, 2009; Mills, et al., 2022). Richmond et al. (2015) found that although people with a medical license consumed cannabis more frequently than those without a license, the former had a lower risk of experiencing cannabis use problems. Other studies have found that despite a higher likelihood of daily or near-daily (DND) cannabis use, individuals using cannabis for medical versus recreational purposes reported fewer problems with cannabis use (Sznitman, 2017) and drugs more generally (Roy-Byrne, et al., 2015). Lin et al. (Fortin, et al., 2021; 2016) observed that, despite more frequent daily consumption among people using

cannabis medically, there was no discernible difference in cannabis abuse or dependence associated with recreational and medical use.

Another gap in the literature concerns whether the strain of cannabis typically consumed moderates the association between motivations for use and cannabis use problems. Although opinions and research are divided (de Meijer, et al., 2003; Vergara, Gaudino, Blank, & Keegan, 2020), the general consensus is that the cannabis plant can be categorized into two primary sub-strains, *C. indica* and *C. sativa* (Hillig & Mahlberg, 2004). Research suggests that *C. sativa* produces high delta-9-tetrahydrocannabinol (THC) and low cannabidiol (CBD) concentrations, whereas *C. indica* has higher relative concentrations of CBD to THC. Cannabis growers can access hundreds of strains – or cultivars – through seedbanks, and many also develop their own hybrids, with reportedly different THC and CBD content. Growers, especially those who are growing cannabis for medical use, often report deliberate selection of strains with cannabinoid contents that give them their preferred (recreational and/or therapeutic) effects (Klein & Potter, 2018; Sznitman, et al., 2019). Importantly, although research has shown that higher CBD levels can attenuate the dependence-producing effects of THC, there remains much we do not know about cannabinoid content and dependence liability (Schlag, Hindocha, Zafar, Nutt, & Curran, 2021).

An additional area of consideration regarding cannabis use problems and motivations for use is cannabis product differentiation (e.g., herbal, resin, oil, edibles) and different routes of administration (e.g., smoked, vaporized, oral). Preference for these modalities may differ by use motivation – especially medical versus recreational use – and impact the onset, intensity, and duration of effects (Pacula, Jacobson, & Maksabedian, 2016; Sznitman, 2017). Research has, for instance, found that

individuals who use cannabis for medical purposes are more likely to vaporize and consume edibles than individuals who use for recreational purposes (Pacula, et al., 2016; Sznitman, 2017). Other research, not related to motive of use, has found that use of extracts (Bidwell, YorkWilliams, Mueller, Bryan, & Hutchison, 2018) and cannabis administrated by vaping or smoking (Simpson, Cho, & Barrington-Trimis, 2021) are related to cannabis use problems.

Current study

To our knowledge, no single study has formally assessed whether patterns of cannabis use (e.g. frequency of use, strain of cannabis or type of cannabis product used) moderate the association between cannabis use motives and cannabis use problems. In this paper, we use data from a large international survey of small-scale cannabis growers to test, first, whether the risk of cannabis use problems differs between the following three groups with divergent motivations for using: (1) individuals who grow cannabis to supply themselves with cannabis for recreational purposes only, (2) individuals who grow cannabis to supply themselves for both recreational and medical purposes, and (3) individuals who grow cannabis to supply themselves with cannabis for medical purposes only. Second, we assess whether cannabis use frequency, cannabis strain, and type of cannabis product, moderate the association between motivation for use and cannabis use problems.

The focus on individuals who self-grow their cannabis is important as this population is likely to have relatively regular stores of cannabis so that intention to use would not be hampered by lack of availability. Growers are also more likely to know (or, at least, believe that they know) the specific cannabis strain and its cannabinoid profile that they are cultivating (Decorte, 2010; Sznitman, et al., 2019).

Small-scale cannabis growers are also more likely to produce cannabis products that align with their personal consumption preferences (Klein & Potter, 2018).

Methods

Data were collected by the Global Cannabis Cultivation Research Consortium (GCCRC, www.worldwideweed.nl). The online questionnaire, probing respondents about cannabis use patterns and cannabis growing experiences, was presented in 12 languages (Danish, German, English, Spanish, Finnish, French, French-Canadian, Hebrew, Italian, Georgian, Dutch, Portuguese) and ran from August 2020 to September 2021 in the following 18 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Georgia, Germany, Israel, Italy, the Netherlands, New Zealand, Portugal, Switzerland, the United Kingdom, the United States, and Uruguay. All languages were available to all countries as the survey was programmed in a single build with multiple language options.

The recruitment and engagement plans were broad-based to maximize the diversity of respondents. Strategies included updates on the project website (https://worldwideweed.nl), launching feature articles and media releases, engaging with alternative and mainstream media outlets, distributing flyers in alternative shops, promoting/advertising the study through online social media platforms such as Facebook and Twitter, and engaging with cannabis communities through online forums and social media groups. Research teams obtained approval from their respective institutional ethics committees and validations from institutional data protection officers, and the international survey obtained ethical approval through the Australian team at Curtin University who hosted the survey using Qualtrics (2005).

For this analysis, out of 11,479 valid cases, 6,032 respondents fulfilled the following inclusion criteria: residence in one of the 18 recruitment countries, being

≥18 years of age, grew cannabis within past 5 years, and self-reported past month cannabis use. Furthermore, since the core variable of interest was based on whether respondents grew cannabis to provide themselves with recreational or medical cannabis, only respondents who reported that at least 50% of their cannabis use was covered by their own growing were included. A further 685 respondents had missing data on at least one of the variables used in the analysis leading to a final analytical sample of 5,347 with the following country distributions: Australia n= 364 (6.8%), Austria n = 22 (0.4%), Belgium n= 939 (17.6%), Canada n= 286 (5.4%), Denmark n = 389 (7.3%), Finland n= 293 (5.5%), France n = 331 (6.2%), Georgia n= 74 (1.4%), Germany n = 412 (7.7%), Israel n = 30 (0.5%), Italy n= 414 (7.7%), Netherlands n = 156 (2.9), New Zealand n= 103 (1.9%), Portugal n = 56 (1. 1%), Switzerland n= 120 (2.2%), United Kingdom n = 202 (3.8%), United States of America n= 1,024 (19.1%), Uruguay n= 135 (2.5%).

Measures

Dependent variable: The Severity of Dependence Scale (SDS) (van der Pol, et al., 2013) consists of the following five items focusing on psychological aspects of dependence during the past 3 months:

1. Did you think your use of cannabis was out of control?

2. Did the prospect of missing a dose of cannabis make you anxious or worried?

3. Did you worry about your use of cannabis?

4. Did you wish you could stop the use of cannabis?

5. How difficult would you find it to stop, or go without cannabis?

Response options for items 1-4 ranged from 0 = never/almost never to 3 = always/nearly always, whereas item 5 answer options ranged from 0 = not difficult to 3 = impossible. As it is not recommended to use the SDS as a screener to differentiate

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dependence from non-dependence within community-based samples (van der Pol, et al., 2013), we generated the SDS by summing responses item values.

Focal independent variable: Respondents were asked about various motivations for growing cannabis. We focused on the following motivations for the current study: "To get high - to provide myself with cannabis for recreational use" and "To provide myself with medical cannabis." From these indicators, we operationalized motivation for use with the following mutually exclusive groups: "recreational only," "recreational and medical," and "medical only."

Moderator variables: Daily or near-daily (DND) use was dichotomized from a measure of past-month frequency of use (1-30 days) as follows: 0 = 1-19 days and 1 = 20-30 days (Davenport, 2018). We asked about strains of cannabis grown in the last 12 months, and created three non-mutually exclusive indicators as follows: C. indica, C. sativa and hybrid. Respondents were also asked to report types of cannabis they consumed within the last 12 months (whether self-grown or not). From these items, we created the following five non-mutually exclusive indicators for type of cannabis used: herbal (dried flower), hash/resin, oil, edibles, and extracts.

Sociodemographic and other control variables: We operationalized several sociodemographic measures: age, gender (including a non-binary answer category, yet no one in the current sample reported non-binary), employment status (employed versus not in paid employment), and education (beyond high school/technical trade diploma or not). Regarding substance use, we recorded age at onset of cannabis use and duration of cannabis use (in years), as well as past year use of alcohol, tobacco, and other illicit substances (0 = no, 1 = yes). Other illicit substances were recorded based on endorsement of use of any of the following substances: synthetic cannabinoids, methamphetamine, amphetamine, powder cocaine, crack cocaine,

ecstasy (MDMA), LSD, magic mushrooms, heroin, other opioids, benzos and sedatives, designer psychedelics, other hallucinogens, other NPS, ketamine, GHB+, kratom, inhalants.

Statistical analysis

When using self-reported scale data, such as the SDS, in a comparative framework (e.g. across individuals using cannabis for recreational and medical purposes), it is important to first of all ensure that the measure has the same meaning across groups (Gregorich, 2006). To ensure this we applied a multi-group Measurement Invariance (MI) approach (Byrne, 2010; Wang & Wang, 2012) comparing the "configural model" (e.g. all parameter are set to be free across the three groups) to a "weak MI model" constraining factor loadings to be identical across groups. The configural model fit was only satisfactory after excluding item # 5 (difficulty stopping use; CFI=0.991; TLI = 0.972, RMSEA = 0.058). Using only four of the SDS items, we performed the weak invariance test, which indicated no better fit than the configural model (ΔCFI=.004) (Byrne, 2010; Wang & Wang, 2012). Based on these results, the SDS was calculated by taking the sum of the four first items (i.e., excluding item #5 difficulty stopping use).

Kruskal–Wallis H (due to non-normal distributed continuous variables) and χ^2 tests assessed differences in sociodemographic factors and cannabis use factors across the three groups. Robust linear regression was used to test whether the three cannabis motivation groups had different SDS scores after controlling for sociodemographic background and cannabis and other substance use patterns. Robust regression computes standard errors that are robust when data fails to meet assumptions concerning normality and homogeneity of variance of the residuals (White, 1980). Interactions were tested between the three groups and the following variables (each

interaction was entered separately): DND use, hash/resin, edible, oil, extracts, C. indica, C. sativa, hybrid. Post hoc analysis for significant interactions with Bonferroni's adjustment was used to adjust for multiple comparisons within factor variable terms and predicted values were graphed to aid interpretation. Duration of cannabis use was excluded from the multivariate models after multicollinearity testing showed that it was highly correlated with age (r = .914, VIF = 7.14) and herbal cannabis use was excluded due to lack of variability as almost all respondents (98%) endorsed herbal use.

Results

Sample characteristics

Table 1 shows sample characteristics for the analytical sample (N = 5,347) which consisted of 1,977 (37%) individuals using cannabis for recreational purposes only, 2,133 (40%) individuals reported using for both recreational and medical purposes, and 1,237 (23%) individuals reported using only for medical purposes. The average age of the sample was 41.34 years (S.D. = 14.41, range 18-80) with individuals using for recreational purposes being younger than the other groups (36.57 versus 42.76 [recreational and medical] and 46.52 [medical only]). The majority (n = 4,647, 87%) were male with people who only reported medical use having the lowest proportion of males (n = 988, 80%). Furthermore, 37% (1,988) had completed high school or technical trade diploma, and 59% (n = 3,384) were in paid employment (n = 3,145, 59%) with those using for medical purposes being the least likely to be in paid employment (n = 569, 46%).

In terms of substance use other than cannabis, 2,987 (56%) reported tobacco use, 3,941 (74%) reported alcohol use and 1,679 (31%) reported other illicit substance use. Individuals reporting using cannabis only for medical purposes were less likely

than the other groups to use any of these substances. The average SDS score was 5.22 (S.D. = 1.77) with individuals reporting using cannabis only for medical purposes scoring the lowest (mean 4.75, S.D. = 1.45). The majority of the sample reported DND use of cannabis (n = 3,490, 65%) with individuals using cannabis only for recreational purposes being the least likely to report DND use. Respondents had used cannabis for an average of 24 years (S.D. = 14.41), and the average age at onset of use was 17 years (S.D. = 6.38). Individuals using for recreational purposes only had used for shorter periods than the two other groups (19.97 years versus 29.13 [recreational and medical] and 27.03 [medical only]), whereas medical only users started use at older ages compared to the other groups (19.58 years versus 16.6 years for the two other groups). In terms of cannabis type, 2,001 respondents (37%) reported use of resin, 2,178 (41%) used edibles, 1,474 (28%) used oil and 1,135 (21%) reported use of extracts. Individuals reporting using cannabis only for recreational purposes were least likely to use oil, extracts and edibles. C. indica growing was less common among individuals using cannabis for recreational purposes only (n=767, 39%).

[Table 1]

Correlates of SDS scores

Results from the robust regression models predicting SDS scores (table 2, model 1) show that individuals using cannabis for medical purposes (with and without recreational motivation) had lower SDS scores than those reporting only recreational motivations (B: -0.190 and B: -0.459, $p \leq 0.001$ respectively). SDS scores decreased with older age (B: -0.030, $p < 0.001$). Employed individuals had lower SDS scores (B: -0.235, p < 0.001), those with high school/technical diploma had higher SDS scores (B = 0.175, $p < 0.001$) and SDS scores were higher for respondents endorsing last year tobacco use (B: 0.327, $p < 0.001$), other illicit substance use (B: 0.174, $p =$

0.001), and DND use (B: 0.669, $p < 0.001$). Use of hash was associated with higher SDS scores (B: 0.187, $p = 0.001$), whereas use of edibles (B: -0.126, $p = 0.011$), oil (B: -0.138, $p = 0.011$), and extracts (B: -0.126, $p = 0.045$) was associated with lower SDS scores.

Model 2 shows that the associations between motivation for cannabis use and SDS scores were moderated by DND cannabis use. Figure 1 specifies that compared to individuals who use cannabis for recreational only purposes, the magnitude of the association between DND use and SDS scores was significantly smaller in the two groups with medical cannabis use motivations and more specifically the smallest, in the medical only group. None of the other interactions with strain and form were significant (see Table 2).

[Table 2, Figure 1]

Discussion

This study set out to reach a better understanding of the potential different levels of SDS scores among growers who use cannabis by comparing across recreational and/or medical motivations of use. We also explored whether type, strain and frequency of cannabis use moderate the association between motivation of use and SDS rates. The current study supports previous findings regarding differences in cannabis use problems across individuals using cannabis for recreational and medical purposes (Mills, et al., 2022; Sznitman, 2017). Specifically, the results confirm that after controlling for DND use and other confounders, individuals who use cannabis for recreational purposes experience more cannabis use problems than individuals with medical cannabis use motivations. Furthermore, similarly to other studies, we found that people with medical motivations tend to be older, more likely to be female, use more frequently, use a variety of cannabis types and report less use of other

substances (Choi, et al., 2017; Hakkarainen, et al., 2015; Lin, et al., 2016; Schlag, et al., 2021; Sznitman, 2017).

Additionally, the results suggest that establishing a direct connection between medical motivations for cannabis use, usage frequency, and cannabis-related problems may not be a straightforward process. Specifically, our analysis showed that DND use was strongly associated with higher SDS scores in individuals using cannabis only for recreational purposes, whereas this effect was smaller in individuals using for both recreational and medical purposes, and even smaller in individuals reporting use only for medical purposes. In other words, the findings of this study emphasize that DND use cannot be assumed to be synonymous with problematic cannabis use across individuals who use for recreational and medical purposes.

Clearly more research is needed to enlighten how recreational versus medical motivations for cannabis use relate to problems associated with use. This type of research is not only important to better understand relative risk of cannabis use disorders/problems? across motivation types, but also important in order to shed light on aggregate level trends. Research has shown that despite an increase in DND use in the U.S., CUD rates have not increased over the same period (Compton, Han, Jones, Blanco, & Hughes, 2016; Davenport, 2018). One potential reason for this unexpected trend is that the DND increase is partly driven by individuals using for medical reasons and, as the current results testify, the association between DND use and CUD is weaker when use is for medical than recreational purposes. More research in this area using representative and longitudinal data is needed.

It is worth noting that product differentiation and different routes of administration did not influence the connection between SDS scores and cannabis use motivation. This could be because while strains, products and modes differ in

cannabinoid profiles, they all contain the primary psychoactive compound, THC. This consistency may explain the lack of interaction. The interplay of various factors like genetics, environment, social influences, and personal psychology likely has a more substantial impact on cannabis use motivation and problematic use, although further research is needed to explore this.

In preparing the data for analysis this study included tests of the psychometric properties of the SDS scale in a multi-group invariance framework comparing across individuals who use for recreational and/or medical purposes. Results showed poor fit for the scale across groups when item #5 (difficulty stopping use) was included. This suggests that this item measures different things in individuals who use cannabis for recreational versus medical reasons and that it may therefore not be a valid measure of cannabis use problems when comparing across the groups (Gregorich, 2006). Difficulty stopping use was more highly endorsed by individuals using cannabis for medical versus recreational reasons, yet the reason for endorsement may not relate to cannabis use problems *per se* in individuals using cannabis for medical purposes. It is, for instance, possible that in this population, difficulty stopping use is endorsed because of anticipated re-emergence of medical symptoms (e.g. pain, depression, anxiety, PTSD symptoms). There may also be other reasons why this item may not be equally effective in measuring cannabis use problems across cannabis motivation groups. Identifying these is beyond the scope of the current study. Yet the findings highlight that there is a need for research that develops and tests new measurement tools for determining cannabis use problems across individuals who use cannabis for recreational and medical purposes and which may be particularly appropriate for comparing such problems across different types of use (Schlag, et al., 2021; Sznitman & Room, 2018). Until such assessment tools have been developed and tested, extra

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caution is needed when measuring use problems across individuals with divergent motivations for use and acceptable psychometric properties should be established statistically and documented. Indeed, a recent study examining the validity of the Cannabis Use Disorder Identification Test – Revised (CUDIT-R) showed higher CUDIT-R validity among non-medical cannabis card holders compared with medical card holders (Myers, et al., 2023). More research in this realm is clearly needed.

Limitations

The use of cross-sectional data and convenience sampling limits our ability to examine causation or make generalizable inferences. This study was conducted on a sample of recent (last 5 years) cannabis growers' reported experiences. Small-scale (illegal) cannabis cultivators represent a distinct subgroup and studying this group can contribute to a more comprehensive understanding of cannabis consumption, reasons for use and associations with problems resulting from that use. Nevertheless, the sample used has implications as the findings may not translate to individuals who use cannabis that is bought rather than self-grown. A more nuanced measure of this kind should be employed in future studies. Furthermore, the assessment of cannabis use problems in this, and other research, relies on self-reports, which may be subject to recall and other biases. It is possible that new scales are needed that better measure cannabis use problems across different motivational subtypes. More research is needed to test the psychometric properties of the cannabis use problem construct across different groups and caution is needed when interpreting results from established scales that have not been specifically developed to measure cannabis use problems across different motivational subtypes.

Conclusions

In the current environment, with changing cannabis policies for recreational and medical cannabis use, it is crucial that policymakers, researchers and other stakeholders work towards a better understanding of the potential harms of cannabis use. In particular, it is important to reach a better understanding for whether the extent to which people experience cannabis use problems differ based on whether use is for recreational and/or medical purposes. This is not only important in order to gauge the effects of liberal cannabis policies, but also to manage and guide the potential negative unintended effects of new policies. Results showing that psychometric properties of the SDS and SDS scores are different across individuals who use for recreational and medical purposes suggest that new measurement tools may be needed for improved comparative evaluation of cannabis use problems across groups with different underlying motivations for use. Furthermore, the higher SDS scores in individuals using cannabis for recreational purposes and the finding that DND use was most strongly associated with higher SDS scores in this group suggest that public education efforts, harm reduction approaches and policy responses need to be tailored depending on the underlying motivation for use.

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**Are Cannabis Use Problems Comparable Across Individuals Using for
Recreational and Medical Purposes? An International Cross-Sectional Study of
Individuals Who Use Self-Grown Cannabis**

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Abstract

Background: Little is known about cannabis use problems among individuals who use cannabis for medical purposes and whether rates and determinants of cannabis use problems how they mayin medical users differ to those observed among individuals using for recreational reasons. This study examines whether Severity of Dependence Scale (SDS) scores differ across individuals who use self-grown cannabis for the following reasons: "recreational only", "medical and recreational" and "medical only". Furthermore, the study tests whether cannabis use frequency,

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cannabis strain, and type of cannabis influences the strength of the association between purpose of use and cannabis use problems.

Methods: Data (n = 5,347) were collected from a subsample of the Global Cannabis Cultivation Research Consortium project, focusing on small-scale cannabis growers in 18 countries. Robust regressions analyzed differences in SDS scores across the three use motivation groups.

Results: Compared with respondents reporting only recreational motivations of cannabis use, those with medical (with and without recreational) motivations were associated with lower SDS scores (B: -0.190 and B: -0.459, $p < 0.001$ respectively). Daily use was associated with significantly higher SDS scores across all cannabis motivation groups, albeit the magnitude of the association was significantly smaller among individuals with medical motivations of use.

Conclusion: The extent to which people experience cannabis use problems, and the determinants of these problems may differ depending on whether cannabis use is motivated by recreational or medical purposes. As such, the findings of the current study suggest that pPublic education efforts, harm reduction approaches and policy responses should be tailored depending on whether cannabis is used for recreational or medical purposes.

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Instead of including this we have added a sentence of the main finding and made a direct link to this finding and the policy implication. We think this improves the conclusion, but we are happy to revise if you have further suggestions for improvement.

Introduction

Cannabis is one of the most commonly consumed substances worldwide (UNODC,

2021), primarily used recreationally for its psychoactive effects, although therapeutic use is becoming more common in jurisdictions such as the U.S., Israel, Canada where ~~that have legalized~~ medical use is legalized (Boehnke, Dean, Haffajee, & Hosanagar, 2022; Myran, et al., 2023; Sznitman, 2020). Cannabis use has a relatively low risk of harm (e.g., mental health, toxicity, accidents) compared to use of other psychoactive substances such as alcohol, nicotine, amphetamines, or cocaine (Boden, Dhakal, Foulds, & Horwood, 2020; Nutt, King, & Phillips, 2010), especially regarding the risk of dependence (Lopez-Quintero, et al., 2011). Nevertheless, it has been estimated that 22% of people who use cannabis recreationally meet DSM-V criteria for cannabis use disorder (CUD) (American Psychiatric Association, 2013; Leung, Chan, Hides, & Hall, 2020), defined as continued cannabis use despite significant functional impairment, loss of control, or withdrawal symptoms when use is discontinued (Patel, 2021). The demand for CUD treatment is substantial and increasing in North America, Europe, and Oceania across some population groups (Askari, Keyes, & Mauro, 2021; Manthey, 2019; UNODC, 2021). While reasons for the increase are varied, including greater availability and use overall (Rose, 1992), increased treatment offerings and court referrals, evidence suggests that it also partly relates to a genuine rise in cannabis use-related problems (Hamilton & Monaghan, 2019; McCulloch, 2017).

Cannabis use problems are often tied to motives for use. Motivational theories of substance use are founded on the idea that people turn to substances in pursuit of distinct desired outcomes, which can vary from one individual to another (Cooper, 2015). While various ~~motives~~ motivations for use have been linked to cannabis use problems, meta-analytic evidence shows that coping (e.g. use to forget problems) and

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> With higher CUD/DUD, more people access treatment.

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conformity (e.g. use because of peer pressure) are most strongly associated with the development of cannabis use problems (Bresin & Mekawi, 2019).

Another way to classify motives for cannabis use, especially against the backdrop of ongoing cannabis liberalization, is whether the intention to use is for recreational or medical purposes, although the evidence for how these motives may relate to cannabis use problems remains inconclusive. Choi et al. (2017) reported proportionately more cannabis use problems among people using cannabis medically (32.88%) than those using it recreationally (25.25%). Sznitman (2017), however, found the opposite: individuals using for recreational purposes faced more ~~serious~~ cannabis-related problems (~~(~~mean = 0.~~74~~ 63 ~~(S.D. = 0.59)~~ versus ~~,~~ mean~~=~~ = 0.54 ~~(S.D. = 0.50)~~). Mills et al. (2022) found that among individuals who used cannabis for both recreational and medical purposes, a relative increase in the proportion of use for recreational versus medical purposes was associated with a significant reduction in experience of CUD criteria. Still, other studies have failed to find a significant difference in cannabis use problems between those who use for recreational versus medical reasons (Bonn-Miller, Boden, Bucossi, & Babson, 2014; Lin, Ilgen, Jannausch, & Bohnert, 2016), so the evidence is inconclusive.

Although many people who use cannabis daily experience few clinical problems, frequency of use has been found to be a strong predictor of cannabis use problems (Compton, Saha, Conway, & Grant, 2009; Mills, et al., 2022). Richmond et al. (2015) found that although people with a medical license consumed cannabis more frequently than those without a license, the former had a lower risk of experiencing cannabis use problems. Other studies have found that despite a higher likelihood of daily or near-daily (DND) cannabis use, individuals using cannabis for medical versus recreational purposes reported fewer problems with cannabis use (Sznitman, 2017)

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and drugs more generally (Roy-Byrne, et al., 2015). Lin et al. (Fortin, et al., 2021; 2016) observed that, despite more frequent daily consumption among people using cannabis medically, there was no discernible difference in cannabis abuse or dependence associated with recreational and medical use.

Another gap in the literature concerns whether the strain of cannabis typically consumed moderates the association between motivations for use and cannabis use problems. Although opinions and research are divided (de Meijer, et al., 2003; Vergara, Gaudino, Blank, & Keegan, 2020), the general consensus is that the cannabis plant can be categorized into two primary sub-strains, *C. indica* and *C. sativa* (Hillig & Mahlberg, 2004). Research suggests that *C. sativa* produces high delta-9-tetrahydrocannabinol (THC) and low cannabidiol (CBD) concentrations, whereas *C. indica* has higher relative concentrations of CBD to THC. Cannabis growers can access hundreds of strains – or cultivars – through seedbanks, and many also develop their own hybrids, with reportedly different THC and CBD content. Growers, especially those who are growing cannabis for medical use, often report deliberate selection of strains with cannabinoid contents that give them their preferred (recreational and/or therapeutic) effects (Klein & Potter, 2018; Sznitman, et al., 2019). Importantly, although research has shown that higher CBD levels can attenuate the dependence-producing effects of THC, there remains much we do not know about cannabinoid content and dependence liability (Schlag, Hindocha, Zafar, Nutt, & Curran, 2021).

An additional area of consideration regarding cannabis use problems and motivations for use is cannabis product differentiation (e.g., herbal, resin, oil, edibles) and different routes of administration (e.g., smoked, vaporized, oral). Preference for these modalities may differ by use motivation – especially medical versus recreational

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use – and impact the onset, intensity, and duration of effects (Pacula, Jacobson, & Maksabedian, 2016; Sznitman, 2017). Research has, for instance, found that individuals who use cannabis for medical purposes are more likely to vaporize and consume edibles than individuals who use for recreational purposes (Pacula, et al., 2016; Sznitman, 2017). Other research, not related to motive of use, has found that use of extracts (Bidwell, YorkWilliams, Mueller, Bryan, & Hutchison, 2018) and cannabis administrated by vaping or smoking (Simpson, Cho, & Barrington-Trimis, 2021) are related to cannabis use problems.

Current study

To our knowledge, no single study has formally assessed whether patterns of cannabis use (e.g. frequency of use, strain of cannabis, or and type of cannabis product used) independently moderate the effect ofassociation between cannabis use motives on and cannabis use problems. In this paper, we use data from a large international survey of small-scale cannabis growers to test, first, whether the risk of cannabis use problems differs across between the following three groups with divergent motivations for using: (1) individuals who grow cannabis to supply themselves with cannabis for recreational purposes only, (2) individuals who grow cannabis to supply themselves for both recreational and medical purposes, and (3) individuals who grow cannabis to supply themselves with cannabis for medical purposes only. Second, we assess whether cannabis use frequency, cannabis strain, and type of cannabis product, moderate the association between effect of motivation for use on and cannabis use problems.

The focus on individuals who self-grow their cannabis is important as this population is likely to have relatively regular stores of cannabis so that intention to use would not be hampered by lack of availability. Growers are also more likely to

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know (or, at least, believe that they know) the specific cannabis strain and its cannabinoid profile that they are cultivating (Decorte, 2010; Sznitman, et al., 2019). Small-scale cannabis growers are also more likely to produce cannabis products that align with their personal consumption preferences (Klein & Potter, 2018).

Methods

Data were collected by the Global Cannabis Cultivation Research Consortium (GCCRC, www.worldwideweed.nl). The online questionnaire, probing respondents about cannabis use patterns and cannabis growing experiences, was presented in 12 languages (Danish, German, English, Spanish, Finnish, French, French-Canadian, Hebrew, Italian, Georgian, Dutch, Portuguese) and ran from August 2020 to September 2021 in the following 18 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Georgia, Germany, Israel, Italy, the Netherlands, New Zealand, Portugal, Switzerland, the United Kingdom, the United States, and Uruguay. All languages were available to all countries as the survey was programmed in a single build with multiple language options.

The recruitment and engagement plans were broad-based to maximize the diversity of respondents. Strategies included updates on the project website (https://worldwideweed.nl), launching feature articles and media releases, engaging with alternative and mainstream media outlets, distributing flyers in alternative shops, promoting/advertising the study through online social media platforms such as Facebook and Twitter, and engaging with cannabis communities through online forums and social media groups. Research teams obtained approval from their respective institutional ethics committees and validations from institutional data protection officers, and the international survey obtained ethical approval through the Australian team at Curtin University who hosted the survey using Qualtrics (2005).

For this analysis, out of 11,479 valid cases, 6,032 respondents fulfilled the following inclusion criteria: residence in one of the 18 recruitment countries, being ≥18 years of age, grew cannabis within past 5 years, and self-reported past month cannabis use. Furthermore, since the core variable of interest was based on whether respondents grew cannabis to provide themselves with recreational or medical cannabis, only respondents who reported that at least 50% of their cannabis use was covered by their own growing were included. A further 685 respondents had missing data on at least one of the variables used in the analysis leading to a final analytical sample of 5,347 with the following country distributions: Australia n= 364 (6.8%), Austria n = 22 (0.4%), Belgium n= 939 (17.6%), Canada n= 286 (5.4%), Denmark n = 389 (7.3%), Finland n= 293 (5.5%), France n = 331 (6.2%), Georgia n= 74 (1.4%), Germany n = 412 (7.7%), Israel n = 30 (0.5%), Italy n= 414 (7.7%), Netherlands n = 156 (2.9), New Zealand n= 103 (1.9%), Portugal n = 56 (1. 1%), Switzerland n= 120 (2.2%), United Kingdom n = 202 (3.8%), United States of America n= 1,024 (19.1%), Uruguay n= 135 (2.5%). Geographic distribution related to cultivation law (whether respondents perceived cannabis cultivation to be prohibited, legal for medical use or legal for any adult recreational use in their country of residence) is presented in supplementary table 1.

Measures

Dependent variable: The Severity of Dependence Scale (SDS) (van der Pol, et al., 2013) consists of the following five items focusing on psychological aspects of dependence during the past 3 months:

1. Did you think your use of cannabis was out of control?

2. Did the prospect of missing a dose of cannabis make you anxious or worried?

3. Did you worry about your use of cannabis?

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4. Did you wish you could stop the use of cannabis?

5. How difficult would you find it to stop, or go without cannabis?

Response options for items 1-4 ranged from 0 = never/almost never to 3 = always/nearly always, whereas item 5 answer options ranged from 0 = not difficult to 3 = impossible. As it is not recommended to use the SDS as a screener to differentiate dependence from non-dependence within community-based samples (van der Pol, et al., 2013), we generated the SDS by summing responses item values.

Focal independent variable: Respondents were asked about various motivations for growing cannabis. We focused on the following motivations for the current study: "To get high - to provide myself with cannabis for recreational use" and "To provide myself with medical cannabis." From these indicators, we operationalized motivation for use with the following mutually exclusive groups: "recreational only," "recreational and medical," and "medical only."

Moderator variables: Daily or near-daily (DND) use was dichotomized from a measure of past-month frequency of use (1-30 days) as follows: 0 = 1-19 days and 1 = 20-30 days (Davenport, 2018). We asked about strains of cannabis grown in the last 12 months, and created three non-mutually exclusive indicators as follows: C. indica, C. sativa and hybrid. Respondents were also asked to report types of cannabis they consumed within the last 12 months (whether self-grown or not). From these items, we created the following five non-mutually exclusive indicators for type of cannabis used: herbal (dried flower), hash/resin, oil, edibles, and extracts.

Sociodemographic and other control variables: We operationalized several sociodemographic measures: age, gender (including a non-binary answer category, yet no one in the current sample reported non-binary), employment status (employed versus not in paid employment), and education (beyond high school/technical trade

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diploma or not). Regarding substance use, we recorded age at onset of cannabis use and duration of cannabis use (in years), as well as past year use of alcohol, tobacco, and other illicit substances (0 = no, 1 = yes). Other illicit substances were recorded based on endorsement of use of any of the following substances: synthetic cannabinoids, methamphetamine, amphetamine, powder cocaine, crack cocaine, ecstasy (MDMA), LSD, magic mushrooms, heroin, other opioids, benzos and sedatives, designer psychedelics, other hallucinogens, other NPS, ketamine, GHB+, kratom, inhalants.

Statistical analysis

When using self-reported scale data, such as the SDS, in a comparative framework (e.g. across individuals using cannabis for recreational and medical purposes), it is important to first of all ensure that the measure has the same meaning across groups (Gregorich, 2006). To ensure this we applied a multi-group Measurement Invariance (MI) approach (Byrne, 2010; Wang & Wang, 2012) comparing the "configural model" (e.g. all parameter are set to be free across the three groups) to a "weak MI model" constraining factor loadings to be identical across groups. The configural model fit was only satisfactory after excluding item # 5 (difficulty stopping use; CFI=0.991; TLI = 0.972, RMSEA = 0.058). Using only four of the SDS items, we performed the weak invariance test, which indicated no better fit than the configural model (ΔCFI=.004) (Byrne, 2010; Wang & Wang, 2012). Based on these results, the SDS was calculated by taking the sum of the four first items (i.e., excluding item #5 difficulty stopping use).

Kruskal–Wallis H (due to non-normal distributed continuous variables) and χ^2 tests assessed differences in sociodemographic factors and cannabis use factors across the three groups. Robust linear regression was used to test whether the three cannabis

motivation groups had different SDS scores after controlling for sociodemographic background and cannabis and other substance use patterns. Robust regression computes standard errors that are robust when data fails to meet assumptions concerning normality and homogeneity of variance of the residuals (White, 1980). Interactions were tested between the three groups and the following variables (each interaction was entered separately): DND use, hash/resin, edible, oil, extracts, C. indica, C. sativa, hybrid. Post hoc analysis for significant interactions with Bonferroni's adjustment was used to adjust for multiple comparisons within factor variable terms and predicted values were graphed to aid interpretation. Duration of cannabis use was excluded from the multivariate models after multicollinearity testing showed that it was highly correlated with age (r = .914, VIF = 7.14) and herbal cannabis use was excluded due to lack of variability as almost all respondents (98%) endorsed herbal use.

Results

Sample characteristics

Table 1 shows sample characteristics for the analytical sample (N = 5,347) which consisted of 1,977 (37%) individuals using cannabis for recreational purposes only, 2,133 (40%) individuals reported using for both recreational and medical purposes, and 1,237 (23%) individuals reported using only for medical purposes. The average age of the sample was 41.34 years (S.D. = 14.41, range 18-80) with individuals using for recreational purposes being younger than the other groups (36.57 versus 42.76 [recreational and medical] and 46.52 [medical only]). The majority (n = 4,647, 87%) were male with people who only reported medical use having the lowest proportion of males (n = 988, 80%). Furthermore, 37% (1,988) had completed high school or technical trade diploma, and 59% (n = 3,384) were in paid employment (n =

3,145, 59%) with those using for medical purposes being the least likely to be in paid employment (n = 569, 46%).

In terms of substance use other than cannabis, 2,987 (56%) reported tobacco use, 3,941 (74%) reported alcohol use and 1,679 (31%) reported other illicit substance use. Individuals reporting using cannabis only for medical purposes were less likely than the other groups to use any of these substances. The average SDS score was 5.22 (S.D. = 1.77) with individuals reporting using cannabis only for medical purposes scoring the lowest (mean 4.75, S.D. = 1.45). The majority of the sample reported DND use of cannabis (n = 3,490, 65%) with individuals using cannabis only for recreational purposes being the least likely to report DND use. Respondents had used cannabis for an average of 24 years (S.D. = 14.41), and the average age at onset of use was 17 years (S.D. = 6.38). Individuals using for recreational purposes only had used for shorter periods than the two other groups (19.97 years versus 29.13 [recreational and medical] and 27.03 [medical only]), whereas medical only users started use at older ages compared to the other groups (19.58 years versus 16.6 years for the two other groups). In terms of cannabis type, 2,001 respondents (37%) reported use of resin, 2,178 (41%) used edibles, 1,474 (28%) used oil and 1,135 (21%) reported use of extracts. Individuals reporting using cannabis only for recreational purposes were least likely to use oil, extracts and edibles. C. indica growing was less common among individuals using cannabis for recreational purposes only (n=767, 39%).

[Table 1]

Correlates of SDS scores

Results from the robust regression models predicting SDS scores (table 2, model 1) show that individuals using cannabis for medical purposes (with and without recreational motivation) had lower SDS scores than those reporting only recreational

motivations (B: -0.190 and B: -0.459, $p \leq 0.001$ respectively). SDS scores decreased with older age (B: -0.030, $p < 0.001$). Employed individuals had lower SDS scores (B: -0.235, p < 0.001), those with high school/technical diploma had higher SDS scores (B = 0.175, $p < 0.001$) and SDS scores were higher for respondents endorsing last year tobacco use (B: 0.327, $p < 0.001$), other illicit substance use (B: 0.174, $p = 0.001$), and DND use (B: 0.669, $p < 0.001$). Use of hash was associated with higher SDS scores (B: 0.187, $p = 0.001$), whereas use of edibles (B: -0.126, $p = 0.011$), oil (B: -0.138, $p = 0.011$), and extracts (B: -0.126, $p = 0.045$) was associated with lower SDS scores.

Model 2 shows that the associations between motivation for cannabis use and SDS scores were moderated by DND cannabis use. Figure 1 specifies that compared to individuals who use cannabis for recreational only purposes, the magnitude of the association between DND use and SDS scores was significantly smaller in the two groups with medical cannabis use motivations and more specifically the smallest, in the medical only group. None of the other interactions with strain and form were significant (see Table 2).

[Table 2, Figure 1]

Discussion

This study set out to reach a better understanding of the the relative and potential different levels of SDS scores among growers who use cannabis by comparing across recreational and/or medical motivations of use. We also explored whether type, strain and frequency of cannabis use moderate the association between motivation of use and SDS rates. The current study supports previous findings regarding differences in cannabis use problems across individuals using cannabis for recreational and medical purposes (Mills, et al., 2022; Sznitman, 2017). Specifically, the results confirm that

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It is worth noting that product differentiation and different routes of administration did not influence the connection between SDS scores and cannabis use motivation. This could be because while strains, products and modes differ in cannabinoid profiles, they all contain the primary psychoactive compound, THC. This consistency may explain the lack of interaction. The interplay of various factors like genetics, environment, social influences, and personal psychology likely has a more substantial impact on cannabis use motivation and problematic use, although further research is needed to explore this.

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after controlling for DND use and other confounders, individuals who use cannabis for recreational purposes experience more cannabis use problems than individuals with medical cannabis use motivations. Furthermore, similarly to other studies, we found that people with medical motivations tend to be older, more likely to be female, use more frequently, use a variety of cannabis types and report less use of other substances (Choi, et al., 2017; Hakkarainen, et al., 2015; Lin, et al., 2016; Schlag, et al., 2021; Sznitman, 2017).

Additionally, the results suggest that establishing a direct connection between medical motivations for cannabis use, usage frequency, and cannabis-related problems may not be a straightforward process. Specifically, ~~Our~~ our analysis showed that

~~the frequency of cannabis use moderated the effect of user motivation on cannabis use problems. Concretely,~~ DND use was strongly associated with higher SDS scores in individuals using cannabis only for recreational purposes, whereas this effect was smaller in individuals using for both recreational and medical purposes, and even smaller in individuals reporting use only for medical purposes. In other words, the findings of this study emphasize that DND use cannot be assumed to be synonymous with problematic cannabis use across individuals who use for recreational and medical purposes.

Clearly more research is needed to enlighten how recreational versus medical motivations for cannabis use relate to problems associated with use. This type of research is not only important to better understand relative risk of cannabis use disorders/problems? across motivation types, but also important in order to shed light on aggregate level trends. Research has shown that despite an increase in DND use in the U.S., CUD rates have not increased over the same period (Compton, Han, Jones,

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Blanco, & Hughes, 2016; Davenport, 2018). One potential reason for this unexpected trend is that the DND increase is partly driven by individuals using for medical reasons and, as the current results testify ~~to~~, the association between DND use and CUD is weaker when use is for medical than recreational purposes. More research in this area using representative and longitudinal data is needed.

It is worth noting that product differentiation and different routes of administration did not influence the connection between SDS scores and cannabis use motivation. This could be because while strains, products and modes differ in cannabinoid profiles, they all contain the primary psychoactive compound, THC. This consistency may explain the lack of interaction. The interplay of various factors like genetics, environment, social influences, and personal psychology likely has a more substantial impact on cannabis use motivation and problematic use, although further research is needed to explore this.

In preparing the data for analysis this study included tests of the psychometric properties of the SDS scale in a multi-group invariance framework comparing across individuals who use for recreational and/or medical purposes. Results showed poor fit for the scale across groups when item #5 (difficulty stopping use) was included. This suggests that this item measures different things in individuals who use cannabis for recreational versus medical reasons and that it may therefore not be a valid measure of cannabis use problems when comparing across the groups (Gregorich, 2006). Difficulty stopping use was more highly endorsed by individuals using cannabis for medical versus recreational reasons, yet the reason for endorsement may not relate to cannabis use problems *per se* in individuals using cannabis for medical purposes. It is, for instance, possible that in this population, difficulty stopping use is endorsed because of anticipated re-emergence of medical symptoms (e.g. pain, depression,

anxiety, PTSD symptoms). There may also be other reasons ~~for~~ why this item may not be equally effective in measuring cannabis use problems across cannabis motivation groups. Identifying these is beyond the scope of the current study. Yet the findings highlight that there is a need for research that develops and tests new measurement tools for determining cannabis use problems across individuals who use cannabis for recreational and medical purposes and which may be particularly appropriate for comparing such problems across different types of use (Schlag, et al., 2021; Sznitman & Room, 2018). Until such assessment tools have been developed and tested, extra caution is needed when measuring use problems across individuals with divergent motivations for use and acceptable psychometric properties should be established statistically and documented. Indeed, a recent study examining the validity of the Cannabis Use Disorder Identification Test – Revised (CUDIT-R) showed higher CUDIT-R validity among non-medical cannabis card holders compared with medical card holders (Myers, et al., 2023). More research in this realm is clearly needed.

Limitations

The use of cross-sectional data and convenience sampling limits our ability to examine causation or make generalizable inferences. This study was conducted on a sample of recent (last 5 years) cannabis growers' reported experiences. Small-scale (illegal) cannabis cultivators represent a distinct subgroup and studying this group can contribute to a more comprehensive understanding of cannabis consumption, reasons for use and associations with problems resulting from that use. Nevertheless, the sample used has implications as the findings may not translate to individuals who use cannabis that is bought rather than self-grown. ~~The cannabis motivation groups were created based on reports of whether cannabis growing was for providing oneself with cannabis for recreational or medical purposes and inclusion criteria ensured that the~~

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analytical sample included only respondents who endorsed use of personally grown cannabis in the last year. Yet, we lack a measure of the proportion of respondents' grown or otherwise obtained (given, bought) cannabis used for recreational/medical purposes. A more nuanced measure of this kind should be employed in future studies. Furthermore, the assessment of cannabis use problems in this, and other research, relies on self-reports, which may be subject to recall and other biases. It is possible that new scales are needed that better measure cannabis use problems across different motivational subtypes. More research is needed to test the psychometric properties of the cannabis use problem construct across different groups and caution is needed when interpreting results from established scales that have not been specifically developed to measure cannabis use problems across different motivational subtypes.

Conclusions

In the current environment, with changing cannabis policies for recreational and medical cannabis use, it is crucial that policymakers, researchers and other stakeholders work towards a better understanding of the potential harms of cannabis use. In particular, it is important to reach a better understanding for whether the extent to which people experience cannabis use problems differ and whether these harms may be changing and may differ based on whether use is for recreational and/or medical purposes. This is not only important in order to gauge the effects of liberal cannabis policies, but also to manage and guide the potential negative unintended effects of new policies. Results showing that psychometric properties of the SDS and SDS scores are different across individuals who use for recreational and medical purposes suggest that new measurement tools may be needed for improved comparative evaluation of cannabis use problems across groups with different underlying motivations for use. Furthermore, the higher SDS scores in individuals

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using cannabis for recreational purposes and the finding that DND use was most strongly associated with higher SDS scores in this group suggest that ~~and~~ public education efforts, harm reduction approaches and policy responses need to be tailored depending on the underlying motivation for use.

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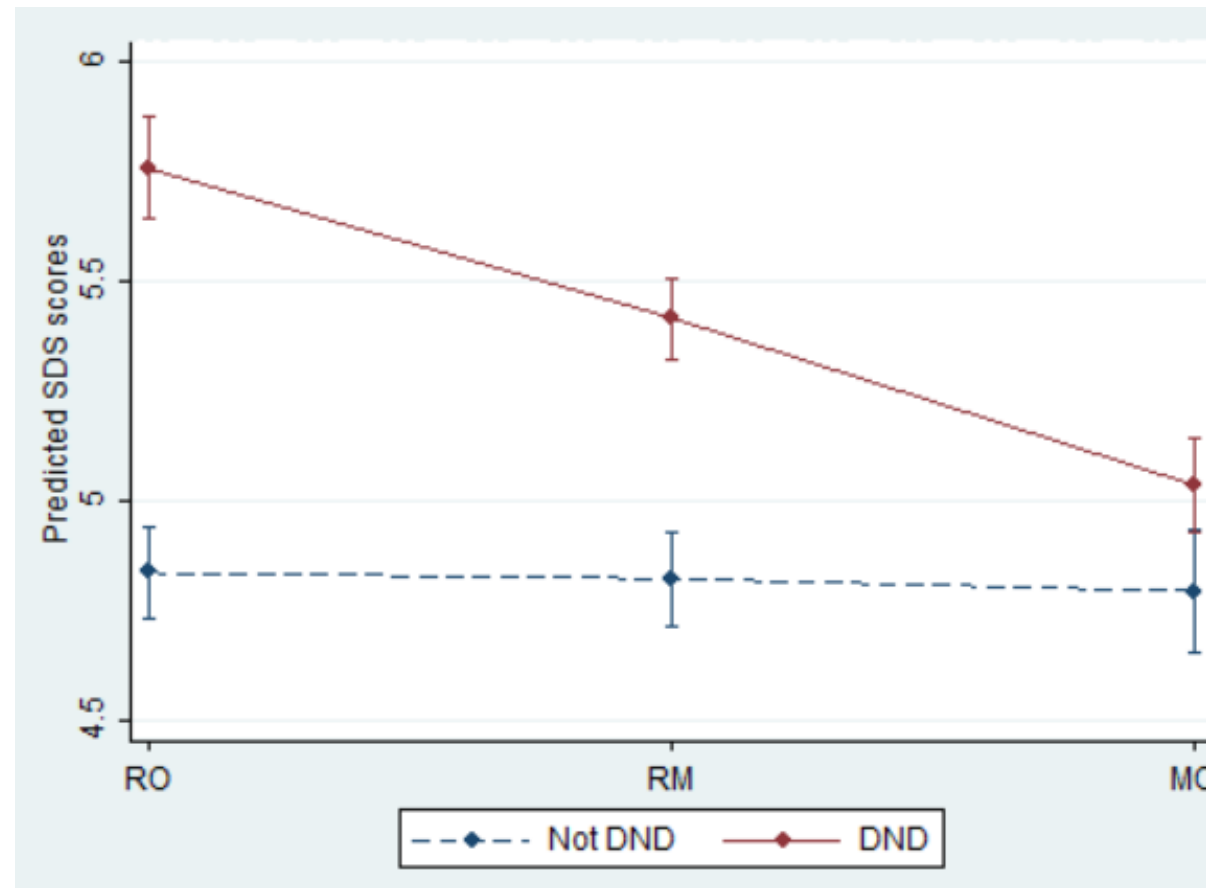**Figure 1:** Interaction plot for predicted SDS scores. Line graph displaying predicted SDS scores (y-axis) as a function of DND use (lines) by recreational and medical motivation for cannabis use (x-axis) in the sample (n=5,347). Data points account for robust regression model covariates. RO = Recreational Only; RM = Recreational and Medical; MO = Medical Only; DND = Daily/near daily; SDS = Severity of Dependence Scale

Table 1: Descriptive sample statistics

		Motivation for use				
		Recreational Only	Recreational & Medical	Medical Only	Total	P-value
		(n = 1977, 36.97%)	(n = 2133, 39.89%)	(n = 1237, 23.13%)	(n =5347, 100%)	
Sociodemographic background						
Male	n	1775[a]	1890[b]	988[ab]	4653	**<0.001**
	%	89.78	88.61	79.87	87.02	
Age	Mean	36.57[ab]	42.76[ac]	46.52[bc]	41.34	**<0.001**
	sd	13.94	13.99	13.56	14.41	
Employed	n	1319[ab]	1257[ac]	569[bc]	3145	**<0.001**
	%	66.72	58.93	46.00	58.82	
Beyond high school/technical trade diploma	n	819[ab]	739[b]	430[a]	1,988	**<0.001**
	%	41.43	34.63	34.71	37.16	
Other substance use						
Tobacco use	n	1283[ab]	1128[ac]	576[bc]	2987	**<0.001**
	%	64.90	52.88	46.56	55.86	
Alcohol use	n	1671[ab]	1546[ac]	724[bc]	3941	**<0.001**
	%	84.52	72.48	58.53	73.70	
Other illicit substance use	n	666[a]	753[b]	260[ab]	1679	**<0.001**
	%	33.69	35.30	21.02	31.40	
Cannabis use						
Daily, near daily use	n	1085[ab]	1544[a]	861[b]	3490	**<0.001**
	%	54.88	72.39	69.60	65.27	
Age at first use	mean	16.60[a]	16.63[b]	19.48[ab]	17.28	**<0.001**
	S.D.	3.91	4.79	10.28	6.38	
Duration of use	mean	19.97[ab]	26.13[a]	27.03[b]	24.06	**<0.001**
	S.D.	13.84	14.18	14.22	14.41	
SDS scores	mean	5.54[ab]	5.19[ac]	4.75[bc]	5.22	**<0.001**
	S.D.	1.91	1.73	1.45	1.77	
SDS item #5: difficulty stopping use	mean	1.44[a]	1.49[b]	1.56[ab]	1.49	**<0.001**
	S.D.	0.67	0.74	0.9	0.76	
Type of cannabis used						
Hash/resin	n	767[a]	892[b]	342[ab]	2001	**<0.001**
	%	38.80	41.82	27.65	37.42	
Edible	n	665[ab]	1014[ac]	499[bc]	2178	**<0.001**
	%	33.64	47.54	40.34	40.73	
Oil	n	272[ab]	688[bc]	514[ac]	1474	**<0.001**
	%	13.76	32.26	41.55	27.57	
Extracts	n	246[ab]	571[a]	318[b]	1135	**<0.001**
	%	12.44	26.77	25.71	21.23	
Indica	n	767[bc]	1141[c]	644[b]	2,552	**<0.001**
	%	38.8	53.47	51.98	47.7	
Sativa	n	746[bc]	1052[ac]	539[ab]	2,337	**<0.001**
	%	37.73	49.3	43.5	43.68	
Hybrid	n	982[bc]	1447[ac]	706[ab]	3,135	**<0.001**
	%	49.67	67.81	56.98	58.6	

Note: SDS = Substance Use Dependence. DND use = daily/near daily use. P values relate to sigificant contrasts for Kruskal–Wallis H tests which were tested using Dunn's procedure with a Bonferroni adjustment for continuous variables; contrasts for X^2 tests involved pairwise comparisons with X^2 tests at P < 0.05; [abs] = groups that share a common superscript are significantly different.

Table 2: Results from Robust Linear Regression Predicting SDS scores (n = 5,347)

Predictors	Coef.	P-value	[95% Conf.	Interval]
	Main effects			
Male	**0.139**	**0.036**	**0.009**	**0.269**
Age	**-0.030**	**<0.001**	**-0.033**	**-0.026**
Employed	**-0.235**	**<0.001**	**-0.328**	**-0.142**
Beyond high school/technical diploma	**0.175**	**<0.001**	**0.082**	**0.268**
Tobacco use	**0.327**	**<0.001**	**0.236**	**0.418**
Alcohol use	-0.065	0.234	-0.173	0.042
Other illicit substance use	**0.174**	**0.001**	**0.069**	**0.278**
DND use	**0.669**	**<0.001**	**0.572**	**0.765**
Age at first use	0.000	0.926	-0.005	0.005
Hash/resin	**0.187**	**<0.001**	**0.083**	**0.292**
Edibles	**-0.126**	**0.011**	**-0.223**	**-0.028**
Oil	**-0.138**	**0.011**	**-0.245**	**-0.032**
Extracts	**-0.126**	**0.045**	**-0.249**	**-0.003**
Indica	-0.071	0.210	-0.183	0.040
Sativa	-0.060	0.280	-0.169	0.049
Hybrid	-0.008	0.878	-0.104	0.089
Motivations for use (recreational only referent category)				
Recreational and medical	**-0.190**	**0.001**	**-0.301**	**-0.080**
Medical only	**-0.459**	**<0.001**	**-0.583**	**-0.334**
Intercept	**6.074**	**<0.001**	**5.791**	**6.357**
Interactions: mode	**Interaction effects**			
Recreational and medical * hash/rasin	-0.098	0.381	-0.318	0.122
Medical only * hash/rasin	-0.003	0.983	-0.252	0.246
Recreational and medical * edibles	0.000	0.997	-0.216	0.215
Medical only * edibles	0.125	0.276	-0.100	0.349
Recreational and medical * oil	-0.031	0.814	-0.293	0.230
Medical only * oil	0.071	0.607	-0.198	0.340
Recreational and medical * extracts	0.012	0.937	-0.291	0.315
Medical only * extracts	0.078	0.635	-0.243	0.398
Interactions: strains				
Recreational and medical *indica	-0.039	0.719	-0.254	0.175
Medical only * indica	-0.068	0.558	-0.294	0.159
Recreational and medical * sativa	0.108	0.323	-0.106	0.321
Medical only * sativa	0.013	0.908	-0.212	0.239
Recreational and medical *hybrid	0.104	0.348	-0.113	0.321
Medical only * hybrid	-0.007	0.949	-0.233	0.218
Interactions: DND				
Recreational and medical * DND	-0.338	0.001	-0.546	-0.130
Medical only * DND	-0.686	**<0.001**	-0.913	-0.460

Role of Funding Source: Nothing declared