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Short communication

Driving under the influence of cannabis among medical cannabis patients with chronic pain

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ABSTRACT

Background: Driving under the influence of cannabis (DUIC) is a public health concern among those using medical cannabis. Understanding behaviors contributing to DUIC can inform prevention efforts. We evaluated three past 6-month DUIC behaviors among medical cannabis users with chronic pain.

Methods: Adults ($N = 790$) seeking medical cannabis certification or recertification for moderate/severe pain were recruited from February 2014 through June 2015 at Michigan medical cannabis clinics. About half of participants were male (52%) and 81% were White; their Mean age was 45.8 years. Participants completed survey measures of DUIC (driving within 2 h of use, driving while "a little high," and driving while "very high") and background factors (demographics, alcohol use, etc.). Unadjusted and adjusted logistic regressions were used to examine correlates of DUIC.

Results: For the past 6 months, DUIC within 2 h of use was reported by 56.4% of the sample, DUIC while a "little high" was reported by 50.5%, and "very high" was reported by 21.1%. Greater cannabis quantity consumed and binge drinking were generally associated with DUIC behaviors. Higher pain was associated with lower likelihood of DUIC. Findings vary somewhat across DUIC measures.

Conclusions: The prevalence of DUIC is concerning, with more research needed on how to best measure DUIC. Prevention messaging for DUIC may be enhanced by addressing alcohol co-consumption.

1. Introduction

Driving under the influence of cannabis (DUIC) is an important public health problem that may pose an increased risk for motor vehicle crash (Li et al., 2012; Neavyn et al., 2014; Rogeberg and Elvik, 2016). Several prior studies suggest have found that presence of THC (delta-9-tetrahydrocannabinol) is associated with impaired driving-related functions (Downey et al., 2013; Liguori et al., 1998; Newmeyer et al., 2017; Ramaekers et al., 2004). A recent meta-analysis also concluded that acute cannabis intoxication is related to an increase risk of MVC (Rogeberg and Elvik, 2016); however, another found that cannabis use was not significantly related to "unfavorable traffic events" (including MVC; Hostiuc et al., 2018). Nonetheless, Hostiuc and colleagues noted that the significant limitations in methodology and measurement across studies might meaningfully relate to such negative outcomes associated with DUIC, and that further study is needed (Hostiuc et al., 2018).

Although prior literature regarding DUIC is mixed, rapidly shifting cannabis policies in the U.S. warrant greater attention to this important public health issue. Specifically, over half of U.S. states currently allow legal use of cannabis for medical purposes, and a handful have legalized non-medical use. Further, public access to cannabis is increasing in concert with increases in cannabis potency (ElSohly et al., 2016), availability of high potency cannabis products (Vandrey et al., 2015), and decreasing perceptions of cannabis-related risks (Azofeifa et al., 2016). Given this context, there is an urgent need to better understand DUIC in order to inform future prevention efforts.

Medical cannabis patients may be at particularly high risk for DUIC, given their high frequency of use (Haug et al., 2017; Lin et al., 2016);

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however, little is known about the prevalence and characteristics of individuals using medical cannabis who engage in DUIC. The clinic visit for certification or recertification may provide an opportunity to engage medical cannabis patients around risk reduction and to prevent DUIC in a non-threatening environment where patients may be receptive to public health interventions. The goal of the present study was to examine the prevalence and correlates of three indicators of DUIC among medical cannabis patients receiving or renewing cannabis certification for moderate/severe pain (the most common medical condition [Ilgen et al., 2013] for which certification is sought).

2. Method

2.1. Participants and procedures

From February 2014 to June 2015, patients aged 21 years and older seeking medical cannabis certification or recertification were recruited from 3 medical cannabis certification centers in Michigan as part of a longitudinal study (methods described previously; Cranford et al., 2017). Potential participants were approached by research staff in clinic areas, provided consent, and self-administered screening surveys to determine eligibility (pain level of > 5 out of 10 in past month; exclusions: pregnant women, seeking certification/recertification for Alzheimer's Disease or cancer). Of the 801 participants who were consented, enrolled in the longitudinal study, and answered baseline surveys, n = 790 (97.5%) provided data on items assessing DUIC and comprise the present analytic sample. Compensation was $10 for screening, $30 for the baseline. Procedures were approved by the University of Michigan Institutional Review Board.

2.2. Measures

We used standard assessment items to query basic demographics (e.g., age, sex, race, etc.). To measure DUIC behaviors, we adapted three items from prior work in young adults (Donovan, 1993) to assess past 6-month frequency of driving (Never to 10+ times): "within 2 hours of using marijuana," "while a little high on marijuana," "while very high on marijuana" (each dichotomized into never vs. ever for analyses), and driving after drinking 4 or more alcoholic drinks. Number of lifetime arrests for "… driving while intoxicated or driving under the influence of marijuana" was assessed based on the Drug Abuse Treatment Outcomes Study (United States Department of Health and Human Services et al, 2010). We assessed substance use with past 6-month measures of drinking 6+ alcoholic drinks on at least one occasion (yes/no) and illicit drug use or misuse of prescription drugs (yes/no; cocaine, heroin, methamphetamine, and prescription sedatives, stimulants, and/or opioids). Past 30-day opioid misuse included a sum of 5 items from the Current Opioid Misuse Measure [(Butler et al., 2007) range 0–20; higher scores indicate more frequent misuse; $\alpha = .67$]. We developed two items for this study to assess cannabis use patterns (i.e., hours high per day, average quantity per week in past month; (Cranford et al., 2017). Items related to driving and cannabis use quantity and hours high are shown in Appendix A.

2.3. Data analysis

We used SAS version 9.4 to calculate descriptive statistics and unadjusted and adjusted logistic regression models examining how demographics, cannabis use patterns, and other substance use might relate to each measure of DUIC. We included variables that were significantly related to any DUIC outcome in adjusted models, except that we selected only one measure of cannabis consumption based on strong associations in univariate analyses and because consumption variables were moderately inter-correlated.

Table 1
Sample descriptive.

	Sample Descriptive M (SD) or % (N)
Age	45.8 (12.8)
Male (vs. Female)	52%
Race (White vs. Others)	81%
Unemployed (vs. Not)	61%
Disability (vs. Not)	32%
Past-month usual pain score (0 to 10)	7.1 (1.4)
Past 6-month drove within 2 hours of cannabis use	56%
Past 6-month drove while "a little high"	51%
Past 6-month drove while "very high"	21%
Lifetime arrests for DUIC[a]	
None	96%
1–2 times	3%
3–5 times	1%
Already Has Medical Marijuana Card (vs. no)	66%
Average cannabis used per week in past month	
No use	12%
< 1/8 oz.	16%
1/8 to < 1/4 oz.	20%
1/4 to < 1/2 oz.	22%
1/2 to < 1 oz.	15%
1 or more oz.	15%
Past 6-month cannabis use almost daily/daily (vs. less)	73%
Number hours high/day	
None/ < 1 h	22%
1-2 h	33%
3-4 h	24%
5-6 h	10%
7-8 h	5%
9+ h	6%
Past 6-month drug use (vs. no)_	13%
6+ drinks in past 6-months (vs. no)	27%
Past 6-month drive after drinking 4+ drinks	
Never	92%
1-2 times	5%
3+ times	3%
Opioid Misuse Score[b]	1.4 (2.4)

[a] N = 770 due to missing data on this item.
[b] Past-month opioid misuse measure items: used differently than prescribed, used medications that belong someone else, used more than prescribed, borrowed from someone else, and used for non-pain symptoms.

3. Results

Table 1 displays descriptive information about participants' demographics, cannabis use, and other substance use. Participants were M = 45.8 years old (SD = 12.8), half male (52%), and primarily White (81%). Most were unemployed (61%) and 32% were receiving disability benefits. Two-thirds (66%) had a medical cannabis certification and were seeking a certification renewal. The majority (73%) reported using cannabis daily or almost daily in the past 6 months. In the past 6-months, over half drove within 2 h of cannabis use (56.4%) or while a little high (50.5%); 21.1% drove while very high. Prevalence of DUIC 10+ times in the past 6 months is as follows: 21.6% of the sample drove within 2 h of cannabis use, 18.7% drove a little high, and 7.2% drove while very high. In the full sample, 4% reported a lifetime history of arrest for DUIC (4.3% of those who drove within 2 h, 4.8% of those who drove a little high, and 3.6% of those who drove very high); of the 29 individuals who reported a lifetime DUIC arrest, 69% reported at least one type of DUIC in the past 6 months. Also related to driving behaviors, 8% of the total sample reported driving after having 4 or more drinks in the past 6-months, with prevalence being 12.6% among those who drove within 2 h, 13.3% among those who drove a little high, and 20.5% among those who drove very high.

Table 2 shows results of unadjusted and adjusted analyses focusing on the three measures of past 6-month DUIC as outcomes. Key patterns shown in logistic regression analyses indicate that White individuals had greater odds of DUIC within 2 h, or while a little high, and that

Table 2
Unadjusted and adjusted results examining correlates of past 6-month DUIC behaviors.

	Driving Within 2 Hours (N = 443; 56.4%)		Driving a Little High (N = 398; 50.5%)		Driving Very High (N = 166; 21.1%)	
	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age	0.99 (0.97-1.00)*	0.99 (0.98-1.01)	0.99 (0.98-1.00)	0.99 (0.98-1.01)	0.98 (0.96-0.99)**	0.98 (0.97-1.00)
Male (vs. Female)	1.08 (0.82–1.44)	0.88 (0.64-1.21)	1.40 (1.06-1.85)*	1.22 (0.89-1.67)	1.33 (0.94-1.88)	1.12 (0.77-1.62)
Race (White vs. Others)	2.10 (1.46-3.02)***	1.80 (1.20-2.71)**	2.10 (1.45-3.04)***	1.78 (1.19-2.67)**	1.39 (0.87-2.22)	1.40 (0.84-2.32)
Unemployed (vs. Not)	0.74 (0.55-0.99)*	0.78 (0.55-1.10)	0.86 (0.65-1.15)	0.97 (0.70-1.36)	0.74 (0.52-1.05)	0.82 (0.55-1.22)
Disability (vs. Not)	0.80 (0.59-1.07)	–	0.95 (0.70-1.28)	–	0.97 (0.67-1.40)	–
Past-month usual pain score (0 to 10)	0.84 (0.76-0.93)***	0.88 (0.79-0.99)*	0.85 (0.77-0.94)**	0.88 (0.79-0.99)*	0.98 (0.87-1.11)	1.00 (0.88-1.14)
Already Has Medical Marijuana Card (vs. no)	1.91 (1.42-2.58)***	1.26 (0.89-1.79)	1.97 (1.46-2.67)***	1.40 (0.99-1.97)	1.52 (1.04-2.22)*	1.09 (0.71-1.66)
Average cannabis used per week in past month						
No use	[ref]***	[ref]***	[ref]***	[ref]***	[ref]***	[ref]***
< 1/8 oz.	2.58 (1.46-4.57)	2.36 (1.27-4.39)	1.96 (1.10-3.51)	1.69 (0.90-3.17)	1.93 (0.77-4.86)	1.57 (0.61-4.04)
1/8 to < 1/4 oz.	4.05 (2.32-7.07)	3.59 (1.93-6.70)	3.16 (1.81-5.52)	2.43 (1.30-4.53)	2.43 (1.01-5.85)	1.74 (0.69-4.38)
1/4 to < 1/2 oz.	5.42 (3.12-9.42)	4.68 (2.53-8.65)	4.56 (2.63-7.93)	3.55(1.92-6.56)	3.67 (1.57-8.57)	2.77 (1.14-6.72)
1/2 to < 1 oz.	7.74 (4.21-14.24)	7.35 (3.75-14.42)	5.23 (2.89-9.49)	4.32(2.24-8.35)	6.28 (2.66-14.83)	5.01 (2.03-12.35)
1 or more oz.	4.17 (2.31-7.50)	3.60 (1.86-6.97)	3.63 (2.01-6.56)	2.73 (1.41-5.30)	6.52 (2.76-15.43)	4.54 (1.82-11.31)
Past 6-month cannabis use almost daily/daily (vs. less)	2.85 (2.05-3.95)***	–	2.59 (1.86-3.61)***	–	3.43 (2.06-5.69)***	–
Number hours high/day						
None/ < 1 h	[ref]***	–	[ref]***	–	[ref]***	–
1-2 h	2.95 (1.96-4.42)		2.80 (1.84-4.26)		3.47 (1.64-7.34)	
3-4 h	3.68 (2.37-5.69)		4.08 (2.61-6.37)		5.84 (2.77-12.34)	
5-6 h	3.77 (2.14-6.64)		5.45 (3.04-9.75)		10.16 (4.49-22.98)	
7-8 h	5.36 (2.50-11.51)		7.32 (3.38-15.87)		16.08 (6.45-40.13)	
9+ h	4.51 (2.22-9.14)		4.57 (2.29-9.14)		11.85 (4.83-29.09)	
Past 6-month Drug Use (vs. no)	1.47 (0.95-2.29)	1.56 (0.96-2.54)	1.66 (1.08-2.55)*	1.76 (1.10-2.83)*	1.14 (0.69-1.89)	1.05 (0.61-1.80)
6+ Drinks in Past 6-months (vs. no)	1.50 (1.07-2.08)*	1.27 (0.88-1.83)	1.67 (1.21-2.31)**	1.41 (0.99-2.02)	1.74 (1.20-2.52)**	1.53 (1.02-2.29)*
Opioid Misuse Score[b]	0.98 (0.93-1.04)	–	1.00 (0.94-1.06)	–	0.97 (0.89-1.04)	–

* $p < .05$.
** $p < .01$.
*** $p < .001$.

younger individuals had increased odds of DUIC. Having already obtained medical cannabis certification was associated with greater odds of DUIC; however, this was not sustained when accounting for other variables (e.g., quantity of cannabis used) in adjusted analyses. Those using the highest average cannabis quantity per week had greater odds of DUIC while very high, although in some adjusted analyses, lower quantities consumed were not associated with increased odds of DUIC while a little or very high. Specifically, in adjusted analyses, average weekly quantities used in the past month of < 1/8 oz. were not related to DUIC while a little or very high, and 1/8 to ¼ oz. was not related to DUIC while very high, relative to no cannabis use. Higher pain scores were associated with lower odds of DUIC; opioid misuse was not associated with DUIC. Drug use was not associated with any DUIC outcomes, although binge drinking was related to DUIC.

4. Discussion

Compared to 4.3% of individuals age 16 and older in the U.S. who drove after use of cannabis in the past-year (Substance Abuse and Mental Health Service Administration, 2017), the prevalence of past 6-month DUIC (21% to 56%, depending on the measure used) among medical cannabis patients with chronic pain (i.e., one of the most cited reasons for seeking medical cannabis) in this sample from Michigan is concerning. In light of cannabis policies expanding legal access to cannabis and given the potential risks of impaired driving, these findings underscore the need for interventions to prevent impaired driving among individuals using cannabis for medical reasons. Given there is no standard recommended “dose” for medical cannabis across conditions, further research is needed to better understand dosing of cannabis

products within the context of cannabis potency and the effects of dose, potency, and route of administration on driving-related functions. The use of multiple measures of DUIC is a strength of this investigation. As researchers and policy-makers continue to understand DUIC, it will be important to consider variations in measurement and individuals' subjective perceptions of driving while "high," particularly because the impairing effects of cannabis may last several hours (Neavyn et al., 2014). Thus, subjective perceptions of impairment may not be the best marker of driving-related impairment. Further, although few had reported DUIC-related arrests in their lifetime, as the policies shift and access increases, it is possible that arrests and criminal justice involvement of this population could increase.

Results point to relationships between some demographic (e.g., age, race) and substance use factors, particularly heavy episodic drinking and quantity of cannabis consumption as markers of DUIC risk. Prevention efforts may specifically need to target simultaneous use of alcohol and cannabis. Few members of our sample reported driving after consuming 4 or more drinks in the same period as they reported DUIC; however, we did not collect data on simultaneous co-ingestion of alcohol and cannabis, which is a direction for future research. A prior examination from these data found that participants who could be classified as "high risk drinkers" had lower pain severity and lower odds of receiving disability benefits compared to non-drinkers and low-risk drinkers, but these groups did not differ in their cannabis consumption (Davis et al., 2018). In current analyses, higher pain was associated with decreased risk for DUIC (within 2 h and "a little high"), and may be an indicator of how likely these patients are to drive, particularly given that pain conditions could inhibit driving. Nonetheless, pain itself is associated with impaired driving-related functions and driving-related performance (Lagarde et al., 2005; Nilsenl et al., 2011; Veldhuijzen et al., 2006), thus mitigating the effects of pain on driving is also a concern for this population regardless of their acute cannabis use. Future research could also examine interactions between pain, alcohol and cannabis consumption, and driving risk.

Limitations include the cross-sectional nature of the data and the retrospective self-reported assessment, precluding causal interpretations. Future research may be improved by using ecological momentary/intensive longitudinal designs and improved measurement of cannabis dosage/consumption. Further, because we used measures created for this study, they have not been subjected to formal psychometric evaluation, thus reliability and validity is unknown. There is a potential lack of generalizability to other populations, given data came from medical cannabis patients with chronic pain, living in a single state. Finally, there is no parallel data available for the past 6-month DUIC measures at the state-level, prohibiting conclusions regarding whether members of this sample engage in DUIC more or less frequently than the general population within the state itself. Future research could also be improved by including driving records and/or MVC data to provide additional data on driving safety among medical cannabis patients.

In conclusion, these results point to the potential need for interventions to increase medical cannabis patients' understanding of cannabis-related driving impairment as well as to increase motivation to avoid driving after consumption. Greater understanding of DUIC among medical (and recreational) cannabis users is needed, particularly in light of shifting state-level policies increasing access to legal medical or recreational cannabis. Recommendations to avoid driving within several hours after consumption (Neavyn et al., 2014) require further validation, given lack of consensus in the literature, to provide clear public health messaging.

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Contributors

The final manuscript has been reviewed and approved by all authors.

Erin E. Bonar wrote the first draft of the manuscript and incorporated significant content from co-authors. James A. Cranford conducted the preliminary analyses and reviewed the manuscript draft providing critical scientific feedback. Brooke J. Arterberry assisted with literature review and assisted with writing and critical scientific feedback. Maureen A. Walton was a Co-investigator involved in the design and execution of the study and execution of the RCT and she assisted with writing and critical scientific feedback. Kipling M. Bohnert assisted with conceptualization of analyses and edited the paper for critical scientific feedback. Mark A. Ilgen was the Principle Investigator responsible for the research study from which these data were collected; he provided guidance on analyses and edited the paper providing critical scientific feedback.

Conflicts of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2018.11.016.

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