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## Operating a motor vehicle after marijuana use:

### Perspectives from people who use high potency marijuana

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**ABSTRACT.** *Background:* With advancing marijuana legalization in the United States, a primary concern is the possible increase in consequences relating to marijuana driving impairment, especially among people who use high potency marijuana (i.e., extracts). In this study we assessed the risk perception and experiences of driving under the influence of marijuana by investigating people who use extracts. *Methods:* Participants from two studies were queried about driving after using marijuana. In *Study 1*, phone interviews (n=19) were conducted with people who use extracts. In *Study 2*, we conducted a nationwide survey of people who use extracts (n=174) recruited via an online existing panel. Responses to marijuana and driving-

related questions were qualitatively coded for themes (e.g. riskiness, engagement in behavior) developed by the research team. *Results:* Prominent themes identified in Study #1 suggested a belief that driving risk following marijuana use is dependent on the individual (i.e., response/tolerance) or the amount/type of marijuana consumed. This theme was corroborated by Study #2 participants. Those who perceived no or minimal risk from driving following marijuana use were more likely to report, engagement in driving following extracts use. *Conclusions:* More research is needed to understand how marijuana, especially in its concentrated form, impacts driving ability in order to develop appropriate and scientifically sound regulations. Such research could subsequently fill the need to improve and more widely disseminate prevention messages on marijuana use and driving risks.

***Keywords:*** Marijuana; driving under the influence; impaired driving; drugged driving

## INTRODUCTION

Substance use is a key risk factor that contributes to fatal motor vehicle accidents.<sup>1-3</sup> Marijuana use can impair driving abilities and increase crash risk by affecting psychomotor functions, decreasing reaction time and increasing one's tendency to weave across lane lines.<sup>4-8</sup> The topic of driving under the influence of marijuana is a timely research area as more potent forms of marijuana are increasing in popularity and state policies are shifting towards marijuana use leniency.<sup>9</sup> Marijuana extracts (hereafter extracts), which are derived from marijuana plant material using a solvent (e.g., butane, CO<sub>2</sub>) contain levels of THC (the main psychoactive ingredient) that exceed dried marijuana by 3 to 5 times.<sup>10</sup> Extracts are ingested via smoking or vaporization (e.g., dabbing); dabbing produces a quicker, more intense effect than marijuana in its traditional plant-based form.<sup>11,12</sup>

In light of the movement towards marijuana legalization, understanding the experience of people who use marijuana is pertinent in order to mitigate the public health impact of driving under the influence of marijuana. Of particular interest are those individuals who consume extracts given its more immediate and intense high.<sup>11,12</sup> In this research, we aimed to assess the risk perceptions and experiences of driving under the influence of marijuana with two distinct studies: a qualitative assessment of participants who self-report frequent extracts use (Study #1) supplemented with a mixed-methods national survey of participants who also use extracts (Study #2).

**STUDY 1: Interviews with participants who use extracts****METHODS**

Both the study protocols described below were reviewed and approved by a University's Human Research Protection Office.

**Participants**

The research team conducted phone interviews with people who use extracts between April and October, 2015. Participants (n=20) were adults ( $\geq 18$  years) residing in the United States and had used extracts in the past 30 days. YouTube was the primary method of recruitment. Members of the research team searched YouTube for individuals who posted videos about extracts use. Once individuals were identified, YouTube's private messaging feature and/or email (when provided) were used to invite them to participate in our study. Fourteen participants were recruited via YouTube, and six additional people were subsequently referred through word-of-mouth by the YouTube participants. Interviews, which lasted approximately 30-60 minutes, were conducted using Skype's voice calling feature and were digitally recorded. Participants were compensated with a \$50 Amazon gift card.

Research assistants transcribed the interviews verbatim for qualitative coding of themes. The present study focuses on responses to the question: "What are your thoughts on using marijuana and driving?" One of the 20 participants was not asked this question, resulting in 19

for analysis. Quantitative items pertaining to demographic characteristics were also queried and recorded.

### **Themes**

An inductive approach was used to examine emerging themes. To develop the codebook, 5 of the 19 responses from Study 1 were first reviewed by the Principal Investigator and three team members. Code definitions were refined during the coding process and additional themes were included as needed.

### **Coding**

All 19 interview responses to the marijuana and driving question were coded by three members of the research team who had developed the codebook and therefore had an intimate understanding of the codes. Each team member independently coded the responses. The unit of text chosen for assigning themes was each paragraph of response from the participant. Coding was performed in small batches (approximately 5 participant responses at a time) and then inter-rater reliability was calculated. This allowed for discussion of discrepancies in order to refine codes or interpretation of codes before moving on to code the next batch of responses. Any differences were discussed in detail to reach consensus. Across all themes for all participants, median percent agreement was 94% (range 84% to 98%) and median Krippendorff's alpha was 0.74 (range 0.54 to 0.90).

## RESULTS

### Demographic characteristics (Table 1)

Participants tended to be White (63%, 12/19), male (68%, 13/19), and live in the Western U.S (79%, 15/19), with a median age of 24 years.

---TABLE 1 HERE---

### Themes about driving after marijuana use (Table 2)

The final list of the themes is presented in Table 2. We identified prominent themes from our participants including when they acknowledged engaging in driving while under the influence of marijuana, as well as when they knew of others who similarly engage in this behavior. Participants tended to express a belief that driving under the influence of marijuana was a safe behavior (i.e. low risk), but that it could be dependent on an individual's level of marijuana-related tolerance and/or his/her response to marijuana following its use. Likewise, the opinion that driving under the influence of marijuana was safer than driving following alcohol use was mentioned, as well as the belief that marijuana could help one to be a better driver given improvements in attentiveness and relaxation following marijuana use.

---TABLE 2 HERE---

### STUDY 2: Nationwide survey of people who use extracts

## METHODS

Participants (n=234) were adults (18-35 years) residing in the U.S. who indicated use of extracts one or more times in the past six months. Survey participants were recruited in September 2015 using SurveyMonkey® Audience (<https://www.surveymonkey.com/mp/audience/>), a preexisting panel of participants recruited from more than 30 million people who take SurveyMonkey® surveys. Audience members take surveys in exchange for a sweepstakes entry or a charity donation that SurveyMonkey® provides on their behalf. The online survey for the present study was not linked to any personal identifiable information with the exception of an email address which participants had an option of providing if they wanted us to follow-up with them about future studies.

The survey queried participants about the number of times they had driven after using extracts in the last 30 days, and how soon they felt comfortable driving after consuming extracts. They also had an option to respond to an open-ended question about their perceptions of people who drove after using extracts. There were 174 people who chose to respond to this question and were thus analyzed in this study.

### Coding

The research team members coded survey responses in batches of 25. Because responses were short, the unit of text for assignment of themes was the participant's full response to the question. As with the Study 1 interviews, each set was independently coded by each of the three coders, inter-rater reliability was calculated, and then differences were discussed until there was



agreement before moving on to code the next batch of responses. Median percent agreement across themes for all participants was 98% (range 88% to 100%) and median Krippendorff's alpha was 0.85 (range 0.60 to 1.0).

### **Statistical analysis**

We used descriptive statistics to describe the demographic composition of our samples and the prevalence of themes. We used the Pearson chi-square test to compare the prevalence of reporting driving after using extracts among participants with differing perceptions regarding the risk level of this behavior. SAS version 9.4 (SAS Institute Inc., Cary, NC) was used for analysis and  $p < 0.05$  was considered statistically significant.

## **RESULTS**

### **Demographic characteristics (Table 1)**

Most participants were White (66%, 115/174) and male (73%, 127/174) with a median age of 25 years. Quantitative items about driving behaviors were only queried of Study 2 participants; 34% (59/174) reported driving after extracts use at least once in the past month. Over one-third (37%) (65/174) said they would feel comfortable driving immediately after using extracts while another one-third of participants (35%) (61/174) believe that they need to wait at least one hour following extracts use before driving. Table 1 provides additional details.

### **Themes about driving after extracts use (Table 2)**

Roughly, 39% (67/174) of participants considered driving after extract use to be a risky behavior, while 24% (42/174) believed it to be safe and 32% (56/174) believed that the level of risk depended on one's response to marijuana, tolerance level, and/or amount/type of marijuana consumed. Approximately 11% (19/174) specifically mentioned the need to wait for effects following extracts use to dissipate before driving.

Participants who perceived that driving while intoxicated from marijuana is risky were significantly less likely to indicate having engaged in this behavior during the past 30 days. Specifically, only 9% of participants who perceived driving after marijuana use as risky reported engaging in this behavior; in contrast, driving following marijuana use was significantly more likely among participants who perceived it as safe or who felt that its safety is determined by such factors as one's tolerance to marijuana or the type of marijuana consumed (51% and 54%, respectively;  $X^2_{df=2}=33.3, p<0.001$ ).

## DISCUSSION

This study provides novel insight into the perceptions of driving after marijuana use from individuals who use extracts which is a highly potent form of marijuana. Our findings indicate that driving following marijuana use is relatively common, and risk-level was often perceived as dependent upon one's tolerance to marijuana. About 1 in 7 participants from our national survey (Study 2) reported frequent episodes of driving following extracts use ( $\geq 10$  times in the past month), and this behavior was clustered among individuals who believe that driving following marijuana use presents minimal to no risk.

Our findings also suggest a wide range of views surrounding the riskiness of driving while under the influence of marijuana. While some research does support that marijuana may not impair driving ability to the same extent as alcohol, the intoxicating effects following marijuana use can vary greatly between individuals and may be dependent on their tolerance to marijuana as indicated by research and as further suggested by many of our participants.<sup>13-15</sup> It is therefore important to note that over one-third of participants from our national survey did report the belief that marijuana use and driving is a risky behavior.

As public health workers and policy officials seek to develop appropriate regulations for protection against the possible harms associated with driving after consuming marijuana, they can look at the progress made in alcohol regulation for guidance. The harms associated with drinking and driving have been well documented in research,<sup>16-18</sup> which has aided in the development of policies and penalties for those who engage in this behavior.<sup>19-21</sup> Additionally, government-mandated warnings about risks of driving under the influence are placed on alcohol products and could be similarly placed on marijuana labels.<sup>19,20,22,23</sup> Furthermore, the efforts of grassroots organizations such as Mothers Against Drunk Driving (MADD)<sup>24</sup> have shifted the public's perception on driving after alcohol, which is in sharp contrast to decades past when this behavior was less stigmatized and not legally penalized to the degree that it is now.<sup>25</sup> Public health communication campaigns like those from MADD may likewise be beneficial for developing and enforcing regulations surrounding driving following marijuana use, especially as states in the U.S. move towards more leniency of marijuana use.

**Limitations**

Given that we used self-report interview and survey data to study marijuana and driving which is considered an illegal behavior, participants might have responded in a socially desirable manner. Furthermore, interview participants were recruited from YouTube with a snowball, non-systematic sampling approach; thus, they might not be a true reflection of people who use extracts. We do not know the span of time that passed between participants' use of marijuana and driving for those who endorsed this behavior. Findings are not generalizable to the larger population of people who use marijuana.

**Conclusions**

The debate surrounding the safety of marijuana use and driving will likely continue as more states legalize it. Our findings underscore the need for continued research on this topic, especially with regards to delineating what is an acceptable wait-time for driving following marijuana use. To this end, prevention messages are needed to convey the potential consequences of driving under the influence of marijuana, and our findings signal that such messages may be particularly critical for individuals who engage in this behavior and do not believe that adverse outcomes could result.

## FUNDING

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Dr. Bierut is listed as an inventor on Issued U.S. Patent 8,080,371, “Markers for Addiction,” covering the use of certain SNPs in determining the diagnosis, prognosis, and treatment of addiction. All other authors declare they have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

Dr. Cavazos-Rehg led all aspects of the project including the acquisition of the data, analyses, interpretation of results and manuscript writing and revision. Ms. Krauss performed the data analysis and contributed to interpretation of results and drafting the manuscript. Ms. Sowles and Ms. Zewdie participated in the acquisition and analysis of the data, as well as drafting the manuscript. Dr. Bierut contributed to the interpretation of results and made critical revisions to the manuscript.

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Table 1. Demographic characteristics of participants

Variable	Study 1 (N=19) n (%)	Study 2 (N=174) n (%)
Gender		
Male	13 (68%)	127 (73%)
Female	5 (26%)	47 (27%)
Other	1 (5%)	-
Race		
White	12 (63%)	115 (66%)
Black	0 (0%)	10 (6%)
Hispanic	4 (21%)	26 (15%)
Other	3 (16%)	18 (10%)
Missing	0 (0%)	5 (3%)
Age (years), Median (range)	24 (18-46)	25 (18-35)
Region		
West	15 (79%)	71 (41%)
South	3 (16%)	36 (21%)
Midwest	1 (5%)	33 (19%)
Northeast	0 (0%)	29 (17%)
Missing	0 (0%)	5 (3%)
Number of times driven after using marijuana extracts in past 30 days		
0 times		113 (65%)
1-5 times		24 (14%)
6-9 times	-- <sup>a</sup>	9 (5%)
≥10 times		26 (15%)
Missing		2 (1%)
How soon do you feel comfortable driving after using marijuana extracts?		
Immediately		65 (37%)
1-2 hours		35 (20%)
3-4 hours		16 (9%)
≥5 hours		10 (6%)
I don't drive after using extracts/doesn't apply		46 (26%)
Missing		2 (1%)

<sup>a</sup> Not explicitly queried among interviewees, but 15 (79%) mentioned during the course of the interview that they have driven after marijuana use

Table 2. Themes about driving after marijuana use

Themes	Study 1 n(%) (N=19)	Study 2 n(%) (N=174)	Examples
Mentions they drove after marijuana use	15 (79%)	-	<ul style="list-style-type: none"> <li>• <i>I was a pizza delivery driver for over a year and a half. Like dabbing and smoking on the job.<sup>a</sup></i></li> <li>• <i>I drive high every day, but the thing is that I smoke weed every day.<sup>a</sup></i></li> </ul>
Mentions they know people who drive after marijuana use	5 (26%)	1 (1%)	<ul style="list-style-type: none"> <li>• <i>I know a lot of people that definitely do drive behind the wheel perfectly fine, no accidents, no long-term impairments.<sup>a</sup></i></li> <li>• <i>It is still a form of intoxication but I do know friends that have driven under the use of marijuana and they don't seem to have any negative effects from what I hear.<sup>a</sup></i></li> <li>• <i>I've been with people that do it and its okay it affects absolutely nothing.<sup>b</sup></i></li> </ul>
<b>Risk Level</b>			
Driving after marijuana use is a risky behavior	2 (11%)	67 (39%)	<ul style="list-style-type: none"> <li>• <i>I don't believe it should be done. I don't think it could be safe. Maybe in small amounts it would be safe, but there's no control over that. Like I don't think it should be done at all.<sup>a</sup></i></li> <li>• <i>Totally against it. Stay off the roads.</i></li> <li>• <i>I wouldn't recommend it you cannot take back a life after its been taken.<sup>b</sup></i></li> </ul>
Driving after marijuana use is safe	4 (21%)	42 (24%)	<ul style="list-style-type: none"> <li>• <i>I don't think that there's any danger to it. I think that I've been a better driver since I've driven more higher than I have sober, quite honestly, in my entire life.<sup>a</sup></i></li> <li>• <i>I've been driving while using marijuana since I was sixteen and I do not feel in any way incapable of operating anything while I'm using marijuana.<sup>a</sup></i></li> <li>• <i>You're either a good driver or a poor driver, marijuana does not change that fact.<sup>b</sup></i></li> <li>• <i>Marijuana does not impact one's ability to drive.<sup>b</sup></i></li> </ul>
Driving after marijuana use is dependent on users tolerance, individual	12 (63%)	56 (32%)	<ul style="list-style-type: none"> <li>• <i>I believe it all depends on the person. There is people who can tolerate it more, and it doesn't affect their driving. But then again, I believe there are also people who just, they can't handle it or they can't tolerate it, so their driving is a little more impaired.<sup>a</sup></i></li> <li>• <i>I don't think that people that have that tolerance and</i></li> </ul>

response to  
marijuana or  
the  
amount/type

*that experience should be unable to drive when they're on small doses, you know, whereas someone who has smoked weed for the first time and is not a good driver, you know, certainly probably shouldn't be getting behind the wheel.<sup>a</sup>*

- *Depends on the person. Some people can function just fine and some people just can't.<sup>b</sup>*
- *Depending on how much you consume and how much it affects you it can cause difficulty especially driving at night.<sup>b</sup>*

Mentions the  
need to wait  
until effects  
wear off before  
driving

1 (5%) 19 (11%)

- *[you should wait] maybe until the onset effects wear off, so that would be maybe 30 minutes after...<sup>a</sup>*
- *Immediately after is not good. But after an hour or so people seem to be fine.<sup>b</sup>*
- *Everyone should be aware of their tolerance level and take the necessary amount of time to sober up before driving.<sup>b</sup>*

Compares  
driving after  
marijuana to  
driving after  
using alcohol

Driving after  
marijuana use  
is safer

3 (16%) 14 (8%)

- *I for one believe that [alcohol] is far more intoxicating than marijuana can ever be, having basically done too much of both.<sup>a</sup>*
- *Cannabis does not impair you the way that alcohol does.<sup>a</sup>*
- *Generally not a good idea to drive under any influence but certainly nowhere near as dangerous to self or others when compared to driving drunk.<sup>b</sup>*
- *... alcohol actively affects your cognitive processes as well as your motor functions whereas marijuana (with an experienced and comfortable user) doesn't.<sup>b</sup>*
- *I would rather see a stoned driver driving slow than a drunk driver, drunk drivers kill.<sup>b</sup>*

Driving after  
marijuana use  
is similar to  
after  
using alcohol

2 (11%) 13 (7%)

- *I still look down on it, and I still think that it's just as harmful and just as dangerous as when you're drinking and driving.<sup>a</sup>*
- *I think it's just as dangerous as driving drunk if not more.<sup>a</sup>*
- *It's stupid, you're intoxicated just like with alcohol. A car is a large metal object that can kill people so*

*you shouldn't handle one while you're less than capable.<sup>b</sup>*

- *I think it's like drinking and driving. You need time to let the effects wear off first. No one should drive when high.<sup>b</sup>*

Mentions specific effects experienced while driving under the influence			
Positive effects (i.e. effects that help/improve driving ability)	8 (42 %)	10 (6 %)	<ul style="list-style-type: none"> <li>• <i>At the times that I've had to drive, I've noticed that I myself was maybe more alertive (sic) perhaps because I was under the influence.<sup>a</sup></i></li> <li>• <i>I feel like I'm kind of more anxious and more nervous driving without it, and then I feel like I'm more of a danger that way.<sup>a</sup></i></li> <li>• <i>depends on there tolerace. some people cant handle it and me i pay more attention to the road. when im not high im looking around and I hand on the wheel, when im high 2 hands on the wheel and staring out the front of the window.<sup>b</sup></i></li> <li>• <i>I feel I drive really cautious when I smoke it relaxes me so I'm not stressed. I don't mind if people smoke and drive.<sup>b</sup></i></li> </ul>
Negative effects (i.e. effects that worsen driving ability)	1 (5 %)	3 (2 %)	<ul style="list-style-type: none"> <li>• <i>I don't drive and dab, because of just, you know, you'll space out, you'd just, you're not paying as much attention to what's going on around you, as you would if you were sober.<sup>a</sup></i></li> <li>• <i>They drive slower and react more slowly....<sup>b</sup></i></li> </ul>
Specifically mentions driving after extracts use (as opposed to general marijuana use)	5 (26 %)	11 (6 %)	<ul style="list-style-type: none"> <li>• <i>I think that you can smoke a couple joints, or a couple big dabs, and go driving immediately after, and be just fine...if you're a person who's a good driver, and who can handle the high, and have that experience to control it.<sup>a</sup></i></li> <li>• <i>There should be a cool down period between dabbing and driving.<sup>b</sup></i></li> <li>• <i>Just like any prescription drug that has a warning to not operate heavy machinery, those who have used.<sup>b</sup> marijuana concentrates should avoid driving while under the influence.<sup>b</sup></i></li> </ul>

<sup>a</sup>Quotes from Study 1 participants

<sup>b</sup>Quotes from Study 2 participants