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## Associations among Simultaneous and Co-occurring Use of Alcohol and Marijuana, Risky Driving, and Perceived Risk

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### 1. Introduction

Motor vehicle accidents are a leading cause of death among young adults (Tavris, Kuhn, & Layde, 2001; WHO, 2015); identifying risk factors for motor vehicle accidents among young adults is a research priority. Risky driving behaviors (e.g., driving under the influence, aggressive driving) are important predictors of motor vehicle accidents and fatalities (Fergusson, Horwood, & Boden, 2008; Hingson & Winter, 2003; Lambert-Bélanger, Dubois, Weaver et al., 2012) and perceptions of risky driving may influence driving decisions. Increased risk perception (i.e., subjective judgements regarding the riskiness of a potential behavior) has been negatively associated with engaging in a variety of risk behaviors (Cohn, Macfarlane, Yanez, & Imai, 1995), and perceived driving risk in particular has been linked with less risky driving among young drivers (Deery, 1999; Harbeck & Glendon, 2013; Ivers, Senserrick, Boufous et al., 2009; Machin & Sankey, 2008).

Substance use is an important factor in risky driving among young adults, with nearly 30% of college students and 20% of young adults driving under the influence of alcohol in the past year and over 10% driving under the influence of marijuana (Hingson, Zha, & Weitzman, 2009; Lipari, Hughes, & Bose, 2016). With high prevalence rates and recent legalization of recreational marijuana in many states, there is an increasing need to better understand simultaneous alcohol and marijuana (SAM) use and concurrent use (co-use) among young adults. Examining SAM use is especially important given that the majority of individuals who use both alcohol and marijuana use them at the same time and experience overlapping effects (Patrick, Terry-McElrath, Lee, & Schulenberg, 2019; Subbaraman & Kerr, 2015). In 2005 and 2010 data drawn from the National Alcohol Survey, a large population-based survey of adults, Subbaraman and Kerr (2015) found that SAM use was twice as common as co-use, with 15% of young adults aged 18–29 reporting SAM use in the past year, rates twice those of adults aged 30–49. Others have found 22.5% of 19/20 year-olds engaged in SAM use (Patrick et al., 2019).

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Conflict of interest

The authors declare that they have no conflicts of interest.

SAM users may be more likely to drive while intoxicated and be involved in traffic accidents (Subbaraman & Kerr, 2015; Terry-McElrath, O'Malley, & Johnston, 2014). Subbaraman and Kerr (2015) reported that relative to alcohol-only users, SAM users were over twice as likely to have driven while drunk in the past 12 months with no significant associations observed for co-users. Examining 35 years of Monitoring the Future data, Terry-McElrath and colleagues (2014) found that among high school seniors, SAM users were more likely than nonusers to receive tickets/warnings and be involved in traffic accidents in general and after alcohol and/or marijuana use.

### 1.1. The present study

The current study extends a limited but growing research by drawing on a community sample of young adults to examine if SAM use is associated with risky driving or perceptions of risky driving. Specifically, we examined if relative to alcohol-only or marijuana-only use, SAM use and/or co-use was associated with 1) risky driving, including driving a vehicle after alcohol or marijuana use, and/or 2) perceptions of risky driving, including thinking that driving after alcohol and/or marijuana use is relatively safe. We hypothesized that SAM use would be positively linked to risky driving and perceptions of risky driving.

## 2. Method

### 2.1 Sample

Participants included a subsample of 511 young adults participating in Project Transitions ( $n=779$ ), a longitudinal study examining young adult social role transitions and substance use. Participants were recruited through a variety of methods such as online ads and posted flyers. Eligibility criteria included being 18–23 at screening, living in Seattle area, drinking alcohol at least one time in the past year, having a valid email address, and consenting to and completing a baseline laboratory assessment (See Patrick, Fairlie, & Lee, 2018 for additional details about recruitment and compensation).

Data were drawn from Month 18 assessment when risky driving behaviors and perceptions and past month substance use were assessed; retention rates were 80% ( $n=626$ ). Of these, one had missing data on variables of interest, 18% ( $n=114$ ) reported no alcohol or marijuana use in the past month and were excluded from these analyses, with 511 participants composing the final sample (58% were female, average age was 22.20 [ $SD=1.74$ ]).

### 2.2 Measures

Respondents completed a questionnaire (Ivers et al., 2009) assessing risky driving behaviors (16 items) and perceptions (11 items). For behavior items, participants were asked “How often do you [engage in a behavior]?” (e.g., “drive fast just for the thrill of it”, “driving while talking on a mobile phone”). Responses ranged from 0 (never) to 4 (very often). Scores were summed with higher scores indicating greater risky driving. Additionally, participants reported whether in the past month they have “driven a car when I knew I had too much to drink to drive safely” and/or “drove a car or other vehicle within three house of using cannabis (e.g., marijuana, hashish) whether or not you still felt high.”

For risk perception items, participants were asked “When you are driving, how safe do you think the following are?” (e.g., “driving 10 to 19 mph above the speed limit”, “driving after smoking marijuana”). Responses ranged from 0 (never) to 3 (always safe). Scores were summed with higher scores indicating lower perceived risk (i.e., thinking that a risky behavior was safer). Two perception items related to driving under the influence (i.e., “driving with a blood alcohol level just over the legal limit” and “driving after smoking marijuana”) were also examined as dependent variables.

Participants reported past month alcohol use, marijuana use, and SAM use. Dummy variables were coded for past month SAM use and co-use, with single substance use comprising the reference group. Participant age and gender were reported at Month 18.

### 2.3. Analytic Strategy

Analyses were conducted using SAS 9.4 (SAS, 2014). Descriptive statistics were examined as part of preliminary analyses. Multinomial logistic and multivariate regression analyses were conducted to test for differences by gender in independent and dependent variables. Logistic and multivariate regression models were estimated examining associations among risky driving, perceived risk, and past month substance use (i.e., SAM use and co-use relative to single substance use), controlling for participant age and gender. In subsidiary analyses, we limited the sample to participants who engaged in SAM use or co-use ( $n=116$ ) to examine differences in risky driving and perceived risk for SAM users relative to co-users, controlling for participant age and gender.

## 3. Results

### 3.1. Preliminary analyses

Average overall risky driving score was 12.64 ( $SD=8.53$ ; scale of 0 to 64), 4% ( $n=22$ ) and 13% ( $n=66$ ) of participants reported driving a car after having too much to drink and/or within three hours of using marijuana, respectively. Average overall risk perception score was 9.44 ( $SD=4.54$ ; scale of 0 to 33). On average, participants believed it was unsafe to drive with a blood alcohol level over the legal limit ( $M=0.19$ ,  $SD=0.53$ ) or after smoking marijuana ( $M=0.48$ ,  $SD=0.75$ ). In the past month, 58% ( $n=299$ ) of participants reported alcohol-only user, 5% ( $n=24$ ) marijuana-only user, 14% ( $n=72$ ) co-user, and 23% ( $n=116$ ) SAM user. Of the eligible sample, 18% ( $n=114$ ) were excluded because they did not use alcohol or marijuana in the past month.

### 3.2. Associations between substance use and risky driving

Results are presented in Table 1. Neither age nor gender were associated with risky driving. Relative to alcohol- and marijuana-only users, SAM users had higher overall risky driving scores indicating that they were more likely to engage in risky driving behaviors. Relative to alcohol- and marijuana-only users, the odds of driving after having too much to drink was 3 times higher for SAM users and the odds of driving within 3 hours of using marijuana was 29 times higher for SAM users and 9 times higher for co-users. Relative to co-users, SAM users were more likely to engage in risky driving ( $\beta=3.73$ ,  $p$ -value $<0.01$ ) and were 3 times more likely to drive within 3 hours of using marijuana ( $OR=3.20$  [95%CI: 1.54–6.68]).

### 3.2. Associations between substance use and perception of risky driving behaviors

Results are presented in Table 2. Being female was associated lower perceived risk scores (i.e., with thinking that risk behaviors were less safe) and with thinking that driving after alcohol or marijuana use was less safe. Relative to alcohol- and marijuana-only use, SAM use was associated with higher perceived risk scores (i.e., thinking that risk behaviors were safer), and with thinking that driving after using marijuana was safer. Co-use was not associated with measures of perceived risk. Relative to co-users, SAM users were more likely to think that driving after smoking marijuana was safer ( $\beta=0.37$ ,  $p$ -value<0.001).

## 4. Discussion

Our study contributes to a growing body of research on associations between SAM use and risky driving and further explores associations among SAM use, co-use, risky driving, and perceived risk. Rates of alcohol-only use, co-use, and SAM use in our sample generally mirrored those found in other studies (see Subbaraman & Kerr, 2015; Terry-McElrath et al., 2014), with observed higher marijuana-only use (5%) than prior studies, perhaps because marijuana is legal in Washington state where our sample lived.

Findings are consistent with prior research suggesting that SAM use is associated with increased risky driving and drunk driving relative to other types of users (Subbaraman & Kerr, 2015; Terry-McElrath et al., 2014). Regarding driving after smoking marijuana, we found that SAM users and co-users were more likely than single substance users and that SAM users were more likely than co-users. Previous research suggests that those who drive under the influence of alcohol or drugs are more likely to perceive driving under the influence as less risky (Cutler, Sexton, & Mischley, 2018; Kelly, Darke, & Ross, 2004), however, no studies have examined SAM users relative to other types of users. It is particularly concerning that SAM users were more likely than single substance users to perceive risky driving behaviors as less risky and more likely than single substance users and co-users to perceive driving after smoking marijuana as less risky. SAM users in particular may benefit from increased education regarding driving-related risks and risks associated with drugged driving (Fergusson et al., 2008; Li, Brady, DiMaggio et al., 2011). Although more research is needed to better understand motivations for SAM use, some young adults say that they use marijuana simultaneously with alcohol to help offset negative effects of alcohol (Patrick et al., 2018), which may include helping them “sober up,” perhaps contributing to SAM users being more likely to drive while intoxicated.

### 4.1. Limitations and future directions

The present study extends research on an issue of great public safety interest, however, should be viewed in light of several limitations, including generalizability as the study was conducted in a state where non-medical/recreational marijuana use is legal (although eligibility drinking criteria for inclusion was low). In addition, our study excluded non-users and conducted cross-sectional analyses. Future research should examine these patterns longitudinally to determine stability of associations and examine if changes in use impact changes in risk, and vice versa. Future research should examine event-level associations of

SAM use and driving as well as other variables such as amount of use or personality characteristics such as impulsivity.

## 5. Conclusions

Young adult SAM users engaged in greater risky driving and perceived risky driving behaviors as less risky than single substance users and co-users. Over the past several decades prevention and intervention strategies aimed at educating young drivers about and decreasing rates of drinking and driving have been successfully implemented (Elder, Shults, Sleet et al., 2004; Perkins, Linkenbach, Lewis, & Neighbors, 2010; Shults, Elder, Sleet et al., 2001). However, despite evidence that driving under the influence of marijuana is associated with increased risk of being in motor vehicle crashes (Brady & Li, 2014; Li et al., 2011), 13% of our sample drove after using marijuana in the past month and driving after marijuana was seen as less risky than driving after drinking. Thus, programs aimed at educating drivers regarding risks associated with drugged driving are greatly needed. Clinically, future research could examine if interventions aimed at increasing perceived risk of potentially risky driving behaviors could decrease engagement in risky driving.

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### Highlights

- Young adults who engaged in past month simultaneous alcohol and marijuana (SAM) use engaged in greater risky driving than single substance users including driving after drinking alcohol and after using marijuana
- SAM users perceived risky driving behaviors to be safer than single substance users
- SAM users engaged in greater risky driving than concurrent users of alcohol and marijuana including driving after using marijuana
- SAM users thought that driving after smoking marijuana was safer than concurrent users of alcohol and marijuana

**Table 1**

Parameter Estimates from regression models examining associations between risky driving behaviors and substance use

	Overall risky driving behavior score <sup>a</sup>		Driving after having too much to drink to drive		Driving within 3 hours of using marijuana <sup>a</sup>	
	<i>n</i> =490		safely <i>n</i> = 497		<i>n</i> = 496	
	$\beta$ (SE)	<i>p</i> value	OR (95% CI)	<i>p</i> value	OR (95% CI)	<i>p</i> -value
Age	0.20(0.22)	0.3599	1.15(0.89-	0.2955	0.85 (0.71-	0.0742
Gender						
Male	(ref)		(ref)		(ref)	
Female	-1.43	0.0653	0.79 (0.33-	0.5981	0.60 (0.33-	0.0932
Substance Use						
Alcohol-	(ref)		(ref)		(ref)	
only/mar ijuana-						
Concurrent alcohol and	-0.45 a. 14)	0.6899	2.12(0.63–7.10)	0.2255	<b>9.13 (3.43–24.30)</b>	<b>&lt;0.0001</b>
Simultaneous alcohol	<b>3.19 (0.94)</b>	<b>0.0007</b>	<b>3.00 (1.15–7.87)</b>	<b>0.0253</b>	<b>29.28 (12.62–67.90)</b>	<b>&lt;0.0001</b>

<sup>a</sup> Male>female, *p*<0.05

<sup>b</sup> Female>male, *p*<0.05

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**Table 2**

Parameter Estimates from regression models examining associations between risk perceptions and substance use

	Overall perceptions of risky driving behaviors score <sup>a</sup> n = 490		Thinking mat living with a blood alcohol level just over the legal limit is safe <sup>a</sup> n = 497		Thinking mat driving after smoking marijuana is safe <sup>a</sup> n = 496	
	$\beta$ (SE)	p value	$\beta$ (SE)	p value	$\beta$ (SE)	p-value
Age	0.11(0.12)	0.3394	-0.01	0.5327	0.01 (0.02)	0.7862
Gender						
Male	(ref)		(ref)		(ref)	
Female	<b>-1.72</b>	<b>&lt;0.001</b>	<b>-0.13</b>	<b>0.0078</b>	<b>-0.24</b>	<b>0.0003</b>
Substance Use						
Alcohol-only/mar ijuana-	(ref)		(ref)		(ref)	
Concurrent alcohol and	-0.31 (0.60)	0.6036	0.05 (0.07)	0.4952	0.16(0.10)	0.0965
Simultaneous alcohol	<b>1.02(0.50)</b>	<b>0.0402</b>	0.08(0.06)	0.1731	<b>0.56(0.08)</b>	<b>&lt;0.0001</b>

<sup>a</sup> Male>female, p<0.05

<sup>b</sup> Female>male, p<0.05

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