Young adult DUI behavior and perceived norms of driving under the influence of simultaneous alcohol and cannabis use

Brittney A. Hultgren[1], **Miranda L.M. Delawalla**[1], **Victoria Szydlowski**[1,2], **Katarina Guttmannova**[1], **Jennifer M. Cadigan**[1], **Jason R. Kilmer**[1,2], **Christine M. Lee**[1], **Mary E. Larimer**[1,2]

[1]Center for the Study of Health and Risk Behaviors, Department of Psychiatry and Behavioral Sciences, School of Medicine, University of Washington, Seattle, WA

[2]Department of Psychology, University of Washington, Seattle, WA
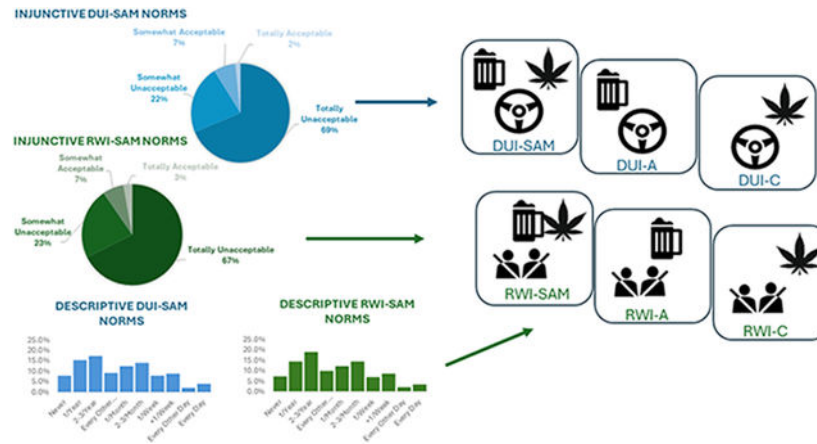
Abstract

Background: Impaired driving behaviors among young adults who are under the influence of simultaneous alcohol and marijuana/cannabis (SAM) use are associated with increased risks of motor vehicle accidents and resulting increased injury and mortality. Exploration of associations with descriptive and injunctive norms may have prevention implications.

Methods: Young adults (aged 18-25; N=1,941) in the 2019 cohort of the Washington Young Adult Health Survey comprised study participants. Associations between descriptive norms (estimates of other's frequency of driving under the influence of SAM [DUI-SAM] and riding with a SAM impaired driver [RWI-SAM]), injunctive norms (perceived approval or disapproval of DUI-SAM and RWI-SAM for young adults in their community), and past month DUI and RWI behaviors were assessed with logistic regression models, adjusting for covariates and applying post-stratification weights.

Results: DUI-SAM was reported by 2.7% and almost double (5.3%) reported RWI-SAM at least once in the past month. Almost half of participants believed the average young adults in Washington state engaged in DUI-SAM (49.8%) and RWI-SAM (48.7%) at least once a month in the past year (i.e., descriptive norms). The majority reported DUI-SAM (68.8%) and RWI-SAM (67.6%) to be *totally unacceptable* for young adults in their community (i.e., injunctive norms). In models adjusting for covariates including SAM use frequency and corresponding injunctive norms, descriptive norms were not associated with DUI, but were positively associated with RWI-SAM. However, after controlling for SAM use frequency and descriptive norms, higher perceived approval (i.e., injunctive norms) was significantly associated with increased odds of all DUI and RWI behaviors.

Conclusions: Injunctive norms for SAM impaired driving behaviors may be a promising intervention focus for DUI and RWI behaviors. Future research is needed to replicate these findings to determine if development and evaluation of individual and community-based interventions focused on changing normative beliefs are warranted.

Correspondence regarding this article should be addressed to Brittney Hultgren, Center for the Study of Health and Risk Behaviors, Department of Psychiatry and Behavioral Sciences, Box # 357283, Seattle, WA 98195; hultgren@uw.edu; fax: 206.543.7624.

Graphical Abstract

Among Washington State young adults, most perceived driving under the influence of simultaneous alcohol and marijuana/cannabis (DUI-SAM) and riding with a SAM impaired driver (RWI-SAM) as unacceptable for their peers (i.e., injunctive norms). More permissive injunctive norms were associated with DUI-SAM and RWI-SAM. Descriptive (i.e. how frequent) peer norms were associated with RWI-SAM only. Replication of these findings would provide support for development and evaluation of interventions focused on changing normative beliefs for DUI and RWI behaviors.

Keywords

Impaired driving; alcohol; cannabis; simultaneous alcohol and marijuana/cannabis use (SAM); norms; young adults

Introduction

Motor vehicle accidents are a decades long leading cause of US young adult (YA: 18-25) mortality (Centers for Disease Control and Prevention [CDC], 2021). Prevention efforts have largely centered on implementing policies that are both broad, such as graduated driver licensing programs, as well as focused on impaired driving, such as increasing the legal minimum drinking age and per se laws that specify amounts of substances deemed legally impairing (Banz, et al., 2019; Hosseinichimeh et al., 2022). These prevention efforts, mainly dedicated to driving under the influence of alcohol (DUI-A), have influenced the downward trends in self-reported DUI-A among both the general population and YAs specifically (Hultgren et al., 2024; Myers et al., 2023). However, prevention efforts specific to cannabis impaired driving (DUI-C), and even more so driving under the influence of simultaneous use of alcohol and marijuana/cannabis (DUI-SAM), have been limited. While overall trends of DUI-A among young adults have continued to decrease, prevalence of DUI-C between 2015- 2019 remained relatively unchanged (Hultgren et al., 2024; Myers et al., 2023). Further, while research is limited, it suggests DUI-SAM has also not had a significant decrease through 2019 (Hultgren et al., 2024).

Recent analyses utilizing data from the National Survey on Drug Use and Health (NSDUC) indicated that 10% of YA drinkers reported past-year DUI-A and 28% of YAs who use cannabis reported past-year DUI-C in a national sample (Myers et al., 2023). However, within a YA sample residing in Washington State where cannabis is legal for non-medical use for individuals 21+, 16% of YA drinkers reported past-month DUI-A and 33% of YAs who use cannabis reported past-month DUI-C (Hultgren et al., 2024). Prevalence rates of DUI-SAM have been less studied, with one study conducted in 2021 with adults across 6 states (3 with recent legalization of non-medical cannabis, 3 without legal non-medical use) reporting 9-15% of the general population engaging in past-year SAM (Eichelbeger, 2023), and ~2% of YAs reporting DUI-SAM in Washington State (Hultgren et al., 2024).

While prevalence of DUI-SAM may be lower than DUI-A or DUI-C, instances of DUI-SAM may pose considerably more risk to public health and safety. First, rates of seriously and fatally injured drivers who have tested positive for both alcohol and cannabis in their system have increased in recent years (Thomas et al., 2020). Both alcohol and cannabis use individually impair the ability to drive, however SAM use is associated with impairment in a magnitude greater than either substance individually (Chihuri, et al., 2017; Simmons et al., 2022). Specifically, SAM use has been shown to increase lateral position variability (i.e., lane keeping; weaving of the car) and time outside of lane more than alcohol or cannabis use only (Simmons et al., 2022).

Research suggests that approximately a quarter of YAs in the U.S. engage in SAM use every year (SAM; Lee et al., 2022). Notably, in a sample of YAs who reported recent SAM use, one in three reported driving after SAM use (Patrick et al., 2021). YAs who engage in SAM use may also be more likely to engage in DUI-A and DUI-C (Gonçalves et al. 2022). Together, this suggests an increasing need for prevention programs focused on reducing YA SAM impaired driving behaviors.

Extant literature examines social norms as an intervention focus for alcohol use and cannabis use, individually (e.g., Borsari & Carey, 2003; Kilmer et al., 2006). Importantly, perceived social norms about how acceptable (i.e., injunctive norms) and frequent (i.e., descriptive norms) alcohol and cannabis use is in a community consistently predicts the frequency of use and related consequences (e.g., Neighbors et al., 2007; Buckner, 2013). Research has found that overestimation of these norms influences use and interventions focused on correcting this overestimation are associated with reduced frequency of alcohol and cannabis use and consequences (Borsari & Carey, 2003; Montes et al., 2021). Regarding impaired driving, a personalized feedback intervention with a component specifically focused on correcting misperceptions of descriptive norms of alcohol-impaired driving reduced alcohol-impaired driving (Teeters, Soltis & Murphy, 2018), and a separate intervention that focused on norms as well as perceived dangerousness of DUI-C showed reductions in DUI-C (Teeters et al., 2022).

Additional research supports the association between norms with impaired driving behaviors. Both descriptive and injunctive norms of DUI-A, DUI-C, as well as riding with an alcohol impaired driver (RWI-A) and riding with an cannabis impaired driver (RWI-C) have been associated with self-report of their respective behaviors either directly (Aston

et al., 2016; DiBlasio, 1988; Kenney, LaBrie, & Lac, 2013; LaBrie, Napper & Ghaidarov, 2012; McCarthy, Lynch & Pedersen, 2007; Thombs et al., 1997; Ward et al., 2017) or through intentions and/or willingness (Earle et al, 2020; Hultgren et al., 2015; Scott et al., 2021). Our previous research utilizing the same sample of the current study (Hultgren et al., 2023) indicated DUI-A, DUI-C, RWI-A and RWI-C were all significantly associated with injunctive norms relevant to the specific behavior (e.g., injunctive norms of DUI-A was associated with likelihood of DUI-A). While the extant research collectively suggests that norms are important psychosocial factors related to driving impaired or riding with a driver impaired by alcohol or cannabis alone, to date no research has examined associations between descriptive and injunctive norms of SAM impaired driving behaviors (i.e., DUI-SAM and RWI-SAM) and impaired driving behaviors. One previous study identified an association between SAM norms and the experience of negative SAM consequences generally, but impaired driving behaviors were not specified (White et al., 2019).

Therefore, the current study examined the associations between both perceived descriptive and injunctive norms of SAM impaired driving-related behaviors (i.e., DUI-SAM and RWI-SAM) and self-reported driving-related behaviors in a sample of Washington State (WA) YAs. If a similar pattern of associations holds between norms for SAM impaired driving and impaired driving behaviors, then SAM impaired driving norms may be a promising intervention development focus for high-risk SAM impaired driving behaviors. Additionally, given that SAM-impaired driving behaviors occur at lower frequencies than alcohol- or cannabis-only impaired driving-related behaviors (Hultgren et al. 2024), and there is evidence that individuals who engage in SAM use are at higher risk of DUI-A and DUI-C (Gonçalves et al., 2022), we sought to examine how perceived norms of DUI-SAM and RWI-SAM may be associated with alcohol- and cannabis-only impaired driving behaviors (i.e., DUI-A; DUI-C; RWI-A; RWI-C).

Methods

Participants

This analysis utilized data from the 2019 cohort of the Washington Young Adult Health Survey (N=1941) of WA residents ages 18 to 25. Participants were recruited through direct mailing using Washington State Department of Licensing-provided contact information and through social media advertisements. Participants completed a web-based survey of substance use, risk factors, and health behaviors. All measures and procedures were reviewed and approved by the University of Washington Institutional Review Board. Full details of procedures for recruitment, screening, and data collection are available elsewhere (Kilmer et al., 2022).

Measures

Demographics.—Participants reported their age, sex assigned at birth (i.e., male, female), work status (i.e., 35 or more hours per week), and education (i.e., enrolled in a four-year university). Additionally, participants reported their race and ethnicity (i.e., Hispanic/Latinx), from which a composite variable was created with the following groups: Non-Hispanic/Latinx (NH) Asian American, Hispanic/Latinx, NH White, and NH other race

(including American Indian or Alaskan Native [1.29% of total sampled], Black or African American [1.91%], more than one race [6.08%], Native Hawaiian or Pacific Islander [0.26%], and other race not listed [0.46%]). Using each participant's address, the following variables were created: WA region (i.e., East, Northwest, Southwest) and Rural-Urban Commuting Area (RUCA; United States Department of Agriculture, 2023), comparing metropolitan areas (RUCA codes 1-3) to nonmetropolitan areas (RUCA codes 4-10).

Finally, sex assigned at birth, WA geographic region, and race/ethnicity were used to calculate post-stratification weights in order to ensure the generalizability of findings to WA young adults based on 2010 US Census data (Kilmer et al., 2022). These variables used to determine weighting were included as covariates in all analyses, in addition to the use of survey weights. For weighted and unweighted demographic variable counts and percentages see Hultgren et al., 2023.

Impaired Riding and Driving Behaviors.—To assess DUI-SAM and RWI-SAM participants reported the number of times in the past month (i.e., 30 days) they had 1) "driven a car or other vehicle within three hours of using alcohol and cannabis (e.g., marijuana, hashish) at the same time so that the effects overlapped (i.e., cross fading)?" (i.e., DUI-SAM) and 2) been "a passenger in a car or other vehicle when the driver used cannabis (e.g., marijuana, hashish, edibles) within three hours of driving?". Participants additionally reported on the number of times in the past 30 days they had engaged in alcohol- and cannabis-impaired driving and riding (i.e., DUI-A, DUI-C, RWI-A, RWI-C) with similar questions (e.g., "during the past 30 days, how many times did you drive a car or other vehicle after consuming alcohol?"; Hultgren et al., 2023). Response options included number of instances: 0, 1, 2-3, 4-5, or 6 or more. In the analysis, response options were turned into a dichotomous variable (0 = no instances, 1 = one or more instances). The decision to dichotomize was based on the lower rates of endorsement of these variables and is consistent with past impaired driving literature.

SAM Use.—To assess past month (i.e., 30 days) SAM use, participants reported on the number of times they "used alcohol and cannabis (e.g., marijuana, hashish, edibles) at the same time so that the effects overlapped (i.e., cross fading)." Response options included number of instances: 0 = "0 times", 1 = "1 time", 2 = "2-3 times", 3 = "4-5 times", or 4 = "6 or more times".

Norms.—To assess perceived descriptive norms for DUI-SAM and RWI-SAM, participants were asked, "How often do you believe a typical person your age living in Washington State…" 1) …"has driven a car or other vehicle within three hours of" SAM use, and 2) …"has been a passenger in a car or other vehicle when the driver has" engaged in SAM use "within three hours before driving?" Response options were on a 10-point Likert scale: 0 = "Never", 1 = "Once a year", 2 = "2 to 3 times a year", 3 = "Every other month", 4 = "Once a month", 5 = "2 to 3 times a month", 6 = "Once per week", 7 = "More than once a week", 8 = "Every other day", 9 = "Every day". Alternative coding of descriptive norms are described in sensitivity analyses.

To assess perceived injunctive norms, participants were asked, "How acceptable or unacceptable is it for someone your age in your community to…" 1) "…drive a car or other vehicle…within three hours of" SAM use, 2) "…be a passenger in a car or other vehicle… when the driver has" engaged in SAM use "within three hours of driving?" Response options across all injunctive norm questions were: 1 = "Totally Unacceptable", 2 = "Somewhat Unacceptable", 3 = "Somewhat Acceptable", and 4 = "Totally Acceptable". For the purpose of these analyses, injunctive norms were dichotomized (0 = totally unacceptable, 1 = all other response options). This was consistent with our previous analyses assessing alcohol- and cannabis-only injunctive norms (Hultgren et al., 2023). This dichotomization is also consistent with dichotomizing of impaired driving-related outcomes, and reflects prevention goals of zero occasions of impaired driving (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018). Alternative coding of injunctive norms is described in sensitivity analyses.

Statistical Analysis

To assess the associations between descriptive and injunctive SAM norms and impaired driving-related behaviors (i.e., DUI-SAM, RWI-SAM, DUI-A, RWI-A, DUI-C, RWI-C), a series of weighted multivariable logistic regression models were conducted using R version 4.2.2 to calculate odds ratios (OR), adjusted ORs (aORs), and 95% confidence intervals (CI) (Lumley, 2020). First, Model 1 regression analyses were bivariate including only descriptive or injunctive norms as independent variables. Model 2 analyses included descriptive or injunctive norms while controlling for the demographic covariates (i.e., sex assigned at birth, geographic region, race/ethnicity [Non-Hispanic/Latinx White was selected as the reference group as this was the largest group and in consideration of additional racism-related stress associated with marginalized racial/ethnic identities], age (i.e., < 21 vs. 21+), and 4-year college enrollment, employment status, and RUCA). In Model 3 analyses, frequency of SAM use was added as a covariate to additionally account for the possible association between impaired driving-related behaviors and the frequency of SAM use. Finally, Model 4 analyses included the aforementioned covariates, SAM use frequency, and the analogous other norm (e.g., in models for injunctive RWI-SAM norms, the variable descriptive RWI-SAM norms was added).

Sensitivity Analyses

We considered the alternative operationalization of descriptive norms modeling descriptive norms as dichotomized variables with 0 indicating less than one time per month and 1 indicating one or more times per month. An alternative parameterization of injunctive norms was considered as well, modeling injunctive norms continuously with the original response options (i.e., 1 to 4, ranging from "totally unacceptable" to "totally acceptable"). To examine for potential differences in associations among only those who reported past month SAM use, we also assessed the impact of excluding participants who did not report SAM use in the past 30 days from the analytic sample.

Results

Descriptives

DUI-SAM and RWI-SAM in the past month were reported by 2.7% and 5.3% of the weighted sample (Table 1). Results indicated an overlap between DUI-SAM and RWI-SAM – 43.2% of YAs who reported DUI-SAM in the past month also reported engaging in RWI-SAM. Regarding other impaired driving behaviors, 11.5 % and 10.9% reported DUI-A and RWI-A, respectively; 12.4% and 20.9% reported DUI-C and RWI-C, respectively (see Hultgren et al., 2023 for additional descriptive information). Among YAs who reported DUI-SAM 71.8% also reported DUI-A and 91.5% DUI-C. Among YAs who reported RWI-SAM, 48.2% report RWI-A and 40.1% reported RWI-C. For descriptive norms, the majority reported that they believed a typical person living in WA engaged in DUI-SAM (49.8%) and RWI-SAM (48.7%) at least once a month in the past year. This represents a large discrepancy between descriptive norms and reported behaviors. Regarding injunctive norms, approximately two-thirds of the weighted sample reported DUI-SAM (68.8%) and RWI-SAM (67.6%) to be "totally unacceptable", as opposed to any other more permissive injunctive norm. The second largest response category was "somewhat unacceptable" (22.7% DUI-SAM, 22.6% RWI-SAM). Descriptive and injunctive DUI-SAM norms and RWI-SAM norms were weakly but significantly correlated ($r = 0.12$, $p < 0.001$; $r = 0.08$, $p < 0.001$; respectively; Supplemental Table 1).

Descriptive Norms

In the bivariate model (Model 1), higher descriptive DUI-SAM norms (OR = 1.11; 95% CI = 0.99, 1.25) had a statistically non-significant 11% increase in odds of reporting engaging in DUI-SAM in the past month. After controlling for demographic covariates (Model 2), and including past month SAM use frequency (Model 3), the association between descriptive DUI-SAM norms and likelihood of DUI-SAM remained positive and non-significant (aOR = 1.09; 95% CI = 0.98, 1.22; aOR = 1.16; 95% CI = 0.98, 1.37, respectively). In the final model (Model 4) that included injunctive DUI-SAM norms, estimate for descriptive norms remained relatively unchanged (aOR = 1.11; 95% CI = 0.92, 1.33; Figure 1). The associations between descriptive SAM norms and DUI-A and DUI-C were similar to those of DUI-SAM showing positive but not significant associations between descriptive SAM norms and any of the other DUI outcomes, with the exception of the bivariate model for DUI-C, which reached statistical significance (OR = 1.07; 95% CI = 1.01, 1.14) (see Table 3 for Model 4 results; Supplemental Table 2 for Model fit indices).

Model 1 descriptive RWI-SAM norms were significantly associated with a 20% increase in the odds (95% CI = 1.09, 1.32) of the participant themselves engaging in RWI-SAM in the past month. Adding demographic covariates (Model 2; aOR = 1.18; 95% CI = 1.06, 1.31) and then additionally SAM use frequency (Model 3; aOR = 1.18; 95% CI = 1.06, 1.31), the associations remained similar and significant. Finally, in Model 4 which added RWI-SAM injunctive norms, the small statistically significant positive association remained (aOR = 1.16; 95% CI = 1.03, 1.30) (Figure 2; Table 3). The associations between descriptive SAM norms and RWI-A and RWI-C were qualitatively similar to those of RWI-SAM.

Specifically, descriptive RWI-SAM norms were associated with increased odds of RWI-A and RWI-C.

Injunctive Norms

In Model 1, more permissive DUI-SAM injunctive norms (as opposed to "*totally unacceptable*") were positively associated (OR: 5.95; 95% CI: 2.63, 13.45) with engaging in DUI-SAM in the past month. After adjusting for demographic covariates (Model 2), YAs who reported more permissive injunctive norms (as opposed to "*totally unacceptable*") for DUI-SAM had 5.72 times greater odds (95% CI = 2.49, 13.11) of reporting past month DUI-SAM. Controlling for SAM frequency (Model 3), the aOR reflecting the greater likelihood to DUI-SAM for those with more favorable injunctive DUI-SAM norms was slightly attenuated but remained statistically significant (aOR = 4.11; 95% CI = 1.71, 9.85). Finally, in Model 4 which added descriptive norms, the association was further attenuated, but still positive and significant (aOR = 3.80; 95% 1.53, 9.41). Results were qualitatively similar for DUI-A and DUI-C outcomes, with significant, though slightly attenuated, positive associations between DUI-SAM injunctive norms and DUI-A and DUI-C (see Table 3 for Model 4 results; Supplemental Table 2 for Model fit indices)

For RWI-SAM, Model 1 indicated a significant positive association (OR = 3.10; 95% CI = 1.78; 5.38). In Model 2, YAs who reported more permissive injunctive norms (as opposed to "totally unacceptable") for DUI-SAM had 3.16 times greater odds (95% CI = 1.79, 5.55) of reporting RWI-SAM themselves. When additionally including SAM use frequency (Model 3), the association between injunctive norms and RWI-SAM remained significant and almost completely unchanged (aOR = 3.15; 95% CI = 1.84, 5.40). Finally, when adding descriptive RWI-SAM norms (Model 4; Table 3), the association remained positive and significant (aOR = 2.94; 95% CI: 1.70, 5.90). Similar to driving outcomes, results were qualitatively similar but attenuated with RWI-SAM injunctive norms associated with increased odds of RWI-A and RWI-C.

Sensitivity Analyses

Alternative parameterizations of descriptive norms yielded largely similar results, with the exception of a statistically nonsignificant association in Model 2 when descriptive RWI-SAM norms were modeled dichotomized at one or more times per month (Supplemental Table 3). The continuous parameterization of injunctive norms response options was also qualitatively similar to the main analyses. Specifically, there was a statistically significant positive association between descriptive norms and RWI-SAM but not DUI-SAM, while injunctive norms showed significant positive associations with both DUI-SAM and RWI-SAM. (Supplemental Table 4). Truncated models that included only participants who reported past month SAM use indicated significant positive association between descriptive norms and DUI-SAM in Models 1 and 2, that similar to main analyses, were no longer statistically significant when SAM use frequency (Model 3) and injunctive norms (Model 4) were added. For RWI-SAM, among the truncated sample, descriptive norms in all models had positive non-significant associations. The associations for injunctive norms in all models were analogous to the main models (i.e., indicating positive significant associations) with the

exception of injunctive RWI-SAM in Model 1 for norms being nonsignificant, and trending (95% CI = 1.00, 5.69) in Model 4 (Supplemental Table 5).

Discussion

This study was the first to examine perceived SAM impaired driving norms and their relation to SAM impaired driving behaviors as well as alcohol- and cannabis-only impaired driving. In a representative sample of WA YAs in 2019, 2.7% and 5.3% reported DUI-SAM and RWI-SAM in the past month. While percentages were lower than previously reported alcohol- and cannabis-impaired driving behaviors (11.5% DUI-A, 10.9% RWI-A, 12.4% DUI-C, 20.9% RWI-C) in this sample (Hultgren et al., 2023), each SAM-impaired driving occurrence is estimated to have over a 10% higher crash risk compared to DUI-A (Chuhuri et al., 2017). The 2010 Census reported over 460,000 people aged 20-24 living in WA (Washington State Office of Financial Management, 2019). Based on our findings this would suggest more than 12,400 YAs engage in DUI-SAM at least once *every month*. There was a striking discrepancy between these actual reported rates and the percentages of participants who reported they thought the average person their age in their community engaged in DUI-SAM and RWI-SAM at least once a month (49.8% and 48.7%, respectively). Further, more than 30% of WA YAs report SAM injunctive norms that are more permissive than *totally unacceptable* for both DUI-SAM and RWI-SAM. These findings further support the need for preventative efforts aimed at reducing SAM impaired driving behaviors and that normative beliefs vary across YAs, differ from behavior, and may be an avenue for intervening.

While we expected SAM impaired driving descriptive norms to be significantly associated with an increased likelihood of DUI-SAM, we observed a non-significant trend in the expected direction. These findings are unexpected given the robust trend in alcohol research for descriptive norms to be more consistently predictive of alcohol use, over injunctive norms (Miller et al., 2013; Pearson & Hustad, 2014). While descriptive norms for individual cannabis use frequency are associated with cannabis use (Arbour-Nicitopoulos et al., 2010), there is also a body of evidence identifying nonsignificant relationships (Buckner, 2013; Napper et al., 2016). Specific to impaired driving behaviors there have also been mixed findings. No significant association was examined between descriptive norms and willingness to ride with a driver under the influence of alcohol among a sample of college students (Hultgren et al., 2015), but in a sample of 12,407 drivers from 19 European countries showed that those who "fairly" or "very much agree" that most of their friends would drive after drinking were 3.5 times more likely to drive under the influence than those who say they agree "not much" or "not at all" (Meesman et al., 2015). Conversely to DUI-SAM, we observed a small significant association between RWI-SAM norms and RWI-SAM behavior. This may provide some conservative support for personalized descriptive normative feedback interventions to address RWI-SAM. However, because the discrepancy between perceived behavior (i.e., descriptive norms) and actual behavior is so large, there may be a benefit of interventions focused on changing larger societal norms (Anderson et al., 2018) on perceived frequency of SAM impaired driving behaviors. Having more accurate perceived descriptive norms in a collective community may help reduce overall SAM impaired driving behaviors. This may require multicomponent

community-interventions, of which research has suggested use of community mobilization, law enforcement involvement, and media campaigns together may provide the most benefit (Porthé et al., 2021). Research should also consider assessing how social media involvement, imaging and marketing may influence normative perceptions of these behaviors, as recent research has suggested alcohol-related social media engagement is associated with alcohol use and consequences (Curtis et al., 2018) and cannabis social media marketing exposure is associated with cannabis use (Whitehill et al., 2020).

Importantly, injunctive SAM driving and riding norms showed a consistent significant association with increased likelihood of DUI-SAM and RWI-SAM, even when accounting for SAM use frequency. These findings are consistent with other alcohol research which suggests injunctive norms are predictors of longitudinal alcohol use and related consequences (Larimer et al., 2004). Similarly, in individual cannabis research, injunctive norms are also predictive of increased cannabis use and related consequences (Napper et al., 2016). Therefore, prevention efforts may reduce likelihood of SAM impaired driving-related behaviors by providing elements focused on changing YA perceived approval (or disapproval) of impaired SAM driving behaviors by other YAs in their community. From comparable alcohol and cannabis prevention efforts, promising approaches to changing injunctive norms may span the continuum from personalized YA interventions to large-scale media campaigns. Specifically, brief personalized normative feedback within a motivational interviewing (MI) framework (Mun et al., 2022; Teeters, Soltis & Murphy, 2018; Teeters et al., 2022) may be integrated into a variety of settings not specific to mental healthcare delivery (e.g., voluntary and mandatory educational settings, emergency rooms, etc.) and administered by a variety of providers, including lay providers. Moreover, while there has not been a larger media campaign for injunctive norms, a comparable communication route may follow descriptive norm messaging campaigns. Importantly, 2/3 of YAs in this sample reported that both DUI-SAM and RWI-SAM were "*totally unacceptable*". Thus, approaches that aim to increase community-wide awareness that this is the prevalent norm may also help change individual-level injunctive norms of those with more permissive beliefs. Additionally, we observed significant positive associations between SAM impaired driving injunctive norms and DUI-A, RWI-A, DUI-C, and RWI-C. This suggests that prevention efforts addressing these norms may help reduce several types of impaired driving outcomes or, more conservatively, that assessing injunctive norms may be useful as an initial screening tool for individuals at risk of impaired driving behaviors generally who may benefit from brief intervention.

Injunctive SAM impaired driving norms may impact impaired driving-related behaviors through an association with misperceptions of the safety of these behaviors. Past research has shown that not only is driving after using cannabis typically perceived safer than driving after using alcohol (Colonna et al., 2021; Davis et al., 2016), but some individuals report the belief that they drive *better* after using cannabis (Greene, 2018; Watson et al., 2019). Further, qualitative assessments among YAs who engage in SAM use indicate that some YAs believe they have decreased impairment or a balancing effect of the two substances when they use both substances compared to either alone (Waddell et al., 2023). Therefore, some YAs may believe that by using cannabis after drinking alcohol they are safer to drive than if they drank alcohol alone, and therefore believe others think this behavior is safe and

acceptable as well. While a wealth a literature has examined perceived harms of DUI-A and DUI-C (e.g., Goodman, Leos-Toro, Hammond, 2020; Greene 2018), to date, no research has examined the harms of DUI-SAM and RWI-SAM specifically and how they may differ from impaired driving behaviors from either substance alone. Future research should assess risk perceptions of SAM impaired driving behaviors. If the misperceptions of risk are associated with injunctive norms and/or SAM impaired driving behaviors themselves, interventions may benefit from also addressing these risk misperceptions.

Limitations

Limitations of this study include that the participant sample restricted to YAs residing in WA state where the minimum legal cannabis purchasing age is 21. It is not clear how generalizable these results will be across varied legal statuses in other states. While weighting helps mitigate concerns with generalizability by increasing representativeness, the lack of diversity in the sample, which is somewhat reflective of WA state, is exacerbated by our analytic decision to group race and ethnicity categories due to small group sizes and additional work is needed to examine if these effects differ among different racial and ethnic identities. The observational, cross-sectional nature of this analysis limits our understanding of temporality and precludes causal inference. Specifically, injunctive norms of SAM impaired driving-related behaviors may be an outcome of previous impaired driving behavior, or norms and behavior may have a bidirectional association that cannot be assessed in the current study. Future research should examine these associations longitudinally. Additionally, findings should be considered within the context of potential power issues given the lower, but still meaningful, prevalence of DUI-SAM and RWI-SAM in our sample of YAs in the general population. Future research is needed in samples with higher risk of DUI-SAM and/or RWI-SAM. Further, the current study examined self-report of driving after intentionally using alcohol and cannabis so that their effects overlap. While there is variability across studies in how norms are assessed (Shulman et al., 2017), measurement of injunctive norms in the current study may cause some participants to respond reflecting on both their own approval and the approval of peers in their community. Future research should include assessments of both personal approval and injunctive norms to disentangle these effects. Both injunctive and descriptive norms were only assessed using a single item, while other studies have utilized several items that may provide more variability in response (e.g., LaBrie, Napper & Ghaidarov, 2012; Larimer et al., 2004), research should examine if results are replicated utilizing the more nuanced approach. Additional work is needed to assess these driving-related behaviors more objectively, taking into consideration the limitations, increased cost, and participant burden of current available biomarkers of alcohol and cannabis use. Intensive daily or event-level assessment of impaired driving outcomes may provide a more comprehensive understanding of how norms may impact these behaviors.

Conclusion

The current study has provided novel information regarding perceived SAM-impaired driving norms and their associations with impaired driving behaviors. Findings indicate large discrepancies between SAM-impaired perceived descriptive norms and actual reported behavior. Although only RWI-SAM descriptive norms were associated with RWI behaviors,

injunctive SAM impaired driving norms were significantly associated with all DUI and RWI behaviors assessed, indicating that injunctive SAM-impaired driving norms may be related to impaired driving behaviors more generally. Future research is needed to replicate these findings both longitudinally and more intensively (e.g., daily associations) to determine if development and evaluation of individual and community-based interventions focused on changing these normative beliefs are warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

List of Abbreviations

|	
SAM	simultaneous alcohol and marijuana/cannabis use at the same time, so that the effects overlap
DUI-SAM	driving under the influence of SAM
RWI-SAM	riding with a driver under the influence of SAM
WA	Washington State

References

Anderson P, Jané-Llopis E, Hasan OSM, Rehm J (2018) Changing collective social norms in favour of reduced harmful use of alcohol: a review of reviews. Alcohol Alcohol 53:326–332. [PubMed: 29346480]

Arbour-Nicitopoulos KP, Kwan MY, Lowe D, Taman S, Faulkner GE (2010) Social norms of alcohol, smoking, and marijuana use within a Canadian university setting. J Am College Health 59:191–196.

Aston ER, Merrill JE, McCarthy DM, Metrik J (2016) Risk factors for driving after and during marijuana use. J Stud Alcohol Drugs, 77(2), 309–316. [PubMed: 26997189]

Banz BC, Fell JC, Vaca FE (2019) Complexities of young driver injury and fatal motor vehicle crashes. Yale J Biol Med 92:725–731. [PubMed: 31866787]

Borsari B, Carey KB (2003) Descriptive and injunctive norms in college drinking: A meta-analytic integration. J Stud Alcohol 64:331–341. [PubMed: 12817821]

Boyle HK, Carey KB, Jackson KM, Merrill JE (2023) Applying the prototype willingness model to day-level simultaneous alcohol and cannabis use. Psychol Addict Behav: 37:626–638. [PubMed: 37079807]

Buckner JD (2013) College cannabis use: the unique roles of social norms, motives, and expectancies. J Stud Alcohol Drugs 74:720–726. [PubMed: 23948531]

Centers for Disease Control and Prevention Leading Causes of Death Reports, 1981–2019 [database online]. 2021. Available from: https://wisqars.cdc.gov/fatal-leading

Chihuri S, Li G, Chen Q (2017) Interaction of marijuana and alcohol on fatal motor vehicle crash risk: a case-control study. Inj Epidemiol 4:8. [PubMed: 28286930]

Colonna R, Hand CL, Holmes JD, Alvarez L (2021) Exploring youths' beliefs towards cannabis and driving: A mixed method study. Transportation Research Part F: Traffic Psychology and Behaviour 82:429–439.

Curtis BL, Lookatch SJ, Ramo DE, McKay JR, Feinn RS, Kranzler HR (2018) Meta-analysis of the association of alcohol-related social media use with alcohol consumption and alcohol-related problems in adolescents and young adults. Alcohol: Clin Exp Res 42:978–986. [PubMed: 29786874]

Davis KC, Allen J, Duke J, Nonnemaker J, Bradfield B, Farrelly MC , Schafer S, Novak S (2016) Correlates of marijuana drugged driving and openness to driving while high: evidence from Colorado and Washington. PLoS One 11:e0146853. [PubMed: 26800209]

DiBlasio FA (1988) Predriving riders and drinking drivers. J Stud Alcohol 49:11–15. [PubMed: 3347070]

Dubois S, Mullen N, Weaver B, Bédard M (2015) The combined effects of alcohol and cannabis on driving: Impact on crash risk. Forensic Sci Int 248:94–100. [PubMed: 25612879]

Earle AM, Napper LE, LaBrie JW, Brooks-Russell A, Smith DJ, de Rutte J (2020) Examining interactions within the theory of planned behavior in the prediction of intentions to engage in cannabis-related driving behaviors. J Am Coll Health 68(4):374–380 [PubMed: 30681931]

Eichelberger A., 2023. Prevalence of alcohol, cannabis, and simultaneous use among drivers in six states. Transportation Research Record, 2677(11): 237–244.

Goodman SE, Leos-Toro C, Hammond D (2020) Risk perceptions of cannabis-vs. alcohol-impaired driving among Canadian young people. Drugs Edu Prev Policy 27(3): 205–212.

Gonçalves PD, Gutkind S, Segura LE, Castaldelli-Maia JM, Martins SS and Mauro PM, (2022) Simultaneous alcohol/cannabis use and driving under the influence in the US. Am J Prev Med 62(5): 661–669. [PubMed: 35459450]

Greene KM (2018) Perceptions of driving after marijuana use compared to alcohol use among rural American young adults. Drug Alc Rev 37:637–644.

Hartman RL, Brown TL, Milavetz G, Spurgin A, Pierce RS, Gorelick DA, Gaffney G, Huestis MA (2016) Cannabis effects on driving longitudinal control with and without alcohol. J Appl Toxicol 36:1418–1429. [PubMed: 26889769]

Hartman RL, Huestis MA (2013) Cannabis effects on driving skills. Clin Chem 59:478–492. [PubMed: 23220273]

Hosseinichimeh N, Williams R, MacDonald R, Li K, Vaca FE (2022) What determines the success of states in reducing alcohol related crash fatalities? A longitudinal analysis of alcohol related crashes in the U.S. from 1985 to 2019. Accid Anal Prev 174:106730. [PubMed: 35709595]

Hultgren BA, Calhoun BH, Fleming CB, Lyons VH, Rhew IC, Larimer ME, Kilmer JR, Guttmannova K (2024) Young adult alcohol and cannabis impaired driving after the opening of cannabis retail stores in Washington State. Prev Sci 1–11.

Hultgren BA, Guttmannova K, Cadigan JM, Kilmer JR, Delawalla ML, Lee CM, Larimer ME (2023) Injunctive norms and driving under the influence and riding with an impaired driver among young adults in Washington State. J Adolesc Health 73(5):852–858. [PubMed: 37530684]

Hultgren BA, Scaglione NM, Cleveland MJ, Turrisi R (2015) Examination of a dual-process model predicting riding with drinking drivers. Alcohol: Clin Exp Res 39:1075–1082. [PubMed: 25939372]

Hultgren BA, Turrisi R, Mallett KA, Ackerman S, Larimer ME, McCarthy D Romano, (2018) A longitudinal examination of decisions to ride and decline rides with drinking drivers. Alcohol: Clin Exp Res 42(9):1748–1755. [PubMed: 29944183]

Kenney SR, LaBrie JW, Lac A (2013) Injunctive peer misperceptions and the mediation of self-approval on risk for driving after drinking among college students. J Health Commun 18:459–477. [PubMed: 23379424]

Kilmer JR, Rhew IC, Guttmannova K, Fleming CB, Hultgren BA, Gilson MS, Cooper RL, Dilley J, Larimer ME (2022) Cannabis use among young adults in Washington state after legalization of nonmedical cannabis. Am J Public health 112:638–645. [PubMed: 35319936]

Kilmer JR, Walker DD, Lee CM, Palmer RS, Mallett KA, Fabiano P, Larimer ME (2006) Misperceptions of college student marijuana use: Implications for prevention. J Stud Alcohol 67:277–281. [PubMed: 16562410]

LaBrie JW, Napper LE, Ghaidarov TM (2012) Predicting driving after drinking over time among college students: The emerging role of injunctive normative perceptions. J Stud Alcohol Drugs 73(5):726–730. [PubMed: 22846236]

Larimer ME, Turner AP, Mallett KA, Geisner I (2004) Predicting drinking behavior and alcohol-related problems among fraternity and sorority members: examining the role of descriptive and injunctive norms. Psychol Addict Behav 18:203–212. [PubMed: 15482075]

Lee CM, Calhoun BH, Abdallah DA, Blayney JA, Schultz NR, Brunner M, Patrick ME (2022) Simultaneous Alcohol and Marijuana Use Among Young Adults: A Scoping Review of Prevalence, Patterns, Psychosocial Correlates, and Consequences. Alcohol Res 42:08. [PubMed: 35548267]

Linden-Carmichael AN, Stamates AL, Lau-Barraco C (2019) Simultaneous Use of Alcohol and Marijuana: Patterns and Individual Differences. Subst Use Misuse 54:2156–2166. [PubMed: 31304834]

Lumley T (2020) Survey: analysis of complex survey samples. R package version 4.0.

McCarthy DM, Lynch AM, Pedersen SL (2007) Driving after use of alcohol and marijuana in college students. Psychol Addict Behav 21(3): 425. [PubMed: 17874895]

Meesmann U, Martensen H, Dupont E (2015) Impact of alcohol checks and social norm on driving under the influence of alcohol (DUI). Accid Anal Prev 80:251–261. [PubMed: 25957934]

Miller MB, Leffingwell T, Claborn K, Walters S Meier E, Neighbors C. (2013) Personalized feedback interventions for college alcohol misuse: An update of Walters & Neighbors (2005) Psychol Addict Behav 27:909–920. [PubMed: 23276309]

Montes KS, Richards DK, Pearson MR, Marijuana Outcomes Study Team (2021) A novel approach to assess descriptive and injunctive norms for college student marijuana use. Addict Behav 117:106755. [PubMed: 33556670]

Mun EY, Li X, Lineberry S, Tan Z, Huh D, Walters ST, Zhou Z, Larimer ME, in Collaboration with Project INTEGRATE Team (2022) Do brief alcohol interventions reduce driving after drinking among college students? A two-step meta-analysis of individual participant data. Alcohol Alcohol 57:125–135. [PubMed: 33592624]

Myers MG, Bonar EE and Bohnert KM, 2023. Driving under the influence of cannabis, alcohol, and illicit drugs among adults in the United States from 2016 to 2020. Addict Behav 140:107614. [PubMed: 36652810]

Napper LE, Kenney SR, Hummer JF, Fiorot S, LaBrie JW (2016) Longitudinal relationships among perceived injunctive and descriptive norms and marijuana use. J Stud Alcohol Drugs 77:457–463. [PubMed: 27172578]

National Academies of Sciences, Engineering, and Medicine (2018) Getting to Zero Alcohol-Impaired Driving Fatalities: A Comprehensive Approach to a Persistent Problem. Washington, DC: The National Academies Press.

Neighbors C, Lee CM, Lewis MA, Fossos N, Larimer ME (2007) Are social norms the best predictor of outcomes among heavy-drinking college students? J Stud Alcohol Drugs 68:556–565. [PubMed: 17568961]

Patrick ME, Graupensperger S, Dworkin ER, Duckworth JC, Abdallah DA, Lee CM (2021) Intoxicated driving and riding with impaired drivers: Comparing days with alcohol, marijuana, and simultaneous use. Drug Alcohol Dep225:108753.

Pearson MR, Hustad JT (2014) Personality and alcohol-related outcomes among mandated college students: Descriptive norms, injunctive norms, and college-related alcohol beliefs as mediators. Addict Behav 39:879–884. [PubMed: 24589869]

Porthé V, García-Subirats I, Ariza C, Villalbí JR, Bartroli M, Júarez O, Díez E (2021) Community-based interventions to reduce alcohol consumption and alcohol-related harm in adults. J Community Health 46:565–576. [PubMed: 32770477]

Scott B, Ward N, Otto J, Finley K (2021) Modeling the system of beliefs that influence driving under the influence of cannabis (DUIC) in Washington State. Accid Anal Prev 151:105988–105988. [PubMed: 33484972]

Schulenberg JE, Patrick ME, Johnston LD, O'Malley PM, Bachman JG, Miech RA [Monitoring the future Web site]. June 2021. Monitoring the future national survey results on drug use, 1975-2020. Volume II, college students & adults ages 19-60. institute for social research. Available at: http://www.monitoringthefuture.org/pubs/monographs/mtf-vol2_2020.pdf. Accessed August 31, 2022.

Shulman H, Rhodes N, Davidson E, Ralston R, Borghetti L, Morr L (2017) The State of the Field of Social Norms Research. Int J Commun 11:22.

Simmons SM, Caird JK, Sterzer F, Asbridge M (2022) The effects of cannabis and alcohol on driving performance and driver behaviour: a systematic review and meta-analysis. Addiction 117:1843–1856. [PubMed: 35083810]

Teeters JB, Armstrong NM, King SA, Hubbard SM (2022) A randomized pilot trial of a mobile phone–based brief intervention with personalized feedback and interactive text messaging to reduce driving after cannabis use and riding with a cannabis impaired driver. J Subst Abuse Treatment 142:108867.

Teeters JB, Soltis KE, Murphy JG (2018) A mobile phone–based brief intervention with personalized feedback and text messaging is associated with reductions in driving after drinking among college drinkers. J Stud Alcohol Drugs 79(5):710–9. [PubMed: 30422784]

Thomas FD, Berning A, Darrah J, Graham LA, Blomberg RD, Griggs C, Crandall M, Schulman C, Kozar R, Neavyn M, Cunningham K, Ehsani J, Whitehill J, Babu K, Lai, Rayner M (2020) Drug and alcohol prevalence in seriously and fatally injured road users before and during the COVID-19 public health emergency (Report No. DOT HS 813 013) National Highway Traffic Safety Administration.

Thomas FD, Darrah J, Graham L, Berning A, Blomberg R, Finstad K, Griggs C, Crandall M, Schulman C, Kozar R, Lai J, Mohr N, Chenoweth J, Cunningham K, Babu K, Dorfman J, Van Heukelom J, Ehsani J, Fell J, Whitehall J, Brown T, Moore C (2022) Drug prevalence among seriously or fatally injured road users (Report No. DOT HS 813 399) National Highway Traffic Safety Administration.

Thombs DL, Wolcott BJ, Farkash LG (1997) Social context, perceived norms and drinking behavior in young people. J Subst Abuse 9:257–267. [PubMed: 9494953]

Waddell JT, Merrill JE, Okey SA, Woods-Gonzalez R, Corbin WR (2023) Subjective effects of simultaneous alcohol and cannabis versus alcohol-only use: A qualitative analysis. Psychol Addict Behav 37:906–917 [PubMed: 36757980]

Ward NJ, Otto J, Schell W, Finley K, Kelley-Baker T, Lacey JH (2017) Cultural predictors of future intention to drive under the influence of cannabis (DUIC). Transportation Research Part F: Traffic Psychology and Behaviour 49:215–225. doi: 10.1016/j.trf.2017.06.013

Washington State Office of Financial Management. (2019). Distribution of Washington population by age and gender. Office of Financial Management. https://ofm.wa.gov/washington-data-research/statewide-data/washington-trends/population-changes/distribution-washington-population-age-and-gender

Watson TM, Mann RE, Wickens CM, Brands B (2019) "Just a habit": Driving under the influence of cannabis as ordinary, convenient, and controllable experiences according to drivers in a remedial program. J Drug Issues 49:531–544.

White HR, Kilmer JR, Fossos-Wong N, Hayes K, Sokolovsky AW, Jackson K (2019) Simultaneous Alcohol and Marijuana Use Among College Students: Patterns, Correlates, Norms, and Consequences. Alcohol Clin Exp Res 43:1545–1555. [PubMed: 31135972]

Whitehill JM, Trangenstein PJ, Jenkins MC, Jernigan DH, Moreno MA (2020) Exposure to cannabis marketing in social and traditional media and past-year use among adolescents in states with legal retail cannabis. J Adolesc Health 66:247–254. [PubMed: 31708374]
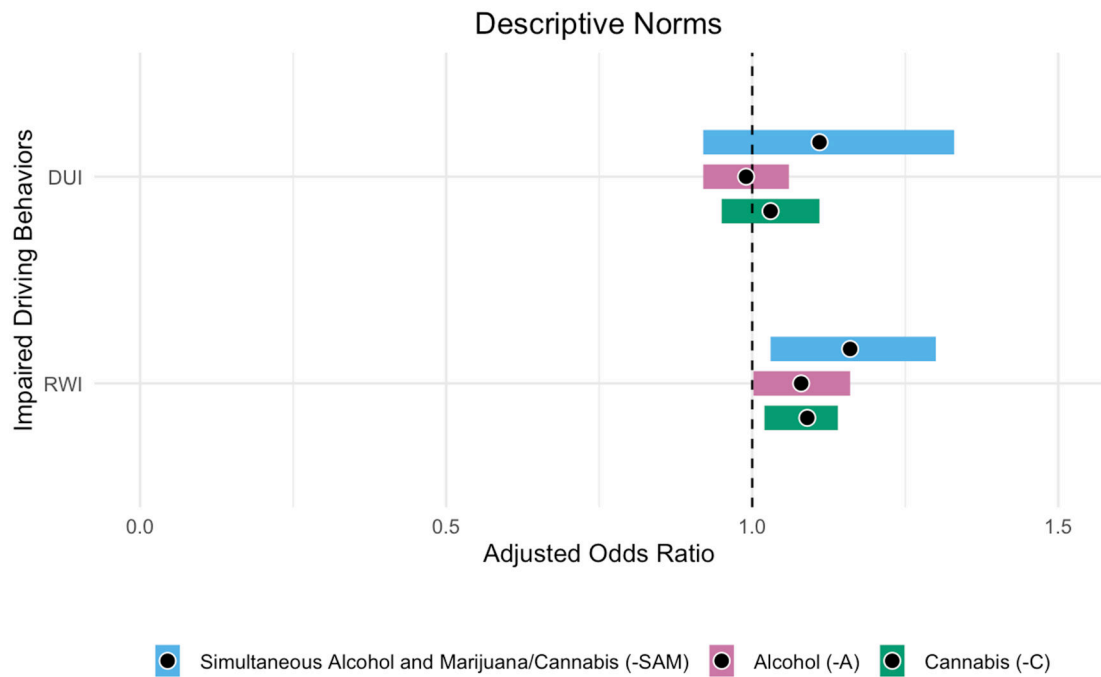
Figure 1.
Forest plot of adjusted odds ratios for associations of descriptive norms with past month driving under the influence (DUI-) and riding with an impaired driver under the influence (RWI-) of simultaneous alcohol and marijuana/cannabis use (SAM), alcohol (A), and cannabis (C). Models are adjusted for sex assigned at birth, geographic region, and race/ethnicity, age, college status, work status, urbanicity, past month SAM use frequency, and injunctive norms.
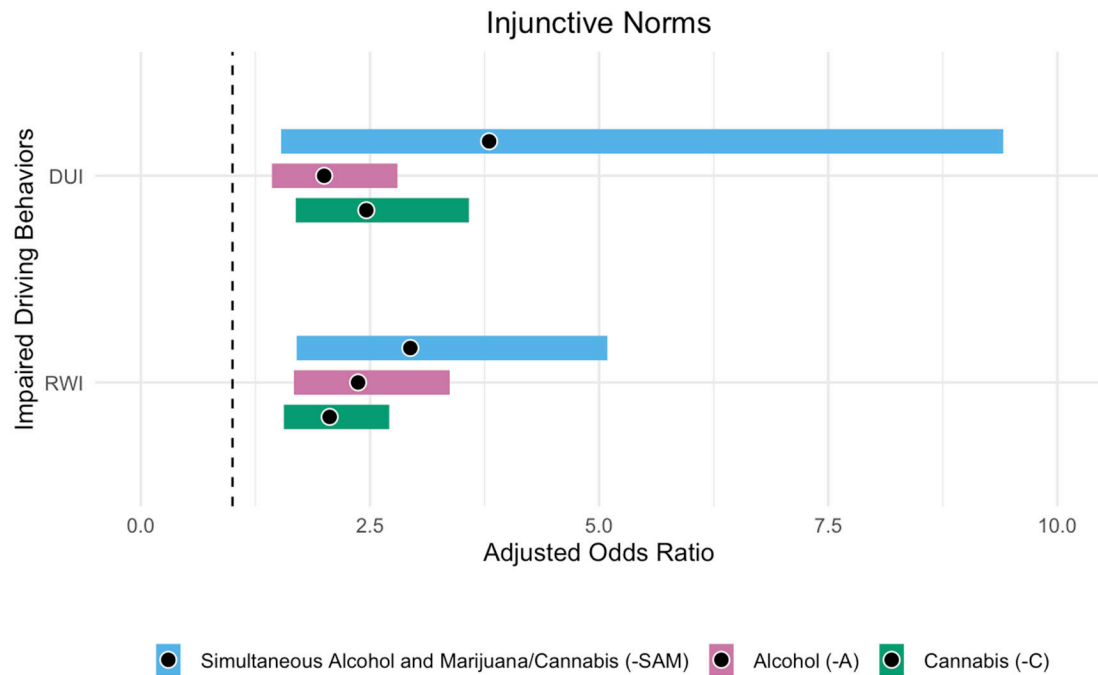
Figure 2.
Forest plot of adjusted odds ratios for associations of injunctive norms with past month driving under the influence (DUI-) and riding with an impaired driver under the influence (RWI-) of simultaneous alcohol and marijuana/cannabis use (SAM), alcohol (A), and cannabis (C). Models are adjusted for sex assigned at birth, geographic region, and race/ethnicity, age, college status, work status, urbanicity, past month SAM use frequency, and descriptive norms.

Table 1.

Distributions of SAM-related Behaviors and Norms.

	Unweighted Sample (N = 1,941) n (%)	Weighted Sample %	Mean (SD)
Past Month SAM Use Frequency			0.3 (0.8)
0 times	1,639 (84.8)	84.7	
1 time	142 (7.3)	6.9	
2-3 times	103 (5.3)	5.2	
4-5 times	21 (1.1)	1.4	
6 or more times	27 (1.4)	1.8	
Past Month DUI-SAM			0.1 (0.2)
0 times	1,887 (97.7)	97.3	
1 time	25 (1.3)	1.4	
2-3 times	11 (0.6)	0.5	
4-5 times	4 (0.2)	0.2	
6 or more times	5 (0.3)	0.6	
Past Month RWI-SAM			0.8 (0.4)
0 times	1,833 (94.9)	94.7	
1 time	59 (3.1)	3.2	
2-3 times	30 (1.6)	1.4	
4-5 times	9 (0.5)	0.6	
6 or more times	1 (0.1)	0.04	
Descriptive Norm: DUI-SAM in Past Year			3.6 (2.4)
Never	143 (7.4)	8.1	
Once a year	274 (14.2)	15.5	
2 to 3 times a year	331 (17.2)	17.5	
Every other month	176 (9.1)	9.1	
Once a month	266 (13.8)	12.5	
2 to 3 times a month	291 (15.1)	14.1	
Once per week	150 (7.8)	7.9	
More than once a week	170 (8.8)	8.8	
Every other day	43 (2.2)	2.2	
Every day	84 (4.4)	4.2	
Descriptive Norm: RWI-SAM in Past Year			3.6 (2.4)
Never	122 (6.3)	7.3	
Once a year	267 (13.8)	14.7	
2 to 3 times a year	378 (19.6)	19.3	
Every other month	191 (9.9)	10.0	
Once a month	255 (13.2)	12.3	
2 to 3 times a month	284 (14.7)	14.5	
Once per week	137 (7.1)	7.2	
More than once a week	173 (9.0)	8.7	

	Unweighted Sample (N = 1,941) n (%)	Weighted Sample %	Mean (SD)
Every other day	48 (2.5)	2.4	
Every day	74 (3.8)	3.6	
Injunctive Norm: DUI-SAM Acceptability			1.4 (0.7)
Totally unacceptable	1328 (68.7)	68.8	
Somewhat unacceptable	439 (22.7)	22.4	
Somewhat acceptable	138 (7.1)	7.2	
Totally acceptable	29 (1.5)	1.7	
Injunctive Norm: RWI-SAM Acceptability			1.4 (0.7)
Totally unacceptable	1314 (68.0)	67.6	
Somewhat unacceptable	437 (22.6)	22.8	
Somewhat acceptable	135 (7.0)	6.8	
Totally acceptable	45 (2.3)	2.8	

SAM = Simultaneous use of alcohol and marijuana/cannabis; DUI-SAM = Driving under the influence of SAM; RWI-SAM = Riding with a driver under the influence of SAM; all impaired driving-related behaviors assessed for the past 30 days.

Table 2.

Prevalence of Past Month SAM Use, Past Month DUI-SAM, Past Month RWI-SAM, and Norms in Weighted Sample

		Past Month SAM Use		Past Month DUI-SAM		Past Month RWI-SAM		Descriptive Norms: DUI-SAM 1+ per Month		Descriptive Norms: RWI-SAM 1+ per Month		Injunctive Norms: DUI-SAM Acceptability		Injunctive Norms: RWI-SAM Acceptability	
		0 times	1+ times	0 times	1+ times	0 times	1+ times	<1 time	1+ times	<1 time	1+ times	Totally unacceptable	More permissive	Totally unacceptable	More permissive
Full Sample		84.7%	15.3%	97.3%	2.7%	94.7%	5.3%	50.2%	49.8%	51.3%	48.7%	68.8%	31.2%	67.6%	32.4%
Past Month SAM Use	Yes			13.0%	100%	13.7%	44.8%	15.2%	15.6%	16.2%	14.6%	12.1%	22.6%	13.9%	18.6%
	No			87.0%	0%	86.3%	55.2%	84.8%	84.4%	83.8%	85.4%	87.9%	77.4%	86.1%	81.4%
Past Month DUI-SAM	Yes					1.6%	22.6%	1.8%	3.6%	2.6%	2.9%	1.1%	6.2%	1.9%	4.4%
	No					98.4%	77.4%	98.2%	96.4%	97.4%	97.1%	98.9%	93.8%	98.1%	95.6%
Past Month RWI-SAM	Yes							3.1%	7.5%	3.5%	7.1%	2.4%	11.5%	3.3%	9.4%
	No							96.9%	92.5%	96.5%	92.9%	97.6%	88.5%	96.7%	90.6%

Prevalence of past month SAM use, past month DUI-SAM, past month RWI-SAM, and norms in weighted sample.* **All prevalence measures presented as percentages of the weighted sample. Missing values excluded from calculation of percentages. Percentages may not sum to 100% due to rounding. SAM = Simultaneous use of alcohol and marijuana/cannabis; DUI-SAM = Driving under the influence of SAM; RWI-SAM = Riding with a driver under the influence of SAM; all impaired driving-related behaviors assessed for the past 30 days.

Table 3.

Adjusted Odds Ratios (aOR) and 95% Confidence Intervals from Final Logistic Regressions (Model 4) Estimating Associations of SAM Norms with SAM, Alcohol, and Cannabis Impaired Driving- and Riding-Related Behaviors.

Model 4	SAM-Related Behaviors				Alcohol-Related Behaviors				Cannabis-Related Behaviors			
	DUI-SAM		RWI-SAM		DUI-A		RWI-A		DUI-C		RWI-C	
	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
	n = 1917		*n* = 1916		*n* = 1907		*n* = 1916		*n* = 1917		*n* = 1915	
Descriptive Norms	1.11	0.92, 1.33	**1.16**	**1.03, 1.30**	0.99	0.92, 1.06	**1.08**	*****1.00, 1.16**	1.03	0.95, 1.11	**1.08**	**1.02, 1.14**
Injunctive Norms	**3.80**	**1.53, 9.41**	**2.94**	**1.70, 5.09**	**2.00**	**1.43, 2.80**	**2.37**	**1.67, 3.37**	**2.46**	**1.69, 3.58**	**2.06**	**1.56, 2.71**
SAM Use Frequency	**4.45**	**3.28, 6.05**	**2.05**	**1.54, 2.73**	**1.56**	**1.31, 1.86**	**1.52**	**1.19, 1.93**	**3.21**	**2.52, 4.10**	**1.98**	**1.65, 2.38**
Male sex assigned at birth	1.32	0.55, 3.16	0.97	0.59, 1.59	1.28	0.92, 1.77	0.86	0.61, 1.22	0.95	0.66, 1.39	0.90	0.69, 1.17
Region												
East	0.22	0.04, 1.31	1.11	0.57, 2.16	1.53	0.99, 2.35	**1.58**	**1.05, 2.39**	1.32	0.81, 2.14	0.95	0.68, 1.33
Southwest	1.69	0.66, 4.31	1.25	0.61, 2.57	1.45	0.94, 2.25	0.97	0.58, 1.61	**1.74**	**1.12, 2.70**	1.26	0.91, 1.76
Northwest	---	---	---	---	---	---	---	---	---	---	---	---
Race and Ethnicity												
Asian or Asian American	**0.00**	**0.00, 0.00**	1.71	0.76, 3.86	0.90	0.48, 1.69	0.91	0.48, 1.72	**0.29**	**0.11, 0.80**	0.71	0.42, 1.20
Hispanic	1.43	0.55, 3.74	1.64	0.91, 2.98	0.90	0.58, 1.40	1.13	0.74, 1.72	1.38	0.90, 2.09	**1.48**	**1.08, 2.05**
Other or multiracial	0.50	0.11, 2.18	1.31	0.52, 3.32	0.65	0.34, 1.24	1.11	0.56, 2.20	0.82	0.35, 1.91	1.05	0.64, 1.72
Caucasian/White	---	---	---	---	---	---	---	---	---	---	---	---
Age 21+	1.04	0.35, 3.11	0.70	0.41, 1.19	**2.54**	**1.64, 3.92**	1.25	0.86, 1.83	0.85	0.56, 1.30	0.77	0.57, 1.05
4 year college	0.87	0.27, 2.77	**0.46**	**0.25, 0.83**	0.92	0.59, 1.45	0.78	0.51, 1.20	**0.57**	**0.36, 0.90**	**0.58**	**0.42, 0.81**
Full time employment	1.25	0.50, 3.16	1.02	0.56, 1.86	1.83	1.26, 2.64	1.05	0.70, 1.56	1.14	0.75, 1.73	0.90	0.66, 1.23
Non-metro RUCA	1.99	0.43, 9.14	1.31	0.58, 2.93	0.76	0.42, 1.36	1.18	0.70, 2.00	0.99	0.57, 1.74	1.46	0.98, 2.18

Adjusted Odds Ratios (aOR) and 95% Confidence Intervals from logistic regressions estimating associations of SAM norms with SAM, alcohol, and cannabis impaired driving- and riding-related Behaviors. *Note:* DUI-A = Driving under the influence of alcohol; DUI-C = Driving under the influence of cannabis; DUI-SAM = Driving under the influence of SAM; RWI-A = Riding with a driver under the influence of alcohol; RWI-C = Riding with a driver under the influence of cannabis; RWI-SAM = Riding with a driver under the influence of SAM; all impaired driving-related behaviors assessed for the past 30 days; SAM = Simultaneous alcohol and cannabis. Models 2–4 provide weighted AOR additionally controlling for sex assigned at birth, geographic region, and race/ethnicity, age, college status, work status, and urbanicity. Bolded associations are significant at *p* < .05. * 95% CIs for this association are 1.001, 1.07.